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A Practice-oriented Assessment Approach of the Mechanical Engineering Diploma Final Year Project for the Application of Scientific and Engineering Knowledge

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Abstract

This article explores the implementation of an assessment structure for the Final Year Project (FYP) in engineering programs, specifically the Diploma in Mechanical Engineering at Universiti Teknologi Mara Johor. FYP serves as a culmination of acquired knowledge, emphasising the application of practical skills and industry relevance. The discussion highlights the transition from MQA to ETAC standards and the hands-on, prototype-oriented approach adopted by the institution. At the beginning of the program, accreditation was received by the Malaysia Qualifications Agency (MQA). At that time, the FYP spans 14 weeks, integrating theory classes and group projects guided by a supervisor. The mechanical engineering design course employs computer-aided engineering software, emphasising a structured design process, market research, and teamwork. Evaluation includes common and FYP-specific assessments, aiming for students to apply engineering software, analyse mechanical systems, and exhibit creative problem-solving. Restructuring the FYP structure allows students to apply theoretical knowledge, fostering independence and originality. ETAC's assessment criteria include an industry-based project that encourages the utilisation of modern technology. Good supervisor-student communication is vital, with a dedicated assessment. FYP phases involve planning, literature review, prototype design, fabrication, and final report presentation, promoting industry-related projects for practical experience and skill development.

Keywords: Final Year Project, Diploma, Mechanical Engineering, ETAC, Practical-orientated Project

Introduction

A good assessment structure for the final year project (FYP) is one of the essential requirements of the study program, including the engineering courses. The FYP course is the cumulative knowledge of theories and requires high practical skills to achieve the course outcome (Mateo et al., 2012). Students are expected to apply the fundamentals of engineering

principles, related theories, and practical to develop solutions to the assigned project. Through the project, student's problem-solving skills will be tested and evaluated (Mateo et al., 2012). FYP equipped the student by providing the initial idea and helping to bridge the gap between industries and learning institutions' requirements. A diploma student is expected to gain specific technical knowledge and skills in supporting engineering activities. The course allows the student to apply the knowledge and skills acquired for undergraduate study, either diploma or degree, to produce the product or research relevant to their study plan (Haldenwang, Slatter, & Pearce, 2006). It is also important to mention that the FYP has been studied in natural sciences and engineering, where it has become a major component of department curricula (Ku & Goh, 2010; Orsmond et al., 2004; Vitner & Rozenes, 2009).

The growing concern among stakeholders, especially the industries and governments, pushes for better program accreditation standards for engineering programs. In 2020, a new engineering technician education program accreditation standard, ETAC, was introduced by the Board of Engineering Malaysia. Accreditation aims to align engineering education programs with global standards, ensuring the highest quality and continual improvement. This commitment spans 76 higher learning institutions, accrediting 261 Diploma and 77 Degree programs.

Graduates must register with the Board of Engineering Malaysia (BEM) to practice in the country, with accreditation from ETAC being a prerequisite. Non-registration is considered an offence covered under the Registration of Engineers Act 1967. Accreditation by ETAC assures BEM and stakeholders that graduates possess the requisite skills and competencies outlined in ETAC Engineering Accreditation and Education Program Standards, endorsing the credibility of engineering, engineering technology, and engineering technician programs in Malaysia (Ma & Mendoza, 2022; Mokhtar et al., 2023).

The FYP runs based on the campus, as program accreditation is evaluated separately. Universiti Teknologi Mara Johor branch, Campus Pasir Gudang (UiTM Pasir Gudang) runs the FYP entirely based on prototype fabrication to cope with practical-orientation project assessment. Students are expected to apply the mechanical engineering knowledge gained in the previous and current semesters to solve the assigned FYP. The project scope can come from various sources, including those proposed by the student, industry projects, or those suggested by the supervisor, which cover a wide range of well-defined engineering problems.

The motivation for this article is to explore the FYP course in the Diploma of Mechanical Engineering based on MQA and ETAC, as the difference is quite large, and the transition made for a particular course is not well known. The article's objective is to discuss the transition from MQA to the current syllabus of ETAC in preparing students and how the course is carried out to achieve the course outcome. The article begins with a general overview of the diploma program in Mechanical Engineering based on MQA, restructuration based on ETAC and the implementation of FYP as required by ETAC.

Diploma Program in Mechanical Engineering Based on MQA

The main objective of the final year project is to provide the platform and opportunity for the student to demonstrate their capability to carry out the mechanical engineering problem-solving process by applying the knowledge suitable for the diploma level. During the process, the student will develop the skill and establish specific methods comparable to those used in the industrial sector in an efficient and well-defined manner.

