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Analysis of learning outcomes of Civil Engineering students of Kerala state using dimension reduction Techniques

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Abstract**—**During the 90s engineering education system is transformed from output model to outcome based education system all over the world. To monitor the new education system as well as to assess the quality of engineering education various accreditation agencies like ABET, CEAB, NBA, EA, etc. were constituted at different parts of the world. Students who were graduated from accredited programs were considered competent graduates. The accreditation agencies measure the learning outcomes of engineering graduates in terms of knowledge, skill, and attitude. The knowledge domain is easy to measure and evaluated by the student's performance in exams, assignments, quizzes, etc. The psychomotor domain evaluates the body brain coordination of the student and the affective domain evaluates the attitude of students towards learning. In this paper, a survey instrument for the perception of psychomotor skills and affective skills by engineering students was presented. The validity and reliability of the survey instrument were confirmed by the exploratory and confirmatory factor analysis using SPSS software. The factor loading, average variance extracted and maximum shared variance values ensured the validity of the instrument. The reliability of the instrument was established from Cronbach's alpha value and composite reliability values. Once the questionnaire was validated the study was extended to a larger population of students and responses were presented in the paper.

Keywords**—**affective skill; competency; factor analysis; psychomotor skill.

JEET Category**—: Research, Practice**

I. INTRODUCTION

GLOBALIZATION brings forth opportunities for engineering graduates to work at multicultural and multinational levels. Along with technical knowledge, professional skills are very much essential for them to compete in the world market. Academia is giving importance to impart knowledge and to assess its cognitive levels. The knowledge domain measures familiarity, awareness, or understanding of course content. As the knowledge domain involves the cognition process, it is easily measurable and is evaluated from the academic performance of students at various levels of cognition like remember, understand, apply, analyze, evaluate and create as presented in Benjamin Bloom's book Bloom (1956) *Taxonomies of educational objectives. Vol1: Cognitive domain.* Examinations, assignments, quizzes, etc are used as tools for the assessment of knowledge for each course in the curriculum. Engineering graduates are expected to exhibit higher cognitive levels for all the courses in the curriculum. Analyze and higher levels of cognition involve critical thinking, attacking new areas of knowledge, and implementing an appropriate solution for a complex problem. These skills are dependent on the competency of engineering graduates and hence it can be used to assess their expertise in the knowledge domain.

In addition to the cognition process, the psychomotor domain, as well as the affective domain, are the other two pillars of the learning domains. The psychomotor skill domain Simpson (1971) measures the relationship between physical movement and cognitive function coordination of a student and the affective domain involved emotional and attitudinal engagement with the subject matter. The psychomotor skill assessment involved the combination of knowledge, speed, precision, application of various techniques in the execution and coordination of activities Hill (2018). As per Dave's taxonomy of learning Hoque (2016) psychomotor domain has five levels. They are imitation, manipulation, precision, articulation, and naturalization. The imitation level of psychomotor skills measures the ability to repeat a process as shown by another person. Manipulation measures the ability to present a process on hearing the instruction from another person or reading the procedure. The next level of psychomotor skill measures the ability to perform an activity precisely. Articulation measures the ability to coordinate previously experienced skills and apply them in a new situation. Naturalization measures the easiness exhibited by a student in doing an activity.

The affective domain assessment involved a combination of cognitive, behavioural, and feelings of students Hoque (2016). The different levels of affective domains are receiving, responding, valuing, organizing, and characterizing. Receiving measures, the ability to pay attention, willingness to hear, etc. Responding involves the measure of active participation in the learning process, valuing means the ability to see the worth of something and express it. Organizing is the ability to handle contradictory thoughts of concepts in the mind and arriving at a unique idea by comparing, relating, and synthesizing values. Characterization measures the personal, social, and emotional attitudes of students. The knowledge domain of students can be evaluated by conducting a written examination for a given question paper. Unlike the knowledge domain, the assessment of both the psychomotor domain and affective domain requires observation of each student in their academic activities especially in laboratories, project work, etc., and hence it is time consuming and difficult.

