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BEYOND DRAWINGS: INNOVATING AND EVALUATING CAD SKILLS WITH A CAP-DRIVEN PEDAGOGICAL MODEL

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ABSTRACT

Computer-Aided Design (CAD) education is integral to developing the technical competencies of engineering students. However, traditional assessment approaches in CAD courses often suffer from subjectivity and lack of consistency. This study introduces a structured evaluation method using the Course Attainment Parameter (CAP) framework to objectively measure student performance across cognitive, psychomotor, and affective learning domains. Conducted with 367 students enrolled in a core CAD course at a Malaysian public university, the research aligns Course Outcomes (COs) with measurable indicators, mapped to Programme Outcomes (POs) based on Outcome-Based Education (OBE) principles. Data analysis revealed a strong overall performance in the psychomotor and affective domains—particularly CO3 to CO5—where over 93% of students achieved satisfactory or higher results. Conversely, only 57.8% met the expected threshold in CO1, highlighting persistent challenges in cognitive attainment, particularly in understanding CAD-related theories. These findings emphasize the disparity between practical skill acquisition and theoretical comprehension. The CAP-based approach offers a transparent, data-driven tool for continuous course improvement and serves as a feedback mechanism for both instructors and students. This method not only enhances assessment accuracy but also supports curriculum refinement, instructional strategy optimization, and alignment with accreditation standards. Ultimately, this study demonstrates the value of CAP as a scalable model to improve learning outcomes and elevate the quality of CAD education in technical programs.

Keywords: *Computer-Aided Design (CAD), Course Attainment Parameter (CAP), Course Outcomes, Outcome-Based Education (OBE), Student Attainment*

INTRODUCTION

This project introduces a structured, data-driven approach to evaluating student performance in a Computer-Aided Design (CAD) course by integrating the Course Attainment Parameter (CAP) methodology within the framework of Outcome-Based Education (OBE). Conducted at a Malaysian public university involving 367 engineering students, the study redefines traditional assessment practices by mapping student achievements across the cognitive, psychomotor, and affective learning domains, in alignment with five Course Outcomes (COs).

The core innovation lies in the application of the CAP model to dissect performance trends and uncover domain-specific strengths and gaps. Unlike conventional grading, which often focuses narrowly on end results, the CAP framework enables granular insight into students' theoretical understanding (CO1), practical modelling skills (CO2), communication (CO3), teamwork (CO4), and ethical awareness (CO5) (Krathwohl, 2002; Means et al, 2013). The results revealed a high success rate in affective and psychomotor competencies—with over 93% of students attaining satisfactory or better levels in CO3–CO5—while also spotlighting deficiencies in cognitive comprehension, particularly in theoretical CAD concepts, where only 57.8% met the minimum expected threshold.

To support student learning, the course incorporated blended learning techniques, including face-to-face lectures, hands-on lab sessions, online resources, and project-based assessments. Despite these interventions, engagement issues were noted among low-performing students, indicating the need for improved instructional scaffolding, motivational strategies, and personalized academic support (Freeman et al., 2014; Mat Isa et al,2024).

This innovation not only enhances the transparency and fairness of student evaluations but also offers a feedback-rich mechanism for continuous curriculum refinement. By using CAP as both an evaluative and diagnostic tool, the study provides actionable insights for educators and program developers to strengthen learning outcomes, address competency gaps, and align teaching practices with accreditation standards (Álvarez Ariza, 2024; Graham, 2018; Terenzini et al., 2001). Ultimately, this project demonstrates how thoughtful integration of structured assessment models can elevate the quality and consistency of technical education in engineering disciplines.

METHODS

This study employed a Course Attainment Parameter (CAP)-based evaluation approach within the framework of Outcome-Based Education (OBE) to assess student performance in the *Computer Aided Design (CAD)* course, offered at a public university in Malaysia during the OCT 24–FEB 25 academic semester. The objective was to determine the degree of attainment across five predefined Course Outcomes (COs), each mapped to relevant Programe Outcomes (POs) as stipulated by the Engineering Accreditation Council (EAC) Malaysia (Mohd Saim et al., 2021).

Course Structure and Participants

The CAD course included both theoretical and practical components aimed at developing cognitive, psychomotor, and affective competencies in CAD. A total of 367 students from multiple sections participated in this study, with all students undergoing the same instructional content, assessments, and evaluation rubrics. Teaching methods included face-to-face and online lectures, practical lab sessions, group discussions, and project-based learning. Assessments were conducted continuously throughout the semester and were distributed across final tests, lab tests, assignments, and mini projects.

