

Gender-Based Analysis of Psychomotor Outcomes in Civil Engineering Drawing Among Diploma Students

Herda Balqis Ismail¹, Siti Shahidah Sharipudin¹, Saiful Jumali¹,
Asmawati Che Hasan¹, Adrina Rosseira A. Talip^{1*}, Mohd. Hanafie Yasin¹,
Nazri Nasir¹

¹ Faculty of Civil Engineering, Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus, Bandar Seri Alam, 81750 Masai, Johor, Malaysia

*Corresponding Author: adrina9587@uitm.edu.my

Received: 30 May 2025 | Accepted: 23 July 2025 | Published: 1 August 2025

DOI: <https://doi.org/10.55057/ijares.2025.7.4.8>

Abstract: *This paper presents the teaching and learning approach for the Civil Engineering Drawing course implemented in the Diploma in Civil Engineering programme at Universiti Teknologi MARA (UiTM). Beyond enhancing students' competency in computer-aided drafting, the course is designed to develop essential psychomotor skills and abilities aligned with industry requirements. The objective of this study is to evaluate the attainment of first-year students in psychomotor-related Programme Outcomes (PO4 and PO5), which focus on the ability to produce technical drawings using both manual drafting tools and Computer-Aided Design (CAD) systems. The analysis was conducted using descriptive and inferential statistical methods to compare PO attainment by gender. The findings indicate that both male and female students achieved good levels of PO4 and PO5 attainment, demonstrating proficiency in technical drawing production. Although there was no statistically significant difference in PO attainment between genders for most assessments, female students showed significantly better performance in the Project Report: CAD System assessment. Overall, the results suggest that the Civil Engineering Drawing course effectively fosters the development of practical and communication skills among first-year students, preparing them to meet professional expectations in the civil engineering field.*

Keywords: Psychomotor skills, Program Outcomes, Assessment, Computer-Aided Design (CAD), drafting

1. Introduction

In engineering education, the acquisition of practical competencies is as critical as theoretical knowledge, particularly in disciplines that require strong spatial visualization, technical drawing proficiency, and tool-based execution. The psychomotor domain, as outlined in Bloom's Taxonomy, encompasses the development of physical skills and coordination essential for executing complex engineering tasks (Salim et al., 2012). It coordinated development of motoric or movement skill, which incorporates speed, repetition, precision, and execution (Ahmad et al., 2018).

In Malaysia, the implementation of Outcome-Based Education (OBE) across higher learning institutions has placed greater emphasis on aligning course design and assessment with

measurable Programme Outcomes (POs), particularly those associated with technical and professional competencies (Aminah et al., 2012; Wahab et al., 2011). Within this context, the Civil Engineering Drawing course, offered in the first year of the Diploma in Civil Engineering programme at Universiti Teknologi MARA (UiTM), plays an important role in developing students' psychomotor attributes. The course introduces students to both manual drafting techniques and Computer-Aided Design (CAD) applications, fostering the ability to interpret, construct, and communicate technical information effectively.

This course is strategically mapped to Programme Outcomes PO4 and PO5, which focus on the ability to conduct technical investigations and utilize modern engineering tools, respectively. These POs are strongly associated with the psychomotor domain, and their attainment reflects students' practical proficiency in performing engineering tasks. While the importance of drawing as a communication tool in the construction industry is well recognized, limited empirical studies have explored how structured drawing exercises in diploma-level programmes contribute to psychomotor skill development. It is essential to address the knowledge gap in engineering students' psychomotor skill development for achieving program outcomes (Isa et al., 2019). Therefore, this study aims to evaluate the extent to which students acquire psychomotor skills through the Civil Engineering Drawing course and to examine whether gender differences influence their level of attainment. The findings provide insights into the effectiveness of current teaching and assessment strategies and offer recommendations for enhancing practical skill development in technical education.

2. Literature Review

The development of psychomotor skills in engineering education is critical for ensuring that graduates possess the technical competencies required in real-world practice. According to Bloom's Taxonomy and subsequent revisions (Subedi, 2022), the psychomotor domain involves skill-based learning that includes perception, readiness, guided response, mechanism, complex overt response, adaptation, and origination. In the context of engineering, this translates into the ability to manipulate tools and software, interpret technical drawings, and produce accurate visual representations of structures (Ahmad et al., 2018). Numerous studies have emphasized the importance of integrating practical skill development within engineering curricula. (Ferris & Aziz, 2005) proposed a hierarchical model of psychomotor skill acquisition specific to engineering students, ranging from recognition and handling of tools to expert-level planning and evaluation of technical work. Courses such as Civil Engineering Drawing are central to this model, as they engage students in both manual drafting and the use of CAD tools, thereby reinforcing psychomotor attributes through repeated practice and applied learning.