In this section observations from the studies related to the psychomotor and the affective domains are presented. Zaghloul (2001) presented an educational model, a three domain model (TDM) to analyse lab works. In the TDM model lab experience, brain body coordination, attitude towards the subject matter, education and lab activities, etc. were measured. The author presented an algorithm for assessing the safety, skill in aligning wiring layout, equipment handling, data observation, and report presentation during the conduct of laboratory experiments. The study was done for electrical engineering laboratory activities, which can later be extended to other disciplines also. Ferris and Aziz (2005) discussed the hierarchical taxonomy of psychomotor skills and presented them from the viewpoint of the need of engineers. The study presented hierarchical levels of knowledge, affective and psychomotor domain based on different taxonomies of learning like Blooms, Krathwohl and Dawson taxonomies. Later the author proposed a seven level hierarchy for psychomotor domain which enabled the evaluation of practical works to attain the desired program outcomes.

Rovai et.al (2009) presented the development and validation of self-report instruments used to measure learning in the cognitive, affective, and psychomotor (CAP) domains. The development and testing of survey instruments addressing CAP domains were explained in the paper. First, a survey instrument with 80 items was developed and 142 online and face-to-face responses were collected. The factor analysis reduced the items to 21 numbers in the second phase and further it was reduced to 9 items in the third phase. Bahorom et.al (2011) discussed the assessment of psychomotor skill assessment in teaching and learning process in concrete lab experiments. Quadrant analysis compared the results of cognitive and psychomotor performance of students and classified them into exam-based, technical-based, well-balanced and poor students. Kasilingam and Chinnavan (2014) discussed the behaviour of the learning domain and effective assessment of each learning domain which facilitates continuous quality improvement. The author explained different levels of knowledge, psychomotor and affective domain, and presented the assessment method for each type of them. He also presented the mapping of each assessment tool with the graduate attributes given by accreditation agencies and with the various levels of learning outcomes.

Ahankari et.al (2018) developed e-rubrics for the assessment of all learning domains, particularly related to the psychomotor and affective domain which provides continuous quality improvement. Since only a few courses were mapped to the psychomotor domain and affective domain, new assessment tools and formulae were used for the attainment of the program outcomes in the affective and psychomotor domain. The assessment of students' performance in labs, classrooms, industrial visits, workshop organized, projects, workshop attended, social activities participated and participation in various events/competitions etc. by direct online method and indirect offline method was also presented.

The majority of the literature discussed the generalized skills required for an engineering graduate. Studies on discipline specific competencies were rare in literature. So, this study aimed to discuss the psychomotor skill and affective skills developed in Civil Engineering graduates during his/her undergraduate engineering program. Students' responses to a self-evaluation questionnaire were presented in the study. A pilot study was performed with around 60 samples and the validity and reliability of the survey instrument were established by exploratory and confirmatory factor analysis. Later the survey is extended to 524 samples and results were presented.

II. THEORETICAL FRAMEWORK

In this paper development of a survey instrument for the assessment of psychomotor and affective domains was presented. First of all, a self evaluation questionnaire was developed for the psychomotor domain and affective domain of learning. The questionnaire was prepared based on the previous research and civil engineering curriculum of APJ AbdulKalam Technological University (APJKTU), Kerala, India. There were 21 items in the psychometric domain questionnaire and 41items in the affective domain questionnaire. The questionnaire is presented as appendix 1 and 2. The psychomotor domain questionnaire was intended to assess the student's involvement in laboratory activities, planning and drafting of civil engineering and structural drawing, selection of good quality material as per specification, testing of material quality and strength, usage of modern equipment and software, ability to perform setting out of building, etc. The affective domain questionnaire measured the student's confidence and attitude towards applying appropriate Civil Engineering knowledge whenever and where ever needed. It also measured soft skills like communication, decision making, leadership skill, teamwork, critical thinking, taking initiate, coordination, time management, dedication. determination etc, and social skills and ethical practices of engineering graduates. The study was focused on the Civil Engineering students of Kerala state, India. There were one hundred and twenty-four colleges in Kerala with Civil Engineering discipline affiliated to All India Council of Technical Education (AICTE). Of which two were state universities, twenty were government institutes and one hundred and two were private self financing colleges. Except the state universities, all other engineering colleges are under APJ Abdul Kalam Technological University (APJKTU).