Course Outcomes and Assessment Plans

The course learning outcomes and the respective assessment plans are as shown in Table 1 and the continuous assessment scores are shown in Table 2. The course outcomes are mapped to the general engineering degree's program outcomes (POs), learning outcomes (LOs), soft skills and CAP assessments. Upon completion of this course, students are expected to fulfil these course outcomes.

Table 1.: Course learning outcomes and the respective assessment plans

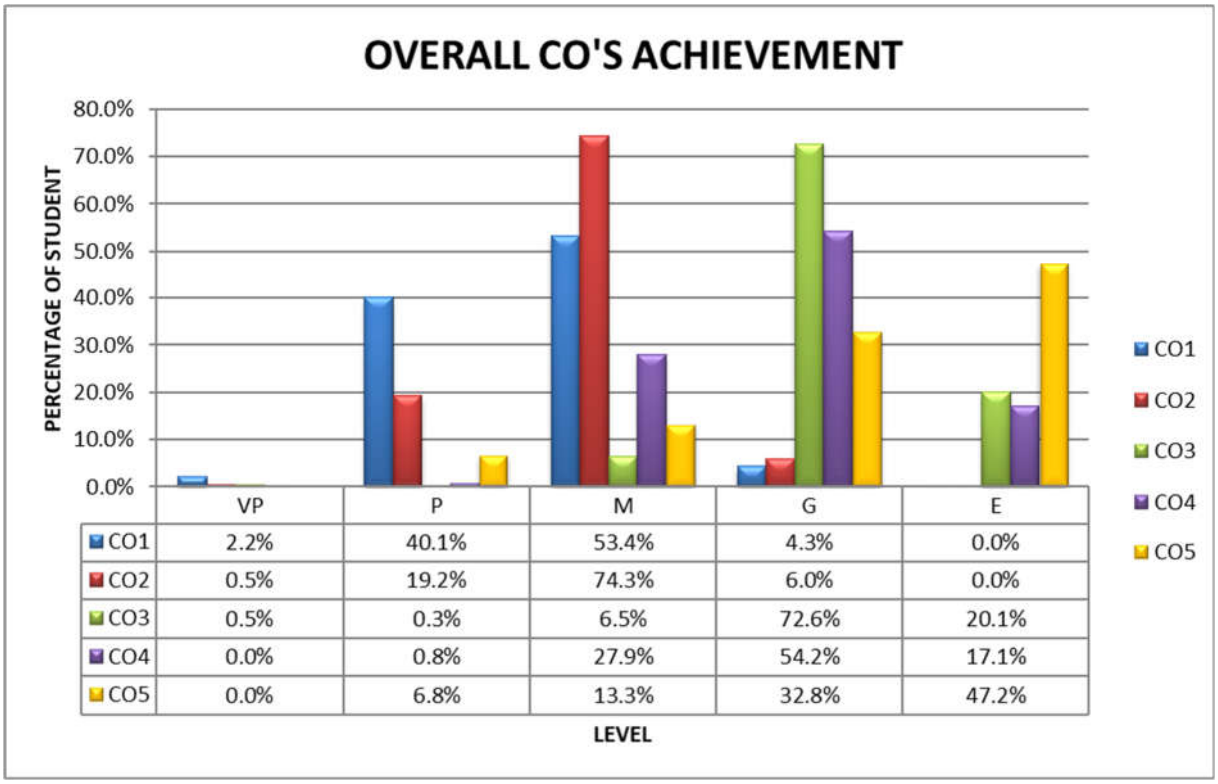
COURSE LEARNING OUTCOMES (CO)	METHOD OF DELIVERY	METHOD OF ASSESSMENT
CO1: Explain various concepts of Computer Aided Design (CAD), Engineering (CAE), and Manufacturing (CAM) in design, engineering, and manufacturing processes	• Face-to-Face and Online Lecture	• Final Test
CO2: Build the competency in applying the techniques available in CAD in order to construct, develop, and draft CAD models	• Face-to-Face (F2F) and Online Lecture • F2F and Online Practical Lab Sessions	• Lab Assignments • Lab Test • Mini Project Report
CO3: Explain and communicate effectively the design solutions for engineering problems and design systems, components, or processes that take into consideration public health, safety, cultural, societal, and environmental considerations	• F2F and Online Lecture • F2F Classroom Discussion	• Presentations for the Mini Project
CO4: Organize and report work independently as well as in a group during the project implementation	• Group Discussion • Problem-Based Learning	• Mini Project Report

COURSE LEARNING OUTCOMES (CO)	METHOD OF DELIVERY	METHOD OF ASSESSMENT
CO5: Adhere to ethical principles and commit to professional ethics and responsibilities and norms of engineering practice	• F2F and Online Lecture • Classroom Discussion	• Mini Project Report