In the Malaysian context, Outcome-Based Education (OBE) has been adopted across higher learning institutions to enhance the alignment between Course Outcomes (COs) and Programme Outcomes (POs) (Aminah et al., 2012; Wahab et al., 2011). Among the key POs relevant to psychomotor development are PO4 (ability to conduct investigations of well-defined problems) and PO5 (ability to use modern engineering and IT tools). These outcomes are particularly targeted in courses that include both theoretical instruction and hands-on practice, such as Civil Engineering Drawing. Despite the structured implementation of OBE, there remains a need for more evidence-based studies to assess how well such courses develop practical competencies, particularly at the diploma level. The current study fills this gap by evaluating the PO4 and PO5 attainment among diploma students enrolled in the Civil Engineering Drawing course. The study also considers potential gender-based performance

differences, as recent literature suggests varying trends in skill acquisition between male and female students (Adom et al., 2020; Salim et al., 2012).

3. Methodology

3.1 Research Design

This study employed a quantitative descriptive approach to evaluate the development of psychomotor skills among first-year Diploma in Civil Engineering students enrolled in the Civil Engineering Drawing course at Universiti Teknologi MARA (UiTM), Pasir Gudang campus. The study focused on assessing Programme Outcomes PO4 and PO5, which relate to students' ability to perform technical drawings using both manual and CAD tools.

3.2 Participants

The participants comprised 191 first-year students (73 females and 118 males) enrolled in the course during the September 2021 – January 2022 semester. These students were grouped into nine class sections. Participation involved performance data derived from course assessments aligned with PO4 and PO5.

3.3 Assessment Instruments and Data Collection

Table 1 shows the details of CO-PO mapping of this course. In general, this CO-PO mapping is instrumental in assessing the development of psychomotor and affective learning domains among students. CO1 and CO2 are particularly focused on developing students' psychomotor abilities as this has been focussed on this study.

Table 1: CO-PO Mapping

Course Outcomes		Programme Outcome	Bloom Taxonomy Domain
CO1	To ensure the students able to; demonstrate the skills in civil engineering drawing with drafting equipment	PO4 To ensure students able to conduct investigations of well-defined problems; locate and search relevant codes and catalogues, conduct standard tests and measurements	Psychomotor
CO2	To construct civil engineering drawing using CAD system	PO5 To be able applying appropriate techniques, resources and modern engineering and IT tools to well-defined engineering problems with an awareness of the limitations	Psychomotor

Three primary types of assessments were used to evaluate student which enrolled in this course which are individual assignment, project report and common test. Each type of assessment required a specific rubric as an assessment tool. According to (Rahmat, 2011), rubric is the regular tool that is used to assess psychomotor domain, Table 2 provides a summary of the rubric criteria used for assessing psychomotor domains evaluation for the subject. Scores were recorded and categorized according to the CO-PO mappings.

Table 2: Summary of the Course Assessment

CO	PO	Assessment	Tool	Criteria of Evaluation
CO1	PO4	Individual Assignment Student is required to demonstrate practical skills by preparing civil engineering drawing using drafting	Rubrics	Marks will be awarded individually based on student's drawing ability.

			equipment. Each student needs to complete the drawing and submit it.		
		Common Test I	Student is required to demonstrate practical skills by preparing civil engineering drawing using drafting equipment. Test question is derived based on the Master Template of Examination Specification Table (EST) ECM256.	Rubrics	Marks required student need to use their physical skill-to draw (psychomotor) using drafting equipment.
CO2	PO5	Project Report CAD Software	Student is required to work in a group of 4 students. Each group compulsory to reproduce a set of civil engineering drawing using CAD software. A project report also needs to be prepared for submission. This task required student to apply the psychomotor skills to draw by using the CAD Software.	Rubrics	Students will be evaluated using a standard rubric based on the following criteria:
		Common Test II	Student is required to demonstrate practical skills by using AutoCAD software to prepare drawing. Test question is derived based on the Master Template of Examination Specification Table (EST) ECM256.	Rubrics	so that the answer required student need to use their physical skill to draw (psychomotor) using CAD software practice during lab & project sessions.