Once the questionnaire was prepared pilot study was executed to ensure the validity and reliability of the survey instrument as discussed in the following literature. Costello, A. B., & Osborne, J. (2005) presented the best practices in exploratory factor analysis. Ro et. al (2012) developed a psychomotor scale to measure contextual competencies. The author presented a set of evaluations based on the statistical procedure and professional judgment for the content, construct, discriminant, and concurrent validity of the scale. Ramadi et.al (2016) explored gaps between industry expectations and perceptions of engineering graduates' skill sets. The author employed principal component analysis for identifying the underlying factors influencing the skills of engineering graduates. Validity was established by conclusion validity and construct validity. The reliability was established by Cronbach's alpha value. The importance of skills and their satisfaction with graduates were compared by t-test method. The study concluded that communication, time management, and continuous learning skills were the important skills needed for employability. Cameli (2015) developed and validated a theoretical based scale to assess students learning about system thinking in relation to the affective domain. Exploratory and Confirmatory factor analysis was performed in SPSS and AMOS software.

Itani (2016) explored the gap between the offering of academic curriculum and requirement of industry. The author also studied the relationship between career aspiration of students and their perception of soft skills. Inferential statistical methods, such as cross tabulation, T- testing, and factor analysis, etc were used to identify the validity of patterns and relationships among different variables. Chan (2017) investigated students' perceptions of generic skills in three universities in Hong Kong. The author performed exploratory and confirmatory factor analysis for establishing the validity and reliability of the questionnaire. Saptano et.al (2018) developed valid and reliable assessment instruments to measure the affective domain of entrepreneurial learning by confirmatory factor analysis. The developed affective domain evaluation instrument was validated with the Product Moment correlation of Pearson and reliability was tested with Cronbach's alpha value. Isa et.al (2019) carried out a study to determine the students' perceptions of their psychomotor skills attainment through open-ended laboratory courses. Statistical analysis was done based on a questionnaire survey administered to a sample of 393 civil engineering students in SPSS software. Following the procedures adopted in the majority of literature, the validity and reliability of the questionnaire were established by performing exploratory (EFA) and confirmatory factor analysis (CFA) in SPSS software. SPSS Statistics and SPSS Amos software were employed for exploratory and confirmatory factor analysis respectively. Factor analysis established the factor structure and internal consistency of survey instrument. After EFA, the items with lesser factor loading and cross loading were eliminated. The items in the questionnaire were grouped into different categories based on the factors loaded. The correlation of the survey items was established by Pearson moment correlation, the suitability of the factor analysis was tested with Kaiser-Mayer-Oklin (KMO) value and Bartlett's Test of Sphericity value. The reliability of the instrument is expressed in terms of Cronbach's alpha. It measures the internal consistency of items in the group. The convergent and discriminant validity of the survey instrument is determined by Average Variance Extracted (AVE) and maximum shared variance (MSV) obtained from the confirmatory factor analysis in SPSS AMOS software. Alarcon et al (2015), Valentine and Damasio (2016) presented the concept of average variance extracted and maximum shared variance for the determination of convergent and discriminant validity of the instrument. The composite reliability value reinforces the Cronbach alpha value. Once the validity and reliability of the survey instrument were established the study was further extended to the actual population.

III. METHODS

To do the self assessment of psychomotor skills and affective skills developed in students during the B Tech program, a survey instrument was prepared based on similar research and the Civil Engineering curriculum. To confirm the validity and reliability of the questionnaire SPSS software was employed. The strength and direction of the linear relationship between variables were tested with the Pearson product-moment coefficient by correlating each item score with the total score of the items. Also, the item wise correlation value should be greater than the critical value. Then the next step was to check the reliability of the instrument which measured the internal consistency of the test items. The reliability of the instrument was tested from Cronbach's alpha value. Pearson moment correlation coefficient for the psychomotor domain and the affective domain was presented in Table 1 and Table 2 and Cronbach's alpha value for both domains was presented in Table 3 and Table 4.

The exploratory factor analysis (EFA) was performed to understand the internal reliability and to explore the underlying theoretical structure of the variables when the researcher has no a priori hypothesis about factors or patterns of measured variables. The EFA was executed in two stages. In the first stage data suitability for the factor analysis was tested by the Kaiser-Mayer-Oklin (KMO) value and Bartlett's Test of Sphericity value. KMO value greater than 0.8 indicates the sampling adequacy and Bartlett's Test of Sphericity test assesses correlation matrix as an identity matrix. In case the significance value is less than 0.05, it indicates the suitability of the sample. The next stage is the factor extraction process in which the large set of data items can be reduced into a smaller one that can give the majority of information on large data sets.

