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Comparative Study of Verbal, Numerical and Reasoning Aptitude among Engineering students

Richa Mandovra
Research Scholar,
Devi Ahilya Vishwavidyalaya, Indore

Dr Saroj Kothari
Professor & Head (Psychology)
Government MLB Girls PG College,Indorere

ABSTRACT

The present study aims to compare the verbal, numerical and reasoning aptitude between students of mechanical engineering and information technology branches. These three aptitudes are usually used to determine the eligibility of any engineering student for job in a company or further studies, i.e. any career. Hence, this comparison can help us understand if there is any difference between the students of these two streams w.r.t. these areas of aptitude, and magnitude of the difference, if any. It will also give a clearer picture of the overall aptitude of engineering students so that appropriate trainings and guidance can be provided to them. **DBDA (David Battery of Differential Abilities)** was used to determine the aptitude. The three subsets of **DBDA- Verbal Ability, Numerical Ability and Reasoning Ability** were administered on the 91 engineering students studying in the fifth semester of a private engineering college in Indore. The results showed that IT students had higher abilities as compared to mechanical engineering students in all three areas. However, overall, both streams showed average to poor aptitude in all the three areas.

Keywords: mechanical engineering, IT engineering verbal aptitude, numerical aptitude, reasoning aptitude

Introduction

What is Engineering?

Engineering is the application of scientific knowledge to solving problems in the real world. While science (physics, chemistry, biology, etc.) allows us to gain an understanding of the World and the Universe, Engineering enables this understanding to come to life through problem solving, designing and building things.

Engineers can be distinguished from other professions by their ability to solve complex problems and implement solutions in cost effective and practical ways. This ability to face a problem, work through various thoughts and abstract ideas and then translating them into reality is what is so exciting about engineering.

There are many branches and fields within engineering. A few are Civil, Chemical, Mechanical, Electrical& Electronics, Telecommunication, Information Technology (also known as Computer Engineering), Production, Instrumentation etc.

Engineering studies in India

The British started engineering education in India by setting up four engineering colleges in the four corners of India i.e. Roorkee, Sibpur, Guindy and Pune to train the engineers needed for the civil and other engineering activities (Subbarao,2013) . The enrolment for these four engineering colleges was 608 students per year during 1884–85. Each had a glorious record, having produced some of the outstanding engineers of India. After this two other prominent institutions were set up nearly 100 years ago one was Indian Institute of Science by the House of TATA and Banaras Hindu University (BHU) by Pandit Madan Mohan Malaviya, who grew as to become institutions of national importance. After independence, there were only 24 engineering degree colleges with a total intake capacity of 2570 students. Around 1950 to 1960 five IITs were established as institutions of national importance by an Act of Parliament. As per AICTE, presently there are 6472 engineering colleges all over India, having around 30 lac students.

Students aspiring to take admission in engineering colleges in India have to appear in entrance examinations after class 12th. These exams test logical reasoning and mathematical aptitude of the candidates. Depending on the ranks in the exam, they get the option of the stream they wish to take in the college. It is a 4 year course spread over eight semesters of rigorous theoretical and practical classes and trainings.

Mechanical engineering and Information Technology

Mechanical Engineers

Mechanical engineering is a discipline of engineering that applies the principles of physics and materials science for analysis, design, manufacturing, and maintenance of mechanical systems. It is the branch of engineering that involves the production and usage of heat and mechanical power for the design, production, and operation of machines and tools. It is one of the oldest and broadest engineering disciplines. Mechanical engineers today are pursuing developments in

fields such as composites, mechatronics and nano technology. Mechanical Engineering overlaps with aerospace engineering, civil engineering, electrical engineering, petroleum engineering and chemical engineering to varying amounts.

The engineering field requires an understanding of core concepts including mechanics, kinematics, thermodynamics, materials science, and structural analysis. Mechanical engineers use these core principles along with tools like computer-aided engineering and product lifecycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, transport systems, aircraft, watercraft, robotics, medical devices and more.

IT Engineers

Information Technology is an engineering division, which concentrates on the study of utilizing computers and telecommunications in order to control, gather, store and circulate information. Both software and hardware sectors are parts of Information Technology.