3.4 Data Analysis

The student's assessment marks were recorded and tabulated according to the standard template provided by the faculty. The marks are being categorized according to the Course Outcome (CO) - Program Outcome (PO) mappings and type of assessment. Then, the scoring marks gathered by the students were analysed by using relevant statistical software. The output was tabulated in a proper format and statistical data analysis was carried out based on the recorded marks scored by each student. Descriptive statistics (mean and standard deviation) were used to summarize performance data for each gender group. An independent samples t-test was conducted to determine whether there were statistically significant differences between male and female students' attainment of PO4 and PO5. Levene's Test for Equality of Variances was applied prior to interpreting the t-test results. Analysis was performed using SPSS statistical software.

4. Results and Discussion

4.1 Students' Demographic Information

Table 3 presents the demographic distribution of students who participated in this study. The students were organized into nine groups (A to I) for the semester. Each group consisted of both male and female students, and the data were categorized accordingly. A total of 191 students were involved in the study, comprising 73 female students and 118 male students. This reflects a gender distribution difference of approximately 23.6%, with male students representing the majority.

Table 3: Numbers of students according to the gender

Group	Female	Male	Total # of student
A	4	13	17
B	4	10	14
C	8	14	22
D	6	12	18
E	11	13	24
F	9	16	25
G	11	14	25
H	10	14	24
I	10	12	22
Total	73	118	191

In this section, the attainment of Programme Outcomes 4 (PO4) and Programme Outcomes 5 (PO5) is examined in depth, as both are directly linked to the development of practical (psychomotor) skills, which are essential in civil engineering education. The allocation and distribution of marks for each assessment type aligned with PO4 and PO5 are summarized in Table 4. Specifically, PO4 focuses on the students' ability to construct technical drawings using manual drafting tools, while PO5 emphasizes students' competence in operating CAD software to produce engineering drawings.

Table 4: Summary of the Course Assessment

CO	PO	Type of Assessment	Marks (%)	Total (%)
CO1	PO4	Individual Assignment	20	50
		Common Test I	30	
CO2	PO5	Project Report: CAD Software	30	40
		Common Test II	10	

The Grade to Performance Criteria Matrix as shown in Figure 5 provides a qualitative interpretation of academic grades based on student performance levels. Grades in the range of A+, A, and A- are categorized as "Excellent," indicating outstanding understanding, analysis, and application of the subject matter. Grades of B+, B, and B- reflect "Good" performance, demonstrating a solid grasp of the content with minor lapses in depth or detail. Students who achieve grades of C+ or C are considered "Satisfactory," showing adequate comprehension and meeting minimum course requirements. Those receiving D+, D, or D- are rated as "Below Average," suggesting limited understanding and marginal achievement. Lastly, grades of E and F signify "Weak" performance, highlighting a failure to meet the fundamental expectations of the course. This matrix serves as a useful reference for evaluating student outcomes and guiding feedback on academic performance.

However, as noted by (Allen, 2005), final class grades primarily reflect a summary of students' academic achievement based on the knowledge content delivered throughout the course. While these grades encompass various forms of assessment, they do not explicitly represent students' development in other domains such as psychomotor skills. This is particularly relevant in the context of this study, which focuses on Programme Outcomes PO4 and PO5, emphasize the application of practical skills, use of appropriate tools, and the demonstration of essential engineering practices. Therefore, a more focused evaluation beyond final grades is necessary to effectively capture the attainment of these specific outcomes.

Table 5: Performance Criteria Matrix

Marks	Grade	Performance Criteria Matrix Score
100 -75	A+, A, A-	Excellent
60-74	B+, B, B-	Good
50-59	C+, C, C-	Satisfactory
44-49	D+, D	Below average
0-39	E, F	Weak

4.2 Overall Programme Outcomes Performance

As illustrated in Figure 1, the overall PO attainment scores indicate that students performed well in both PO4 and PO5, with most scoring between 71 and 80 marks, which falls within the "Good" to "Excellent" range. Notably, male students achieved a slightly higher PO4 score (80, classified as *Excellent*) compared to female students. Conversely, female students recorded a higher PO5 score (74) compared to males (71), suggesting that they were more proficient in using CAD software during the semester.