For psychomotor domain and affective domain survey instruments, the KMO value and Bartlett's Test of Sphericity value are presented in Table 5 and the value indicated that the instrument was suitable for factor analysis. Here factor reduction was performed by Principal component analysis. Since factors were interdependent, oblique rotation was used in the analysis. In the psychomotor domain survey instrument after the EFA, first the items were loaded into four factors. By eliminating the items with lesser factor loading and cross loading, the psychometric scale was loaded into three factors with 15 items. Similarly, for the affective domain, EFA reduced initially loaded seven factors to three factors. And the questionnaire was reduced to 22 items.

Table I Pearson Moment Correlation value for psychomotor domain items

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21
.595**	.614**	.592**	.580**	.645**	.612**	.631**	.690**	.671**	.661**	.629**	.674**	.824**	.815**	.803**	.726**	.656**	.776**	.628**	.727**	.629**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

** Correlation is significant at the 0.01 level (2-tailed)

Table II Pearson Moment Correlation value for affective domain items

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21
.630**	.499**	.713**	.817**	.860**	.774**	.710**	.813**	.772**	.711**	.714**	.631**	.715**	.705**	.760**	.804**	.810**	.801**	.801**	.743**	.596**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41
.635**	.577**	.549**	.505**	.583**	.628**	.515**	.577**	.687**	.686**	.690**	.632**	.643**	.599**	.641**	.686**	.521**	.581**	.606**	.606**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

** Correlation is significant at the 0.01 level (2-tailed)

The next stage in the analysis is the determination of construct validity of the survey instrument which was measured in terms of convergent validity and discriminant validity of the questionnaire. The convergent validity of the measurement model can be assessed by the Average Variance Extracted (AVE). The AVE value measured the level of variance captured by a construct versus the level due to measurement error and a value above 0.7 was considered very good and the level of 0.5 is acceptable. The internal consistency in scale items was measured by composite reliability (CR) value and the acceptable value is 0.7 and above. The AVE value and CR value were computed using the expression given below as equation (1), (2), and (3).

According to Fornell- Larcker testing system, the discriminant validity was assessed by comparing the amount of the variance capture by the construct (AVE) and the shared variance (MSV) with other constructs (ϕij) as the levels of the AVE for each construct should be greater than the squared correlation involving the constructs. The construct validity was tested by performing statistical analysis in SPSS AMOS software by employing the confirmatory factor analysis (CFA). The AVE and CR values were calculated using the expression given below and it was presented in Table 7. In addition to the construct validity goodness of data fit of the model could be assessed by CFA. According to Kline (2010), the model fit could be tested from the Chi-square value (CMIN/DF, less than 5 represents goof fit model), root mean square of approximation (RMSEA, less than 0.08 for good fit model), comparative fit index (CFI, greater than 0.9 for good fit model) and standardized root mean square residual (RMR, less than 0.08for good fit model).

Table III Reliability coefficient of the psychomotor domain

` Case Processing Summary			Reliability Statistics	
Cases	N	%	Cronbach's Alpha	N of Items
Valid	62	100	0.941	21
Excluded	0	0		

Table IV Reliability coefficient of the affective domain

Case Processing Summary			Reliability Statistics	
Cases	N	%	Cronbach's Alpha	N of Items
Valid	55	100	0.831	41
Excluded	0	0		

Table V KMO and Bartlett's Test

a. Psychomotor domain			b. Affective domain		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.836	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.869
Bartlett's Test of Sphericity	Approx. Chi-Square	557.245	Bartlett's Test of Sphericity	Approx. Chi-Square	1158.505
	df	105		df	231
	Sig.	0.000		Sig.	0.000

Table VI Factor loading

a. Psychomotor domain

Item	Factor1	Factor2	Factor3
Q1			0.712
Q2			0.870
Q3			0.801
Q4		0.674	
Q6	0.945		
Q7	0.967		
Q8		0.846	
Q9		0.797	
Q10		0.785	
Q14	0.686		
Q15	0.735		
Q16	0.711		
Q18	0.650		
Q19			0.581
Q21	0.624		

b. Affective domain

Item	Factor1	Factor2	Factor3
q4	0.785		
q5	0.770		
q7	0.815		
q8	0.762		
q9	0.785		
q10	0.956		
q11	0.942		
q14	0.827		
q17	0.831		
q18	0.907		
q24		0.731	
q26		1.016	
q27		0.856	
q28		0.977	
q29		0.969	
q30		0.723	
q32		0.756	
q33		0.736	
q38			0.875
q39			0.783
q40			0.770
q41			0.854