The curriculum for Information Technology Engineering is primarily designed to provide students with both the theoretical knowledge and technical skills. It also enables the aspirants to solve various complex problems. The curriculum also intends to improve a technological depth of knowledge and skills in analysis, design, implementation, and use of both information technology core skills and specialization skills. The students are also taught various fundamental concepts including information security, web systems, computer networking and software engineering.

Mechanical engineering and computer science certainly share many of the same intentions and problem-solving processes, if in different dimensions. However, this is where many of their similarities end. They must nurture different skills and knowledge, for example, and that affects their education. A mechanical engineer might be able to design some of the hardware upon which computer scientists rely, but only the latter can typically put those components to practical use. The reverse is also true.

What are Abilities?

The abstract and numerical reasoning, numerical computation and verbal abilities are the basic foundations of knowledge that need reinforcement to establish confidence and intellectual prowess among the students. Students must not only be given enough knowledge and skills for

them to become successful but also enhancing their character and values will make them more unbeatable (Laguador & Pureza, 2013).

Verbal Ability (VA)

Verbal ability refers to the comprehension of words and ideas, or a person's ability to understand writing language. It is one of the most important human ability.

Numerical Ability (NA)

Numerical ability refers to facility in manipulating numbers quickly and accurately, in tasks involving addition, subtraction, multiplication, division, squaring, dealing with fractions etc. Numerical ability is distinct from both reasoning mathematical knowledge and is about fluency in fundamental number operations. In combination with the verbal ability score, it is a good measure of general learning ability.

Reasoning Ability (RA)

Reasoning ability refers to the ability to apply the process of induction or to reason from some specific information to a general principle. Reasoning ability is important to success in many areas particularly those that stress logic, such as courses and occupation in mathematics or related pursuits, computer programming, engineering, sciences and scientific technology.

Review of Literature

There are many studies about the verbal, numerical and reasoning aptitudes of engineering graduates. There are two main areas that these studies focus on. First is the level of abilities and their relationship with academic performance. Second area is the employability of engineering students. It has been seen over the years that most engineers in India and even other countries are unemployable for any industry because of poor levels, or the lack of these abilities. The main aim of most engineering students is placement in a good company. However, they lack the basic skills for the same.

Wood and Payne have proposed 12 items as basic criteria for competency-based recruitment and selection as communication, flexibility, achievement orientation, developing others, customer orientation, problem solving, teamwork, analytical thinking, leadership, relationship building, planning skills and organizational skills.

In a survey completed by the American Society of Mechanical Engineers (ASME), 52 percent of mechanical engineering department heads considered the written and oral communication skills of their mechanical engineering graduates to be strong, while only 20 percent considered these skills to be weak. Unexpectedly, a parallel survey of industry

representatives found almost opposite results, with only 9 percent considering the communication skills of recent mechanical graduates to be strong and 52 percent considering those same skills to be weak. Hence, there is a disparity between the language skills of engineering students and what industry expects the students to know. Situation in India is no good either. Aspiring Minds, a big HR firm in India conducted India's employability study of technical graduates based on the results of a standardized computer based test called AMCAT conducted for more than 40,000 engineering students across the country. They covered all objective parameters for adjudging employability including English communication, quantitative skills, problem-solving skills and computing and programming skills. The findings of the study are summarized as average 17.84% employability of engineering graduates in the specific sector however with regard to IT product companies is as low as 4.22% (amongst computer/electronics related branches). KPOs find only 9.47% technical graduates employable and employability with regard to BPOs and Technical Support Jobs (TSJ) is 38.23% and 25.88% respectively. This leaves a total of 61.77% students who have poor aptitude and hence require training in both language skills and problem-solving skills to be eligible for any job in the industry.

National Spoken English Skills report of 2015 by Aspiring minds also states that of the six hundred thousand engineers that graduate annually, only 2.9% candidates have spoken English skills (SES) for high-end jobs in corporate sales/business consulting. These candidates show capability to understand and speak English fluently to both natives and non-natives with ease. Around 3/4th engineers do not have SES required for any job in knowledge economy. This signals that there is a need for higher emphasis on English.

National Employability Report of 2016 by Aspiring minds also states that in 2014 employability of engineers was only 18.43% of engineers were employable for the software services sector, 3.21% for software products and 39.84% for a non-functional role such as Business Process Outsourcing. Unfortunately, in 2016, these numbers stand at: 17.91%, 3.67% and 40.57% respectively for IT Services, IT Products and Business Process Outsourcing.