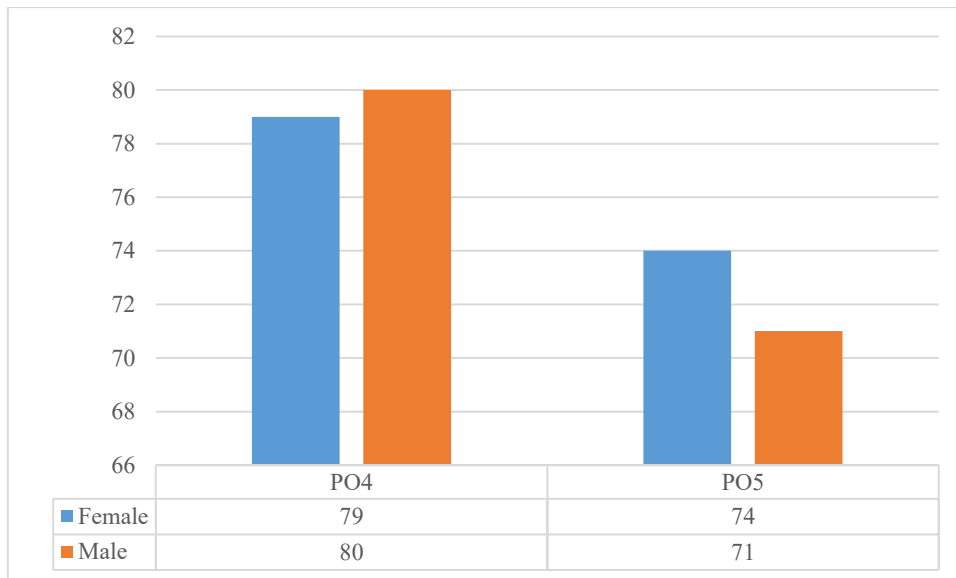


Figure 1: Student attainment for PO4 and PO5

To deepen the analysis, PO attainment was further examined according to assessment type and gender, as presented in Figure 2. For PO4, female students achieved a higher average score of 88 during the individual assignment, indicating stronger performance in tasks that allowed extended time for completion. However, male students outperformed females in the common test, achieving an average score of 76, demonstrating their ability to perform under time constraints using manual drafting equipment. As for PO5, both male and female students recorded similar scores in the common test, but female students demonstrated a significantly higher average score in the Project Report: CAD Software, contributing to their overall higher PO5 attainment. This suggests that female students were more adept at completing complex design tasks using CAD tools in a project-based learning environment. These findings support the notion that both genders can achieve high levels of technical proficiency, though their strengths may vary depending on the nature and format of assessment. It also highlights the importance of incorporating diverse evaluation strategies to capture the full range of student abilities across different learning domains.

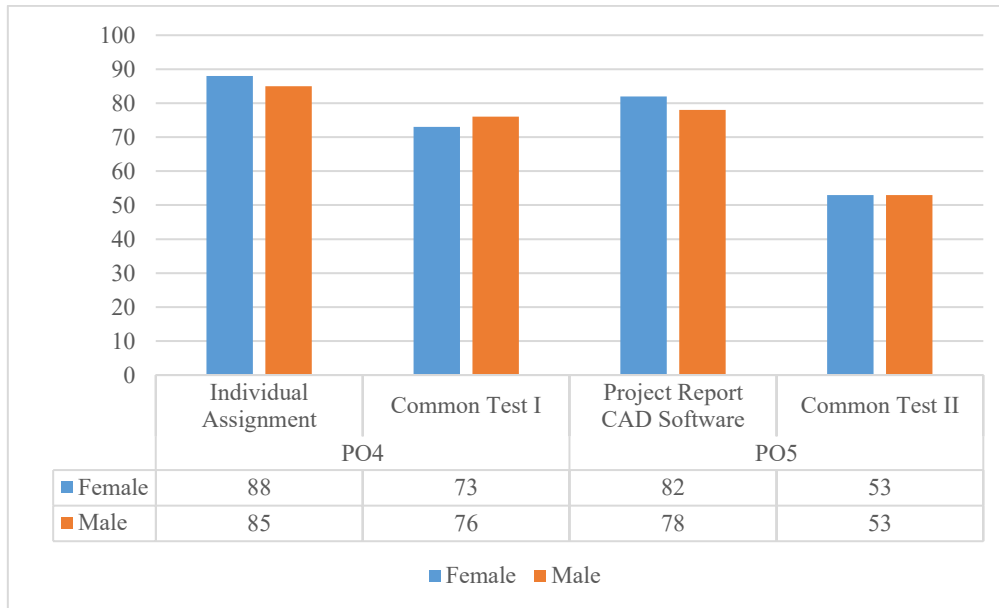


Figure 2: The average attainment of PO4 and PO5 according to type of assessment

4.3 Significant Difference in Students' PO4 Attainment

Table 6 presents the mean scores for Programme Outcome 4 (PO4) attainment based on two types of assessments: individual assignments and common tests. The results show that the mean scores for male and female students are relatively similar. For the individual assignment, the mean PO4 attainment is approximately 17.61 for female students and 17.01 for male students. In the common test, the mean scores are 22.03 for female students and 22.95 for male students, indicating only a slight variation.