$$AVE\ \varepsilon_j = \frac{\sum_{k=1}^{K_j} \lambda_{jk}^2}{(\sum_{k=1}^{K_j} \lambda_{jk}^2 + \theta_{jk})} \quad (1)$$

$$\theta_{jk} = \sum_{k=1}^{K_j} 1 - \lambda_{jk}^2 \quad (2)$$

$$\rho_c\ \varepsilon_j = \frac{\left(\sum_{k=1}^{K_j} \lambda_{jk}\right)^2}{\left(\sum_{k=1}^{K_j} \lambda_{jk}\right)^2 + \theta_{jk}} \quad (3)$$

where: K_j is the number of indicators of construct ξ_j. λ_{jk} are factor loadings

θ_{jk} is the error variance of the k^{th} indicator ($k = 1, ..., K_j$) of construct ξ_j

ρ_c represents the composite reliability

$$AVE\ \varepsilon_j \geq \varphi_{ij}^2, i \neq j$$

For the psychomotor domain CMIN/DF, RMSEA, CFI, and RMR values were 1.711, 0.108, 0.879, and 0.058 respectively and for the affective domain, these values were 1.739, 0.11, 0.866, and 0.07 respectively.

Table VII Construct validity test for the survey instrument

a. Psychomotor domain

CR	AVE	MSV
0.941	0.613	0.426
0.821	0.521	0.367
0.852	0.502	0.345

b. Affective domain

CR	AVE	MSV
0.957	0.687	0.130
0.970	0.741	0.209
0.917	0.626	0.421

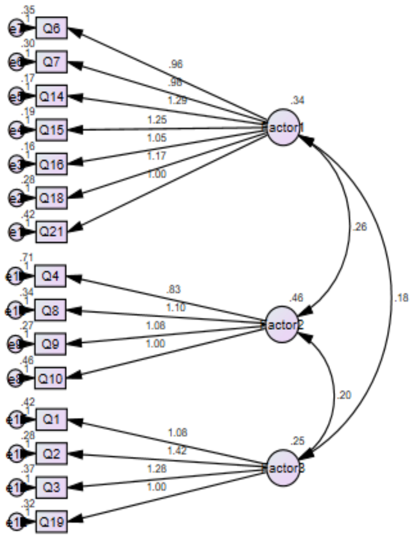

Fig. 1. Path diagram of psychomotor domain

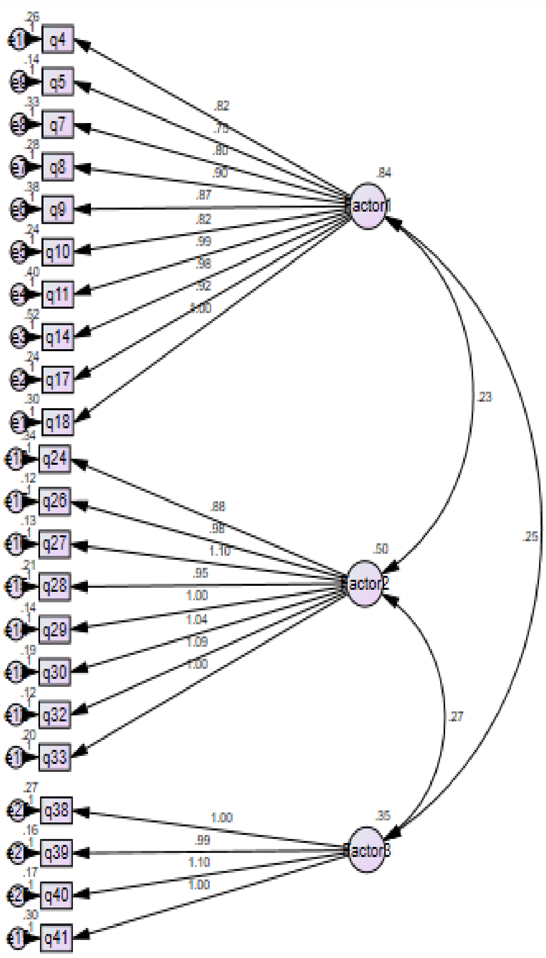

Fig. 2. Path diagram of affective domain

IV. RESULT AND DISCUSSION

First, the questionnaire was formulated and validity and reliability studies were performed in SPSS software. The Pearson moment correlation values presented in Table 1 and Table 2 indicated that the survey items are statistically significant and have a positive correlation with the intended construct for both the psychomotor and affective domain items. All the items exhibited more than 50% positive correlation with the total of all items. Also, from the values presented in Tables 1 and 2, it was clear that the correlation values were greater than the critical value for 2 – tailed correlation significant at 0.01level. The internal consistency of the survey items was established by Cronbach's alpha value. The values presented in Table 3 and Table 4, 0.941 and 0.831 indicated a highly reliable survey instrument that pointed out the one-dimensionality of the data, which had to be confirmed from the exploratory factor analysis. The KMO value presented in Table 5 was greater than 0.8 showed the adequacy of data for factor analysis. Bartlett's test of sphericity, which tests the overall significance of all the correlations within the correlation matrix, was significant ($\chi 2$ (105) = 557.245, p<0.001) and ($\chi 2$ (231) = 1158.505, p<0.001) also supported the use the factor analytic model on this set of data.

On executing the EFA on the psychomotor domain it had seen that six items in the questionnaire had lesser factor loading. The item like the application of project management software, usage of advanced surveying tools, and development of concrete mixes for specified grades were loaded with a lower value indicating these items had a weak influence on the psychomotor skills according to the student's perspective. Even though these activities like project management, application of modern tools as well as mix design procedures are essential from industry perspective, the students were not getting appropriate exposure to such activities during B Tech program. All other factors had loaded into three factors such as material testing skills, building planning and plotting skills, and general experimental skills.

