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A Scale for Measuring Motivation to Learn Engineering in the Indian Context: Developed by Adopting and Modifying Science Motivation Questionnaire II (SMQ II)

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This study introduces a 14-item scale designed to assess motivation for learning engineering, adapted and modified from the Science Motivation Questionnaire – II (SMQ – II) developed by Glynn et al. for evaluating motivation in science education. The items were carefully crafted considering both the English proficiency of students and the unique context of the Indian educational landscape. Data gathered from a sample of 1698 engineering college students, drawn from various institutions, was divided into four sets. The first set (N=500) underwent Exploratory Factor Analysis, while the second set (N=500) was utilized for Confirmatory Factor Analysis. The third and fourth sets were employed for scale comparison with SMQ II and for validation purposes, respectively. Contrary to initial expectations, the Exploratory Factor Analysis revealed a three-factor structure, namely Expectancy, Value, and Grade Importance, elucidating the underlying contributory processes of motivation for Indian engineering students. The high Cronbach's alpha value of 0.827 attests to the scale's reliability and the items' robust internal consistency. The Confirmatory Factor Analysis yielded compelling goodness-of-fit statistics (RMSEA = 0.07; CFI = 0.94; GFI = 0.89; SRMR = 0.067), indicative of an excellent model fit and providing evidence of the construct validity of the questionnaire. The positive correlation between the scores of the developed scale and those of SMQ II further supports its validity. Additionally, an inverse correlation between the developed scale and depression scores adds further validity evidence. This test is anticipated to serve as an effective tool for educators and educational institutes in India to develop and implement strategies aimed at enhancing motivation for learning engineering among students.

Keywords: Motivation, Engineering students, Indian context, scale development

Engineers play a vital role in designing, building, and maintaining the infrastructure and technology that drives economic growth and development. In India, where there is a high demand for skilled engineers, a strong engineering education system is necessary to produce a sufficient number of qualified professionals who can meet this demand. While the number of educational institutions providing Engineering, degrees have increased exponentially in last few years, the poor motivation of students to learn Engineering is a key issue that institutes are struggling with.

As such, Engineering education is a popular choice for students in India and is known for being a preferred option over other available career paths because it has a high probability of employment. According to data from the All India Council for Technical Education (2021), engineering was the most preferred field of study among undergraduate students in India in 2020-2021, with over 1.5 million students enrolled in engineering programs. The explosion of the IT industry in India and the attractive salaries offered by IT companies have resulted in a rush of individuals pursuing careers in engineering and the IT field, regardless of their personal interests or aptitudes.

Despite Engineering being a popular career choice among students in India, their motivation to learn the subject after enrolling in a graduation course can vary. Students face various challenges that can affect their motivation. Educational institutions lack the expertise and tools to measure and manage this motivation. Moreover, the current constructs for measuring motivation are not tailored to the Indian culture and educational system. On this background, this article presents a new, validated assessment tool specifically developed for measuring motivation to learn Engineering among Indian students.

Extending the definition of Motivation to learn science given by Glynn and Koballa (2006), motivation to learn engineering can be defined as an internal state that arouses, directs and sustains Engineering learning behaviour. It is an important topic in education, as it can have a significant impact on students' academic performance and overall success in career (Steinmayr et al., 2019). A number of researchers have studied the psychological factors that contribute to motivation to learn science, and have developed various assessment tools to measure it (Lee and Brophy, 1996, Pintrich et al., 1993, Wolters, 2004).

Pioneering research on motivation by Deci and Ryan (1985), laid the foundation for Self-Determination Theory (SDT) and its associated scale for measuring student autonomy in academic pursuits. SDT posits that there are two main types of motivation: intrinsic and extrinsic. It also suggests that three basic psychological needs drive individuals: autonomy, competence, and relatedness. Building upon SDT, other researchers have explored the influence of specific motivational beliefs on engagement to suggest that individuals are more likely to be motivated when they feel competent and in control of their learning environment (Milyavskaya and Koestner, 2011; Lombas and Esteban, 2018). Furthermore, Eccles and Wigfield's (2002) noteworthy study on science motivation employed a self-report questionnaire to gauge students' internal perspectives. This questionnaire assessed factors such as perceived importance of science, science-related goals and values, and self-perceived science ability.