Table 6: T test Analysis for PO4 Attainment

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Individual Assignment	Female	73	17.61	2.76	0.32
	Male	118	17.01	3.14	0.29
Common Test I	Female	73	22.03	5.46	0.64
	Male	118	22.95	5.52	0.51

An independent samples t-test was conducted to compare Programme Outcome 4 (PO4) attainment between male and female students for two types of assessments: individual assignments and common tests. Levene's Test for Equality of Variances indicated that the assumption of equal variances holds for both assessments, with p-values of 0.27 for the individual assignment and 0.992 for the common test where both exceeding the 0.05 significance threshold. Consequently, the t-test results under the assumption of equal variances were used for interpretation as shown in Table 7. The results revealed that the p-values (Sig. 2-tailed) were greater than 0.05 for both assessments: 0.180 for the individual assignment and 0.270 for the common test. These findings suggest that there is no statistically significant difference in PO4 attainment between male and female students in either assessment type. Thus, gender does not appear to have a significant effect on students' performance related to PO4 in this course.

Table 7: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig. (p)	t	df	Sig. (p) (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
								Lower		Upper
Individual Assignment	Equal variances assumed	1.21	0.27	1.35	189	0.18	0.60	0.45	-0.28	1.48
	Equal variances not assumed			1.39	167.30	0.17	0.60	0.43	-0.26	1.46
Common Test I	Equal variances assumed	0.00	0.99	-1.12	189	0.27	-0.91	0.82	-2.53	0.73
	Equal variances not assumed			-1.12	154.00	0.27	-0.91	0.82	-2.53	0.70

4.4 Significant Difference in Students' PO5 Attainment

Table 8 presents the mean scores for Programme Outcome 5 (PO5) attainment based on two types of assessments: the Project Report using CAD software and the Common Test. The results indicate that the mean PO5 score for the Common Test is nearly identical between female (5.28) and male (5.26) students, suggesting minimal variation. However, in the Project Report, female students achieved a higher mean score (24.49) compared to male students (23.31), indicating a noticeable difference.

Table 8: T test Analysis for PO5 Attainment

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Project Report: CAD software	Female	73	24.49	3.49	0.41
	Male	118	23.31	4.05	0.37
Common Test II	Female	73	5.28	1.86	0.22
	Male	118	5.26	2.09	0.19

To examine whether these differences are statistically significant, an independent samples t-test was conducted for each assessment. Levene's Test for Equality of Variances yielded p-values greater than 0.05 for both the Project Report ($p = 0.59$) and Common Test ($p = 0.37$), confirming that equal variances can be assumed as shown in Table 9. Therefore, the t-test results under the assumption of equal variances are used for interpretation. For the Project Report, the p-value (Sig. 2-tailed) was 0.040, which is less than the 0.05 threshold. This indicates a statistically significant difference in PO5 attainment between male and female students, with female students outperforming their male counterparts. Conversely, for the Common Test, the p-value was 0.94, showing no significant difference in PO5 attainment between genders.

Table 9: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig. (p)	t	df	Sig. (p) (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference		
										Lower	Upper
Project Report: CAD software	Equal variances assumed	0.30	0.59	2.07	189	0.04	1.18	0.57	0.05	2.31	
	Equal variances not assumed			2.14	169.41	0.03	1.18	0.55	0.09	2.27	
Common Test II	Equal variances assumed	0.82	0.37	0.08	189	0.94	0.024	0.30	-0.57	0.61	
	Equal variances not assumed			0.08	166.19	0.94	0.024	0.29	-0.55	0.60	

5. Conclusion

The primary aim of this study was to investigate the attainment of psychomotor skills among first-year undergraduate students enrolled in the Civil Engineering Drawing course. These practical competencies are essential in the engineering field, as they support the development of technical proficiency and workplace readiness. Based on the findings, both female and male students demonstrated satisfactory performance in acquiring practical skills, particularly in producing engineering drawings using manual drafting tools and CAD software. While male students generally showed strong overall performance, female students recorded higher average scores in the Project Report: CAD Software assessment, suggesting a greater proficiency in operating CAD systems. Although statistical analyses indicated no significant difference in PO4 and PO5 attainment between genders, the trend in mean scores reflects that female student slightly outperformed male students in certain skill areas, particularly related to PO5.