From the affective domain questionnaire items like confidence in applying multi-disciplinary knowledge, use of advanced surveying instruments, oral presentation, project management, active participation in discussion, the contribution of new ideas and decision making, etc. were loaded with a lower value. In the affective domain, all other items were loaded into three factors such as confidence in applying the knowledge acquired by the B Tech program, personal and professional skill, and ethics in practice. From the EFA the survey instrument was found suitable for assessing the psychomotor domain and affective domain skill of the students. After EFA, CFA was done on the survey instrument, and convergent and discriminant validity was established by average squared variance and maximum squared variance as presented in Table 7. Since the average variance extracted values were greater than 0.5, it is acceptable and all the AVE values were greater than maximum shared variance values. Thus, the convergent and discriminant validity was established. The reliability was confirmed composite reliability value. For both survey instruments the composite reliability value were greater than 0.8 and thus the instrument is highly reliable.

To understand the influence of demographic variables on the skills possessed by the students, analysis of variance, ANOVA was performed. The demographic variables considered were gender, type of institute, district, year of graduation etc. A one-way ANOVA revealed that there is no significant difference in the psychomotor skills and affective skills among different groups that participated in the survey. This is because the study is limited Kerala state, India. Since the questionnaire was focused on the assessment of psychomotor skills and affective skills developed during B Tech program and 95% students participated in the survey were graduating from APJKTU university, there responses were similar irrespective of district, year of graduation, gender or type of institute. Further to have a clear picture on the competency of civil engineering graduates their responses to actual practical situation is to be measured.

V CONCLUSIONS

In the present study survey instrument to assess the two important domains of learning; psychomotor and affective domain was developed. The questionnaire was prepared for Civil Engineering graduates. The validity and reliability of the survey instrument were established using the statistical package SPSS Statistics and SPSS Amos. The average variance extracted value, as well as the maximum shared variance value, confirmed the convergent and discriminant validity. The Cronbach’s alpha and composite reliability values supported the internal consistency of the survey instrument. As per students’ opinion from the present B Tech Civil Engineering program in Kerala, India the psychomotor skills like material testing skills, ability to perform experiments and drafting and plotting skills were developed in them. Also, civil engineering program equip students with confidence in applying appropriate knowledge in real world situations, practice ethics and exhibit professional skills like communication, teamwork, leadership and critical thinking. Thus, the Civil Engineering program enabled the student to articulate a solution to real world problem and organize it perform effectively. Further one-way ANOVA compared the influence of demographic factors on the skills of students. According to their perception, students' motor skills and attitude were not influenced by factors like gender, district, year of graduation, type of institute, etc