Other assessment tools that have been developed to measure motivation for educational attainment include one developed by Cham H. et al (2014), the Science Motivation Questionnaires I (SMQ- I) (Glynn et al., 2006) and II (SMQ II) by Glynn et al. (2011). These measures assess a variety of motivational factors, including interest in science (applicable for assessment to measure motivation to learn science), curiosity, grade motivation and the value placed on science. However, we did not come across any attempt to adopt these scales or develop new assessments to measure motivation in Indian context.

There have been a few studies of measuring motivation in Indian Adoloscents e.g. study of Socially disadvantaged students in Kashmir, by Fayaz et al. (2022), comparative study by Areepattamannil S. et al. (2011) or by Mahdi et al. (2010) for medical career but none of them is specifically for Engineering students and for developing an assessment.

Indian Context of motivation to learn engineering:

From Psychological perspective there are several factors that are specific to India and contribute differently to students' motivation to learn Engineering.

1. In India, there is a huge disparity between IT companies and non-IT companies in terms of jobs availability,

working environment and also in the salaries offered to employees. This leads many students to opt for engineering, often against their own interests, influenced by the perception that an engineering degree is essential for a successful and well-paying career. Social pressure, parental expectations, and peer influence further contribute to this trend, with many students feeling compelled to pursue engineering due to widely held beliefs. The motivation to learn is significantly influenced by whether the student personally desires to pursue engineering, a critical factor in their overall motivation.

2. The choice of branch within engineering also plays an important role in motivation, as branches related to computer science are often preferred by IT companies when recruiting students. As a result, students may feel compelled to choose computer-related branches, regardless of their own interests. Unfortunately, there are also many cases where students who aspire to pursue computer-related branches are unable to do so due to limited seats, leading to de-motivation. Or they get admission into a college where the campus recruitment does not take place. This particular category is huge in numbers because most students in this category assume that they have missed the bus of a successful life for ever and get demotivated. Both of these scenarios can significantly impact student motivation.

3. Transition of learning Environment: The other important factor that directly impacts the Motivation of students while learning Engineering is a significant change in teaching and learning environment due to the transition from high school (upto 12th grade) to engineering education system. The differences are primarily in terms of teaching style, assessment framework, language of teaching, curriculum, peer groups etc. The effect of this transition on students' motivation and performance may vary when they pursue engineering education.

4. Migration of students away from their homes: Many Engineering colleges in India are located in urban or semi-urban areas, which can result in students from rural areas having to relocate and adjust to a new environment. Students from urban areas may also migrate to other urban areas or metro cities to attend colleges that are highly reputable and preferred by IT companies for campus recruitment. These migrations often lack adequate housing and food facilities, which can negatively impact the mental health of students thereby impacting their motivation to learn.

5. Hormonal Changes in students: While this phenomenon is well known and may hold across the regions and races it will have it's peculiar impact in Indian context. The hormonal changes are coupled with physical and emotional changes in students making them more vulnerable to psychological issues which has direct impact on the motivation to learn.

6. Socio-economical aspects: A large number of students from low-income groups and low merit (approximately 30 to 40 percent) are able to secure the admission to engineering due to various social schemes and concessions given by government. They experience a huge challenge to cope up with the professional education system like engineering which demands high level of capabilities. This has a direct impact on their motivation to learn.

Based on the information discussed above, it is clear that the factors that influence motivation to learn engineering in Indian students differ significantly from those of their Western counterparts, and a specific scale tailored to the Indian context is needed to accurately measure this motivation.

Method

Participants

The study was conducted across three urban engineering colleges situated in the State of Maharashtra, India, spanning a period of six months. Students of first year engineering were gathered in batches of approximately 250 students for a mental health awareness program. Following the awareness session, participants were briefed on the objectives of the study. A strong emphasis on the confidentiality of their data was conveyed, assuring participants that their responses and test scores would remain private, with no impact on their academic grades or ranks. A special appeal for honesty in responses was also made. Subsequently, students were given the option to choose not to participate, ensuring the quality of the collected data. No monetary incentive was given to students for participating in this exercise.