Hence it is evident as to how aptitudes in these three areas are crucial for any engineer. Further Reasoning ability as a major part of critical thinking shows its effect on general knowledge, therefore, it can be concluded focuses on reasoning ability will lead to improve critical thinking and as a results enhance cognitive ability and higher order thinking (Kyllonen & Christal, 1990). Concluding or making logical decision is the other part of thinking critically and as we know, thinking is a complex process and entails to make logical decision or rational conclusion.

Velea and Lache, (2015) asserted that the better conclusion or decision will make up when person used dedicated algorithms combined with the proposed selection method, and that means logical technique have more effect on concluding logically. Analysis of various studies indicated positive impacts of critical thinking on arising academic achievement (e.g., Wang, Pascarella, Laird, & Ribera, 2015; Tiruneh, Verburgh, & Elen , 2014; Chan, 2013; Boghossian ,2006; Fleming, Garcia, & Morning , 1995). Some studies demonstrated positive effect of reasoning and its relation to academic achievement. For example, involving fluid reasoning may provide foundation for academic achievement when students are in early education stages (Pasnak et al., 2015). Another study indicated proportional reasoning strategies can be suitable instruction to influence academic achievement (Kwean, 2011). In a study by Wilkinson, (1993) stated that boys showed strengths visual spatial reasoning ability compare with girls, and girls showed strengths sequential and social reasoning ability in compassion with boys, regarding to functions of academic achievement.

According to Najar (2002) "communicative competence, including teamwork and professional writing skills for example, the ability to research, write and format basic research reports as well as develop formal oral presentation skills is important to prepare students for both academic success and the workplace."

Hence we can see that nearly all studies focus on these three abilities as important for success. However, they focus on either one stream of engineering or engineering in general. There is a need for studies that specifically compare two branches of engineering on these three abilities to ascertain the difference between the students of different streams so as to understand the specific trainings to be imparted and skills to be developed for each of them.

Objectives of the study

1) To compare the verbal aptitude of students of Mechanical Engineering and Information Technology.
2) To compare the numerical aptitude of students of Mechanical Engineering and Information Technology.
3) To compare the reasoning aptitude of students of Mechanical Engineering and Information Technology.

Hypothesis

H_0 1: There will be no significant difference between students of IT and ME streams towards verbal aptitude.

H_0 2: There will be no significant difference between students of IT and ME streams towards numerical aptitude.

H_0 3: There will be no significant difference between students of IT and ME streams towards reasoning aptitude.

Methodology

Sample:

Students of 5th semester of Mechanical Engineering and Information Technology streams (B.E.) of a reputed engineering college of Indore were a part of this study. There were 91 students enrolled in these two streams.

Tool used:

DBDA [David's Battery of Differential Abilities] is a test for measuring an individual's abilities in eight different areas. It has high predictive validity. There are eight sub-tests Verbal Ability (VA), Numerical Ability (NA), Spatial Ability (SA), Closure Ability (CA), Clerical Ability (CL), Reasoning Ability (RA), Mechanical Ability (MA) and Psychomotor Ability (PM), each designed to measure a single primary ability factor and it is important in industrial settings and career and vocational counselling. Age range 13.5 to 30 years.)

Abilities measured in DBDA

Verbal Ability

Verbal ability refers to the comprehension of words and ideas, or a person's ability to understand written language.

Numerical Ability

Numerical Ability refers to ability in manipulating numbers quickly and accurately, in tasks involving addition, subtraction, multiplication, division, squaring, dealing with fractions etc.

Reasoning Ability

Reasoning ability refers to the ability to apply the process of induction or to reason from some specific information to a general principle.

Spatial Ability (SA)

Spatial ability is concerned with perceiving spatial patterns accurately, and following the orientation of figures when their position in a plane or space is altered.

Closure Ability (CA)

Closure ability is primarily a perceptual ability measured by the DBDA. It refers to the ability to see quickly a whole stimulus when parts of it are missing, or to "complete the gestalt".

Clerical Ability (CL)

Clerical ability is perceptual activity primary concerned with making rapid evaluations of features of visual stimuli.