Understanding the level of Programme Outcome (PO) attainment provides the faculty with meaningful feedback to further enhance curriculum design and instructional strategies. This may include the incorporation of more activity-based learning, industry-aligned tasks, or technology-driven tools to strengthen students' skills progressively throughout the diploma programme. Furthermore, the Civil Engineering Drawing course serves as a foundation for higher-level subjects, such as the Civil Engineering Quantities and Estimation and other related courses offered in later semesters. The knowledge and skills acquired here are directly applicable to those advanced assessments, underscoring the importance of ensuring students are well-equipped with psychomotor domain skills from the outset.

This study, however, is exploratory in nature and limited to a single cohort at UiTM Pasir Gudang. As the Diploma in Civil Engineering programme is also offered at various other UiTM campuses across Malaysia, the findings cannot be fully generalized. Future research should consider expanding the sample size and geographic coverage to allow for broader comparisons.

Further research could also explore a wider range of topics and disciplines to obtain a more comprehensive perspective on psychomotor and affective learning approaches in engineering education.

Acknowledgements

The authors would like to express their sincere gratitude to the Academic Affairs Office, Universiti Teknologi MARA (UiTM), Johor, Malaysia, for providing access to the data used in this study. Special thanks are also extended to the Faculty of Civil Engineering, Universiti Teknologi MARA (UiTM), Johor, for their continuous support and facilitation throughout the research process.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this study.

References

- Adom, D., Mensah, J. A., & Dake, D. A. (2020). Test, Measurement, And Evaluation : Understanding and Use of the Concepts in Education. *International Journal of Evaluation and Research in Education*, 9(1), 109–119. <https://doi.org/10.11591/ijere.v9i1.20457>
- Ahmad, A., Kamin, Y., & Md Nasir, A. N. (2018). Applying Psychomotor Domain for Competency Based Teaching in Vocational Education. *Journal of Physics: Conference Series*, 1049(1). <https://doi.org/10.1088/1742-6596/1049/1/012049>
- Allen, J. D. (2005). Grades as Valid Measures of Academic Achievement of Classroom Learning. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 78(5), 218–223. <https://doi.org/10.3200/tchs.78.5.218-223>
- Aminah, S., Jaafar, O., Hamidon, W., & Badaruzzaman, W. (2012). *The Course Outcomes (COs) Evaluation for Civil Engineering Design II Course*. 60, 103–111. <https://doi.org/10.1016/j.sbspro.2012.09.354>
- Ferris, T. L. J., & Aziz, S. M. (2005). A Psychomotor Skills Extension to Bloom’s Taxonomy of Education Objectives for Engineering EDUCATION School of Electrical and Information Engineering, University of South Australia. *Exploring Innovation in Education and Research*, March, 1–5.
- Isa, C. M. M., Joseph, E. O., Saman, H. M., Jan, J., Tahir, W., & Mukri, M. (2019). Attainment of Program Outcomes under Psychomotor Domain for Civil Engineering Undergraduate Students. *International Journal of Academic Research in Business and Social Sciences*, 9(13), 107–122. <https://doi.org/10.6007/ijarbss/v9-i13/6247>
- Rahmat, R. A. A. O. K. (2011). Achievement of program outcomes using assessment plan. *Procedia - Social and Behavioral Sciences*, 18, 87–93. <https://doi.org/10.1016/j.sbspro.2011.05.013>
- Salim, K. R., Puteh, M., & Daud, S. M. (2012). Assessing Students’ Practical Skills in Basic Electronic Laboratory based on Psychomotor Domain Model. *Procedia - Social and Behavioral Sciences*, 56(IctIhe), 546–555. <https://doi.org/10.1016/j.sbspro.2012.09.687>
- Subedi, U. (2022). Indispensability Of Integrating Three Learning Domains in Teaching and Learning. *Shaheed Smriti Peer Reviewed Journal Year*, 11(8), 54–60.
- Wahab, H. F. A., Ayob, A., Mimi, W., Zaki, D. W., Hussain, H., Hussain, A., & Mokri, S. S. (2011). *Program Outcomes Measurement and Assessment Processes*. <https://doi.org/10.1016/j.sbspro.2011.05.008>