Participants who volunteered to complete the questionnaire were administered it online through a Google form. The form comprised three sections: the initial section outlined the study's objectives, obtained participant consent, the second gathered demographic information, and the third included the developed questionnaire along with validation questionnaires, as needed. Responses obtained from the Google form were meticulously collected and organized in an Excel sheet for subsequent analysis. In total, 1698 students submitted questionnaire responses, with 1231 (72.5%) being male and 467 (27.5%) females. Within this group, a subset of 106 students received both the developed questionnaire and SMQ – II, (where the only alteration involved replacing the word 'science' with 'engineering'). Additionally, all 1698 students underwent administration of the Patient Health Questionnaire -9 (PHQ – 9) (Kroenke and Spitzer, 2002) depression scale to validate the results of the developed scale through an independent measure.

Questionnaire development

The Science Motivation Questionnaire II (SMQ - II), developed by Glynn et. al. (2011) was modified to construct a measure for Motivation to Learn Engineering. The selection of SMQ – II as the foundation for our assessment was based on following considerations:

a. Validation and Global Applicability: SMQ – II has undergone extensive validation in numerous studies worldwide (Salta and Koulougliotis, 2015; Zhdanov et al., 2022)

b. Alignment with Engineering Education: SMQ II, designed to assess motivation in the context of science education, was deemed closely related to engineering subjects.

c. Multi-Factor Structure: SMQ II comprises five factors measuring various facets of motivation to learn science, namely (1) intrinsic motivation, (2) Career Motivation (3) self-determination (4) self-efficacy and (5) Grade Motivation. This structured approach, along with average scores for each factor, facilitates educational institutes in formulating strategies to enhance overall student motivation.

Our adaptation retained the response scale of SMQ II that is, (0) Never, (1) Rarely, (2) Sometimes, (3) Usually, and (4) Always, allowing for comparability and validation.

Modification of Items in the Questionnaire

The SMQ II, which has 25 items, was shortened to 15 items as part of our objective to create a concise and pertinent scale. The reduction in the number of items was strategic, aimed at streamlining the instrument for improved usability. Items perceived as redundant in SMQ II, such as "Understanding Engineering will benefit me in my career" and "Knowing in Engineering will give me a career advantage," OR "I prepare well for Engineering tests and labs" and "I study hard to learn Engineering" etc. were omitted to the length of the questionnaire.

Another crucial adaptation involved making our items more elaborate. This decision stemmed from insights gained in a preliminary survey using the original English version of SMQ II. The survey revealed that students often struggled to grasp the context of certain items, resulting in imprecise responses. For example, an item in SMQ II, "I am curious about discoveries in Engineering," was deemed too generic. To address this, we reformulated it as, "When I look at human life today, among various disciplines like Social Sciences or other fundamental sciences, the discoveries in Engineering look most exciting to me."

Additionally, new items were introduced to explore factors specifically relevant to the Indian context and the dynamics of the current education system. For instance, to gauge career motivation, we included the item, "Looking at the situation in India today, an Engineering degree is the best first step in developing a career." Recognizing the significance of projects in engineering education, an item was crafted to assess students' confidence in turning innovative ideas into unique projects within the college.

Exploring self-determination, a question was included about abstaining from the use of social media a week before and during examinations. In the context of intrinsic motivation, an item probed whether students would have chosen the same engineering branch if financial considerations were not a factor and if admissions were open to their preferred branch.

Given the constraints and competition in engineering admissions, a common parental approach is to prioritize prestigious colleges and /or computer science related branches, sometimes disregarding the student's preferred engineering branch. We therefore had initially considered an item to investigate whether students independently chose their engineering branch however it was eventually dropped during exploratory factor analysis.

The final questionnaire, comprising 14 items, underwent rigorous scrutiny by two independent experts with extensive experience in developing similar assessments, particularly in the domain of motivation within the field of psychology. Considering the English proficiency challenges faced by engineering students, we provided item translations in the local language (Marathi) in parentheses, following the standard practice of back translation. This not only ensured clarity in understanding the questions but also alleviated concerns associated with responding to an English-only assessment.