Mechanical Ability (MA)

Mechanical ability refers to an understanding of basic mechanical principle, simple machines, tools, electrical and automotive facts.

Psychomotor Ability (PM)

Psychomotor ability refers to precise movements requiring eye- hand coordination under highly speeded conditions. Psychomotor ability can be considered one of fine- muscle dexterity, primarily manual.

The scores in all eight areas are on scale of 1 to 10, where 1 is the lowest and 10 is the highest.

The study focuses on three abilities- verbal, numerical and reasoning as they are generally considered the predictor of academic as well as professional success

Techniques used

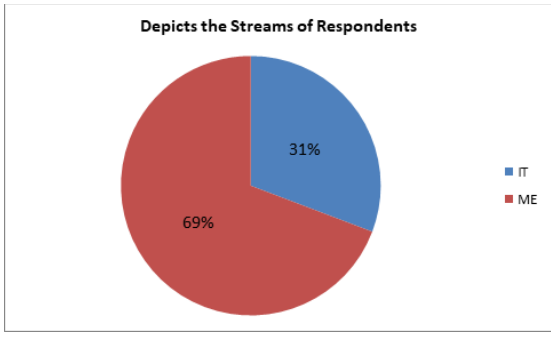
t-test for used to compare the aptitude values of both the groups.

Results and discussion

A. Demographic:

There were 91 students of engineering participated in the study. Out of these 91, 28 were from Information Technology(IT) stream and remaining 63 were from Mechanical Engineering(ME) stream.

Figure 1: Depicts the Streams of Students



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A. Inferential:

H_0 1: There will be no significant difference between students of IT and ME streams towards verbal aptitude.

Figure 2: Mean of Verbal Aptitude Score

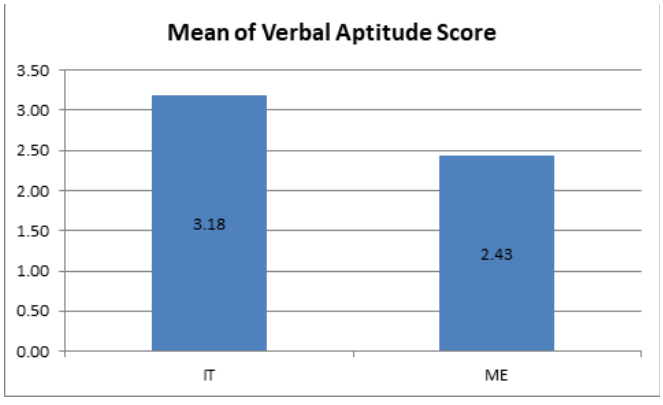

Table 1: t-test between the students of IT and ME w.r.t. Verbal Aptitude

Aptitude	Stream	N	Mean	Std. Deviation	t	df	p-value
Verbal	IT	28	3.18	1.442	2.618	89	.010
	ME	63	2.43	1.174			

The above table 1 shows that the p value is .010 which is less than .05 indicates there is significant difference in verbal aptitude of the students of IT and ME at 5% of significance level. The mean also indicates that the verbal aptitude of IT students is better than ME students.

H_0 2: There will be no significant difference between students of IT and ME streams towards numeric aptitude.

Figure 3: Mean of Numeric Aptitude Score

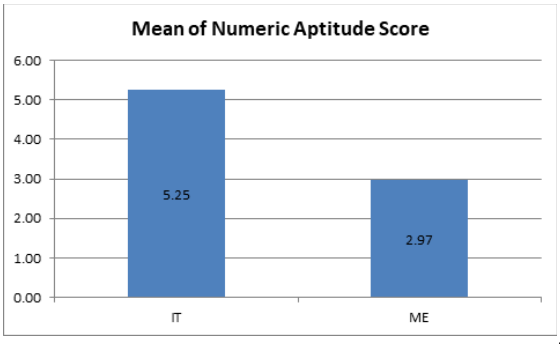

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Table 2: t-test between the students of IT and ME w.r.t. Numeric Aptitude

Aptitude	Stream	N	Mean	Std. Deviation	t	df	p-value
Numeric	IT	28	5.25	1.323	7.812	89	.000
	ME	63	2.97	1.270			

The above table 2 shows that the p value is .000 which is less than .05 indicates there is significant difference in numeric aptitude of the students of IT and ME at 5% of significance level. The mean also indicates that the numeric aptitude of IT students is better than ME students.