Table 2.: Continuous Assessment (100%)

Assessment Components	CO Addressed	Weightage
TESTS		**50%**
1. Final Test	CO1	30%
2. Lab Test	CO2	20%
Mini Project and Assignments		**50%**
3. Lab Assignments	CO2	10%
4. Mini Project	CO2, CO4, CO5	15%, 10%, 5%
5. Presentation	CO3	10%

RESULTS AND DISCUSSION



	VP	P	M	G	E
CO1	2.2%	40.1%	53.4%	4.3%	0.0%
CO2	0.5%	19.2%	74.3%	6.0%	0.0%
CO3	0.5%	0.3%	6.5%	72.6%	20.1%
CO4	0.0%	0.8%	27.9%	54.2%	17.1%
CO5	0.0%	6.8%	13.3%	32.8%	47.2%

Figure 1.: Overall CO Achievement

Overall CAP Achievements

Figure 1 illustrates the comparative achievement levels across the five Course Outcomes (CO1–CO5) for students enrolled in the CAD course during the October 2024 – February 2025 semester. The results reveal a significant disparity in student performance across the cognitive, psychomotor, and affective domains. CO1, which measures students' theoretical understanding of CAD, CAE, and CAM concepts, recorded the lowest achievement. Only 57.8% of students scored 50% and above, falling short of the 75% Key Performance Indicator (KPI) target. This underperformance suggests persistent challenges in cognitive engagement, possibly due to poor preparation, low exam attempt rates, and a reliance on hands-on activities over theoretical mastery.

In contrast, CO2 showed moderate success with 80.4% achieving satisfactory and above, reflecting a reasonable level of practical competency in CAD model construction. However, gaps in engagement and consistency remain, particularly among students who did not complete lab activities or assignments. The most promising results were observed in CO3, CO4, and CO5, where over 93% of students achieved satisfactory or higher scores. These outcomes indicate strong development in communication, teamwork, and ethical awareness—core competencies in the affective and psychomotor domains. High performance in these areas suggests that the blended instructional strategies, group-based mini projects, and presentation components were effective in fostering applied skills and soft skill development.

Overall, Figure 1 highlights the need for targeted instructional interventions to improve cognitive outcomes (CO1), while reinforcing the successful strategies used in CO3–CO5 to ensure balanced performance across all learning domains.

Development of an Educational Assessment Software Tool

The structured CAP model can be translated into a digital platform or software solution that automates course outcome tracking, generates performance dashboards, and provides actionable feedback for instructors and students. This would be particularly valuable to higher education institutions seeking to:

- Ensure OBE and accreditation compliance
- Standardize assessments across multiple course sections
- Conduct real-time performance diagnostics

Such a platform could be developed as a subscription-based SaaS (Software-as-a-Service) model and marketed to engineering faculties, polytechnics, and technical training centres.

Curriculum Consultancy and Training Packages

Given the robust instructional alignment and proven assessment outcomes demonstrated in this study, the CAP-based framework could be packaged into professional development programs or consultancy services for academic institutions. These services may include:

- Customizable CO-PO mapping workshops
- CAP-based rubric development
- In-house academic staff training for OBE implementation
- Diagnostic audits for underperforming programs

This offers a revenue-generating path through institutional capacity-building engagements**.**

Policy and Accreditation Alignment Solutions

As countries shift toward outcome-driven education models, tools that directly support engineering accreditation bodies (e.g., EAC Malaysia, Washington Accord) are in high demand. The methodology outlined in the paper can serve as the foundation for compliance-ready templates, bridging the gap between teaching practice and audit-readiness for academic programs.

Potential for Research Commercialization and Licensing

The underlying methodology, once refined into a framework or toolkit, could be licensed to education technology providers or embedded within Learning Management Systems (LMS) (e.g., Moodle,

Blackboard). Integration with AI-driven analytics could further enhance predictive capabilities and personalized learning pathways.

CONCLUSION

The project presented in this study holds significant commercialization potential and future scalability**,** particularly within the fields of engineering education, educational technology solutions, and curriculum development. The innovative CAP-based assessment framework, grounded in Outcome-Based Education (OBE) principles, offers more than just academic insights—it introduces a replicable, scalable, and data-driven solution that can be commercialized for widespread use across institutions. In summary, this project has clear value beyond academia, offering commercially viable solutions that address ongoing challenges in learning assessment, quality assurance, and accreditation. With targeted development, this framework could evolve into a marketable educational innovation contributing to the digital transformation of technical and higher education globally.

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