Table 1. Details of four data sets used in statistical analysis and their objectives

Data Set	Number of participants	Males	Females	Objective of analysis
Set 1	500	361	139	Exploratory Factor Analysis
Set 2	500	343	157	Confirmatory Factor Analysis
Set 3	106	60	46	Comparison with SMQ II
Set 4	1698	1231	467	Validation through simultaneous administration of developed Questionnaire and PHQ 9 Depression scale.

Results

We derived four sets of data from a pool of 1698 students for the purposes of statistical analysis, as outlined in Table 1. Data Set 1 and Data Set 2 were randomly selected from the pool of 1698 and utilized for Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), respectively. The statistical analysis was conducted using Statistical Program for the Social Sciences, version 22.0 (SPSS, Inc.).

Exploratory Factor Analysis

Exploratory factor analysis (EFA) is designed for scenarios in which the correlations between observed and latent variables are unclear. In our study, we employed EFA to scrutinize students' responses, aiming to unveil the factor structure of the developed questionnaire. The outcomes of the factor analysis are presented in Table 2, revealing a three-factor structure as derived from the EFA.

Adequacy of Correlation Matrix of Items: We computed correlations for all pair-wise combinations of the 14 items and determined that the resulting matrix of correlations was appropriate for factor analysis by means of a Bartlett's test of sphericity, ÷^{2} = 1715.16, df = 91 and a Kaiser–Meyer–Olkin measure of sampling adequacy, KMO = 0.852. These tests of multivariate normality and sampling adequacy indicated that the matrix was of good quality.

Factor Extraction

To extract factors, we performed a principal axis factoring on the items which uses eigenvalues and the proportion of variance accounted for by the factors. Eigenvalues indicate how strongly particular items are related to particular factors. Using the Kaiser–Guttman rule, we identified three factors that had eigenvalues greater than 1, indicating that they accounted for significant amounts of the total variance in the items. Together, these three factors accounted for 50.42% of that variance, which is reasonably good. We examined potential factors by plotting them against their eigenvalues in descending order of magnitude (Please see the screen plot given in Figure 1) to identify breaks in the slope of this plot. The scree plot too supported the 3-factor solution obtained using the Kaiser–Guttman rule.

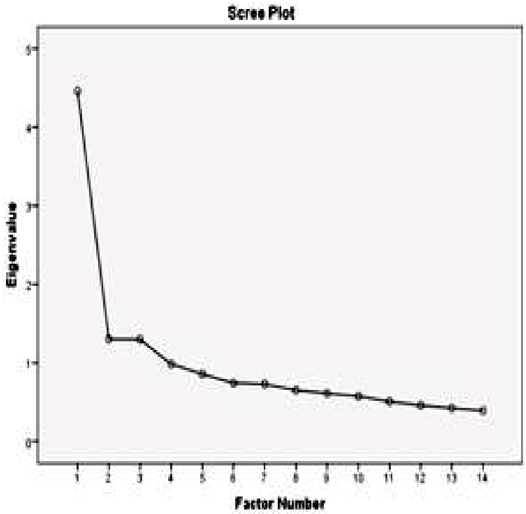

Figure 1. Screen plot of Factors and their Eigen Values. The breaks in the slope of the scree plot supported the 3-factor solution.

Factor Rotation

The three factors were rotated, turning their reference axes about their origin and the rotation converged in 8 iterations. We used a Varimax with Kaiser Normalization rotation method to produce what is called a simple structure that facilitates interpretation.

Factor Loadings and Factor Interpretation

The factor loadings, presented in Table 2, demonstrate that all items (highlighted in boldface) met the criterion of loading at least 0.35 on their corresponding factors. Table 3 provides the eigenvalue and percentage of variance explained by each factor. The cumulative percentage of variance explained by the three factors amounted to 50.42%.

Considering the characteristics of items and their categorization under a specific factor, the first factor (F1) was labelled as 'Expectancy', the second (F2) as 'Value', and the third (F3) as 'Grade Importance'. We will give more explanations of these factors in the next section.

Reliability: The Cronbach's alpha of all 14 items was 0.827 which falls in 'very good" category and indicates that the scale items have good internal consistency. The reliability of the Expectancy factor (F1) was found to be 0.782 (based on 7 items), and that of the Value factor (F2) was 0.701 (based on 5 items), both falling within the "very good" range. While this study did not delve into examining these factors as independent sub-scales, the reliability results suggest that their scores can be effectively employed to pinpoint areas in which students may need improvement and to develop the strategies accordingly.