H_0 3: There will be no significant difference between students of IT and ME streams towards numerical aptitude.

Figure 4: Mean of Numeric Aptitude Score

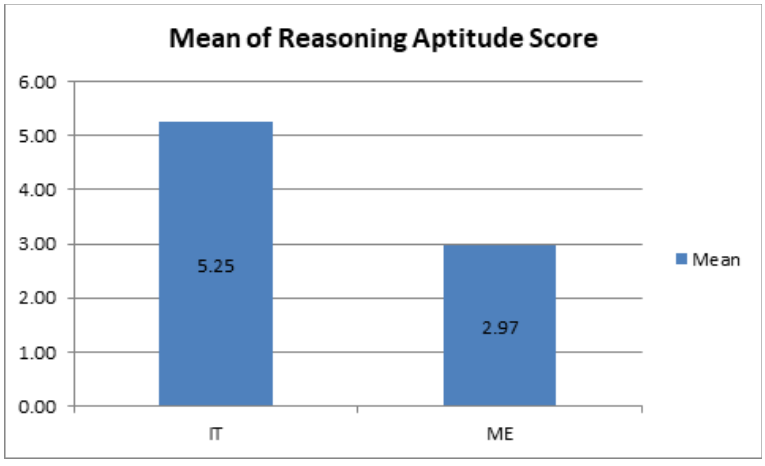

Table 3: t-test between the students of IT and ME w.r.t. Reasoning Aptitude

Aptitude	Stream	N	Mean	Std. Deviation	t	df	p-value
Reasoning	IT	28	5.11	2.132	2.523	89	.013
	ME	63	3.81	2.320			

The above table 3 shows that the p value is .013 which is less than .05 indicates there is significant difference in reasoning aptitude of the students of IT and ME at 5% of significance level. The mean also indicates that the reasoning aptitude of IT students is better than ME students.

Finally, it concludes that there are significant differences in all three aptitudes (Verbal, Numeric and Reasoning) between IT and ME students. And it also indicates that the score of IT students are more than the score of ME students in all three aptitudes.

Discussion and Conclusions

- This study focused on comparisons of the various aptitudes among two engineering streams, mechanical, which is considered a conventional branch and IT, which is a comparatively new branch in engineering colleges.
- The students of IT stream fared well on all the three aptitudes as compared to mechanical engineering students. This is also expected as it is usually seen that students scoring high ranks in engineering entrance examinations choose to study IT and lower rank holders get mechanical engineering. Hence we can see the difference in aptitudes of students of both the specializations.
- The difference is more pronounced in numerical and reasoning abilities rather in verbal ability which is expected as IT students perform better in the entrance exams that also test these abilities only. In verbal ability, the difference is less.
- The three abilities that were compared in the study are the ones that are usually considered important by most big companies while recruiting engineers for various jobs. Hence, a difference like this implies that most mechanical engineering graduates lose the opportunity to work in good companies, whereas IT graduates get all the good jobs on campuses.
- One important result is that the mean of numerical and reasoning aptitudes for both streams is less than 5.5, i.e. just average. Verbal aptitude is even less than 4, which is poor. It a reflection of the present state of employability of the engineering graduates, which is also evident from many previous researches and surveys.
- These levels of aptitudes pose an alarming situation. Colleges and even schools need to take corrective measures urgently. Schools must encourage students to focus on practice and conceptual clarity more than just good marks. Colleges should have stricter admission processes and not just focus on minting money by indiscriminate admissions. Regular trainings should be imparted to students in all the three fields.

DELIMITATIONS AND SUGGESTIONS FOR FUTURE WORK

Limitations and constraints:

- Students of only one private engineering college of Indore were included in the study.

- Many students in fifth semester start preparation for examinations like CAT, GATE, GRE which might have affected their responses.
- The effect of other factors like socioeconomic status was not excluded.

Suggestions for future work:

- More colleges, including government colleges can be included in the survey to get better sample.
- Students of other streams should also be included.
- Other abilities should also be assessed to get a better picture.
- The study can be conducted over longer duration.
- The role of other factors like gender of the student, socioeconomic status etc can also be assessed.

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