APPENDIX 2
SELF EVALUATION QUESTIONNAIRE FOR PSYCHOMOTOR DOMAIN

Sl No	Question Statement	Sl No	Question Statement
q1	The basic science laboratory experiments enabled the enhancement of the experimental skill in students.	q12	Ability to plot survey maps by conducting the total station survey, transferring and interpreting the data obtained.
q2	The Civil Engineering workshop experience enabled the ability to perform setting out of building	q13	Ability to perform appropriate experiments to determine the tensile strength, shear strength, bending strength and torsional strength of different materials used as structural element in construction industry
q3	The basic civil engineering knowledge enabled the selection of good quality construction materials for roofing, flooring, sanitary fittings	q14	Ability to perform experiments to determine the fresh and hardened properties of concrete like workability and strength tests.
q4	The basic engineering workshop enabled the ability to perform activities like carpentry, smithy, simple circuit wiring, soldering	q15	Ability to perform experiments to determine the quality of materials used for making concrete like specific gravity, gradation, bulk

APPENDIX 1
SELF EVALUATION QUESTIONNAIRE FOR AFFECTIVE DOMAIN

Sl No	Statement	Sl No	Statement
q1	Confidence in demonstrating the knowledge from basic science and mathematics to civil engineering related problem	q22	Confidence in demonstrating a clear, logic, structured and organised oral presentation.
q2	Confidence in demonstrating the multi disciplinary engineering (mechanical, electrical, electronics and computer science) knowledge in civil engineering domain.	q23	Ability to use media, graphics, writing texts that support the oral exposition
q3	Confidence and motivation in presenting the importance of civil engineering profession	q24	Ability to present the work performed with voice modulation, maintaining eye contact with audience and by using proper body language
q4	Confidence in performing analysis of structures like beams, frames and trusses manually or using software like STAAD	q25	Ability to prepare a report in prescribed format by writing appropriate, relevant and compelling content that shows mastery of the subject
q5	Confidence and motivation in applying the Civil Engineering knowledge in the design of structural elements like beam, column, slabs, staircase, footing manually or using software like STAAD.	q26	Ability to interact with all group members and encourage communication between members
q6	Confidence and motivation in applying the Civil Engineering knowledge in the analysis and design of multistorey structural building using software like STAAD	q27	Ability to interact and work with others to accomplish team goals and to solve problem
q7	Confidence and motivation in applying the Civil Engineering knowledge in the design of prestressed structures	q28	Ability to take initiative in a group activity
q8	Confidence and motivation in applying the Civil Engineering knowledge in planning efficient, aesthetic and economic residential buildings.	q29	Ability to take leadership in a group activity
q9	Ability to understand the field problems related to geotechnical engineering and ability to take engineering decisions to select appropriate foundation	q30	Ability to think critically about particular problem and present ideas in a team
q10	Ability in planning a reservior at a given location depending on the hydrological parameters	q31	Ability to interpret results and drawing conclusion from the study conducted
q11	Ability to identify the dam failures.	q32	Expertise to contribute with ideas, solutions and effort in a group work
q12	Confidence and motivation in applying the knowledge of advanced surveying technologies like remote sensing and GIS.	q33	Expertise to display dedication, determination and responsibility on team outcomes and performance
q13	Confidence and motivation in applying the knowledge of advanced surveying instruments like total station and GPS	q34	Expertise to apply and integrate engineering knowledge, and to use different technologies to generate ideas and solutions
q14	Confidence and motivation in conducting traffic engineering studies and ability to develop efficient traffic management system	q35	Ability in efficient time management in doing prescribed work
q15	Confident in assessing the quality of water in a region	q36	Ability to manage conflict of opinion among team members and integrate all valuable comment for better outcome
q16	Confidence to adopt suitable construction practice for a given project considering the quality, economy, safety and time management	q37	Ability in taking appropriate decision considering engineering, economic, social and sustainable factors related to a problem
q17	Confidence in proper transportation planning understanding future needs considering budgets, goals and policies and design of highway elements	q38	Ability to understand and practice Engineering Ethics and Human Values.
q18	Confidence in understanding the behaviour of fluid under various forces and at different atmospheric conditions and ability to estimate fluid pressure on different surface	q39	Ability to understand Moral and Social Values, Loyalty and also to learn to appreciate the rights of others.
q19	Confidence in applying the knowledge of materials and construction practices in actual work place	q40	Ability to understand the legal and ethical issues related to construction projects
q20	Confidence in applying the knowledge on principles of planning and scheduling projects, with emphasis on construction	q41	Ability in practising the principles of safe construction method
q21	Confidence in preparing detailed estimate and bill of quantities for a given project		

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