Table 2. Exploratory Factor Analysis of Sample 1 (n = 500) : Factor loading of items. The loading values shown in boldface are all exceeding a criterion of 0.35 on their targeted factors.

	Factor		
	1	2	3
Item1	.391	.399	.089
Item2	.370	.448	-.095
Item3	.093	.404	.328
Item4	.180	.608	.128
Item5	.135	.691	.219
Item6	.437	.265	.163
Item7	.399	.107	.194
Item8	.514	.266	.034
Item9	.581	.185	.350
Item10	.523	.173	.219
Item11	.557	.076	.037
Item12	.139	.124	.703
Item13	.582	.127	.260
Item14	.262	.133	.586

Table 3. Exploratory Factor Analysis that explains the Total Variance of three factors.(Extraction method – Principal axis factoring)

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.457	31.837	31.837	3.846	27.469	27.469
2	1.303	9.308	41.144	.740	5.285	32.754
3	1.299	9.277	50.422	.699	4.994	37.748
4	.985	7.035	57.457			
5	.857	6.125	63.582			
6	.743	5.306	68.888			
7	.729	5.211	74.098			
8	.652	4.661	78.759			
9	.613	4.378	83.136			
10	.576	4.115	87.251			
11	.508	3.630	90.882			
12	.460	3.289	94.170			
13	.424	3.025	97.196			
14	.393	2.804	100.000			

Confirmatory Factor Analysis:

As part of the model building approach, we performed a confirmatory factor analysis, using Lavaan package of R software language, to test our measurement model. (Please see the outcome in Figure 2). To evaluate the model fit, we present the standardized root mean square residual (SRMR), comparative fit index (CFI), goodness-of-fit index (GFI), and root mean square error of approximation (RMSEA). Threshold levels considered acceptable were RMSEA < 0.08, CFI > 0.95, GFI around 0.90, and SRMR < 0.08 (Hu and Bentler, 1999). The obtained goodness-of-fit statistics were as follows:

RMSEA = 0.07, CFI = 0.94, GFI = 0.89, SRMR = 0.067.

These indices indicate an excellent model fit, providing substantial evidence of the construct validity. The positive correlations observed among the factors in Figure 2 suggest that the motivation components are mutually supportive.

Scale Validation

As mentioned in earlier section, to validate the developed scale, we created dataset 3 to compare our results with SMQ II, with the singular change that the word 'science' was replaced with 'engineering'. SMQ II has been used by others 17 in similar manner to measure motivation to learn the respective subject. The correlation between the total scores of these two assessments was found to be 0.55 showing a good correlation and confirming the validity of developed scale.

Further validation of the developed scale is evidenced through the outcomes of dataset 4 (refer to Table 1). Figure 3 presents the results depicting the variation in average motivation scores concerning the severity of depression. It is visible that as the severity of depression increases, the motivation of students declines. It is widely acknowledged that depression in students lowers their motivation to learn. Such effect is attributed to reduced perceived levels of energy, increased susceptibility to fatigue as well as reduced capacity to think or concentrate Thaper et al., 2012).

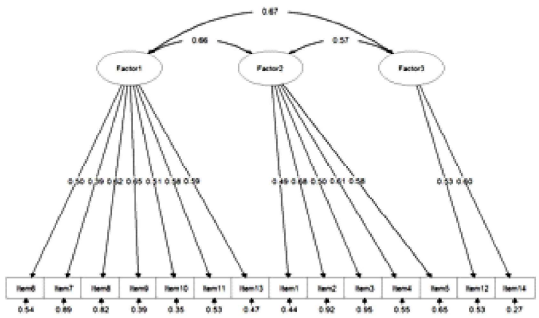

Figure 2. Confirmatory factor analysis using data set 2: Standardized factor loadings and correlations. Factor1 (F1) = Expectancy, Factor2 (F2) = Value and Factor3 (F3) = Grade Importance.

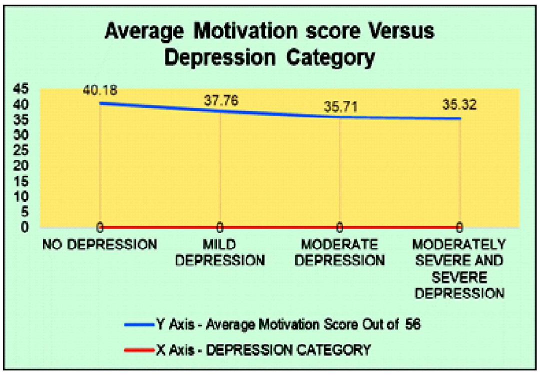

Figure 3. Variation of average scores of Motivation to Learn Engineering with the severity of depression (n = 1698)

Table 4. Gender wise data of Mean values of Motivation scores and it's factors.

	Male (N = 1231)	Female (N=467)	Overall (N = 1698)
F1 (Expectancy) MEAN out of 28	19.23	19.04	19.18
F2 (Value) MEAN out of 20	12.81	12.99	12.86

F3 (Grade Importance) Mean out of 8	6.35	6.76	6.46
Total Score Mean out of 56	38.38	38.78	38.49

Discussion

Our EFA provides insight into how students conceptualise their motivation while learning engineering. It is interesting to see that, the EFA analysis shows three factor structure in Indian context as against five factor structure of SMQ II. Two of these factors namely Expectancy and Value are clearly in line with Expectancy Value Theory. It is noteworthy that this result persists despite our efforts to align our questions with the five-factor structure of SMQ II (Glynn et al., 2011). Our results suggest that these five factors do not function distinctly within the construct. Our explanation of the observed factor structure in the developed questionnaire is as follows

Factors of motivation to learn Engineering:

Expectancy (F1)

If we do a closer examination of our items of F1, it becomes evident that items initially intended to explore self-determination and self-efficacy are contributing to a single factor that we term as 'expectancy'. This alignment aligns with the Expectancy-Value Theory (EVT) (Wigfield & Eccles, 2000), a framework we posit as elucidating the motivation to learn among Indian engineering students. As per EVT, the motivation to learn depends on whether or not an individual expects to be successful in performing various tasks or acquiring the required skills as part of learning process. It implies that, for these students, the belief in their own abilities (self-efficacy) and the sense of autonomy and control over their learning process (self-determination) may be interconnected and contribute jointly to their expectancy for success. In other words, for these students perceived control over their learning (autonomy) is deeply intertwined with their confidence in succeeding (self-efficacy). A study by Sheldon and Elliot (1999), found that individuals with higher levels of self-efficacy were more likely to engage in self-determined behaviour. Simultaneously, students with a heightened perception of control over their learning process naturally exhibit greater confidence in their potential for success. This intricate and interconnected relationship, which we term as intertwining, manifests as the emergence of expectancy as a singular factor structure in our Exploratory Factor Analysis (EFA). Moreover, it bears cultural nuances, such as the autonomy perceived by Indian students within a more closely-knit education system compared to their Western counterparts, who often experience autonomy through open education systems. Additionally, the pressure felt by Indian students to achieve success, as opposed to their Western counterparts, introduces another cultural dimension. However, these cultural assertions warrant in-depth investigation and experimentation for substantiation.

An item initially designed to assess grade motivation, specifically 'I develop my own strategies for studies as part of preparation for examinations,' exhibited a stronger loading on the 'Expectancy' factor rather than the 'Grade Importance' factor. The development of study strategies can be interpreted as an investment of mental effort by students, intrinsically linked to their desire for self-directed learning and constituting a core element of their autonomous behaviour, rather than being primarily motivated by extrinsic factors such as grades.

Value (F2):

Intriguingly, the Value factor (F2) presents a noteworthy observation wherein items originally intended to explore intrinsic motivation and career motivation have converged into a single factor, as opposed to maintaining distinctiveness. This convergence seems to reflect the influence of collectivism in Indian culture, where community values play a bigger role than individual preferences. As we explained in Section 3, Indian students are strongly driven to pursue an Engineering degree as the first step in their career. The cultural environment at home, in society, and at educational institutions emphasizes the importance of learning engineering from an early age, creating a strong belief that an engineering degree is crucial for a successful career and meeting everyone's expectations. In a collective culture, students tend to prioritize the well-being of their family, teachers, and society over their personal goals without realizing it. This makes it difficult to clearly separate intrinsic motivation (enjoying and being interested in learning for the own passion) from career motivation (seeking external rewards and meeting societal expectations). In the Indian context, this lack of pronounced distinction is in contrast to the findings of Glynn et al. (2011), whose experiments were predominantly conducted in a Western cultural setting. Due to this cultural influence, students may see personal satisfaction from engineering studies as closely connected to future career opportunities, making it hard to distinguish these motivations. This is why we observe a strong overlap between intrinsic and career motivations under the Value factor. While describing 'Value' portion of EVT theory, Wigfield and Eccles (2000) defined different components of achievement values: attainment value or importance, intrinsic value, utility value or usefulness of the task, and cost. Presuming that the cost (commitment of a few years for the degree) remains relatively consistent among students, our items have encompassed all three values outlined in the EVT: Attainment Value, which gauges the significance students attach to a career in engineering; Intrinsic Value, measuring the personal enjoyment derived from tasks that align with individual expectations (and family / societal influences in Indian scenario driven by a collectivist culture); and Utility Value, assessing the perceived usefulness of learning engineering in terms of long-term objectives or future perspectives.

Grade Importance (F3) :

The items exploring students' motivation in terms of their aspirations for grades or ranks are evidently forming a separate variable termed here as 'grade importance'. Considering that the factors identified through Exploratory Factor Analysis (EFA) are derived from the data structure rather than preconceived assumptions, the significance attributed to grades appears to wield its own influence on students' motivation to learn engineering, influencing their behaviour and performance. Glynn et al. (2011) too considered career motivation and grade motivation as two distinct factors though both are extrinsic in nature. Our factor analysis suggests that, for students, achieving good grades holds inherent importance. While it may be related to their overarching goal of securing a successful career, students perceive it as an integral aspect of their learning process and view it as a short-term objective.

The intense competitiveness within the Indian education system, coupled with the longstanding emphasis placed by parents on obtaining high grades since childhood, has conditioned students to consistently strive for higher grades. Though such insistence has multiple undesired implications and has been a point of discussion in Indian society (Desai and Sathiyaseelan, 2020), it does contribute to the motivation to learn in the Indian context. In general, students with higher grades receive heightened respect from parents, peers, and teachers, underscoring the crucial importance attached to grades. Furthermore, various opportunities, including the selection of elective subjects in Engineering, admission to advanced courses, preferences in campus placements, and choices of companies during job placements, are contingent on academic performance. Consequently, the motivation to attain higher grades emerges as a distinctive and pivotal component of overall motivation in the pursuit of learning Engineering.

Gender Variation of Motivation to learn engineering:

The average motivation scores for learning engineering, as presented in Table 4 for both males and females, indicate an overall average value of 38.5 (out of 56), with a standard deviation of 7.6. Notably, there is no significant difference observed between males and females. This finding holds particular interest, especially considering that in semi-urban and rural areas of India, girls often encounter secondary treatment in terms of educational support. However, the results demonstrate that these social factors have not notably impacted the motivation of female students to learn engineering after enrolment. Further examination of the data in Table 4 reveals that there is no discernible gender difference in the average scores of individual factors, namely Expectancy, Value, and Grade motivation. This suggests that developing distinct strategies for enhancing motivation in female students may not be necessary, as their motivation levels align closely with their male counterparts.

Conclusion

A 14-item scale for measuring motivation to learn engineering was developed by adopting and modifying Glynn et al's (2011) the Science Motivation Questionnaire – II (SMQ – II). The Exploratory Factor Analysis of the data revealed a three-factor structure; Expectancy, Value, and Grade Importance, highlighting the nuanced motivational processes that are distinctive to Indian engineering students. The robust reliability, as indicated by a high Cronbach's alpha of 0.827, and the exemplary model fit in Confirmatory Factor Analysis affirm the scale's validity. The positive correlation with SMQ II scores and the inverse correlation with depression scores add layers of evidence to its validity. This tool holds promise for educators and institutions in India, offering an effective means to tailor strategies and interventions aimed at fostering motivation to learn engineering among students.

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