Previously, the Diploma in Mechanical Engineering offered by UiTM Pasir Gudang was accredited by the Malaysia Qualifications Agency, MQA. For this accreditation, FYP was placed

under the Mechanical Engineering Design course, which required the student to complete their FYP by the group for 14 weeks of study time, including the theory classes. All the students focused on the group project with the supervisor's guidance. They needed to fabricate the prototype and, at the end of the project, produce the final report for evaluation.
The Malaysia Qualifications Agency (MQA) is a statutory body established in Malaysia that oversees and assures the quality of higher education. The body is the principal reference point for developing and maintaining the Malaysian Qualifications Framework (MQF). The MQF is a unified system that integrates and sets standards for qualifications offered in Malaysia, ensuring consistency and comparability."
This course deals with the design process and using computer-aided engineering software to design and analyse mechanical engineering problems. The design process begins by identifying a problem statement of the interested study. After identifying market demand, a survey was conducted to collect information regarding the user and customer perspectives. Each progress depends on the lesson plan from the resource representative, which means the lecturer teaches the students during the class section, and students progress based on the taught topic. Execution of the project is structured in the team. After the problem statement and market demand are well defined, each team member designs a mechanical device, machine, or system for the desired tasks or functions. The team plans and executes design tasks such as preparing detailed drawings and specifications and producing a prototype. The project is chosen to incorporate most of the knowledge and skills acquired throughout the program of study.

The eight important elements of mechanical engineering design are taught in the class to guide the student to complete the project as follows (Ghannam & Chan, 2023)
1. Introduction to engineering design: *Include definition and concepts of mechanical engineering design*
2. Need identification, problem definition, and planning: *Included identifying customer's need, customer requirement, product design specification, planning the design process, team behaviour, and Gantt chart*
3. Concept generation and evaluation: *Included concept generation method and Pugh's Method for Evaluation*
4. Embodiment design: *Included product architecture, configuration design and parametric design, design for manufacture and design for assembly, design for environment, ergonomic and human factors design*
5. Detail design: *Included activities and decisions in detail design, modelling, and simulation*
6. Cost evaluation: *Include categories of cost and methods of developing cost estimates*
7. Communication and project management: *Included communicating the design, written report, and oral presentation*
8. Contemporary issues and related topics: *Latest Development and Technology in Product Design and Ethics and Legal Factors in Design.*

The course evaluation is divided into two sections: The first is a common assessment of the test and assignment. The second is an FYP-related assessment of the project report and presentation. The teaching lecturer covered the first section of the evaluation, and the FYP supervisor for the project report evaluated the second section. In contrast, the invited judge evaluated the presentation.

It is expected that upon completion of this course, students will be able to demonstrate the use of computer-aided engineering software to solve identified engineering design problems. Besides, analyse the simple mechanical components integrated into a mechanical system using computer-aided engineering software. At the same time, demonstrate the ability to apply creative, imaginative, and innovative thinking and ideas to problem-solving.

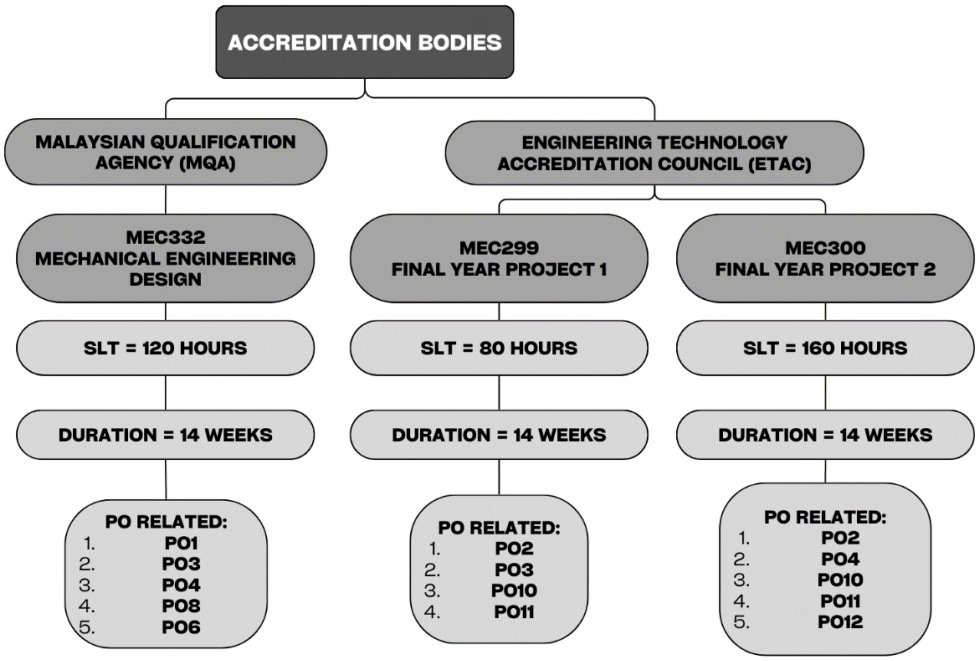

Figure 1. Information on the different approaches to the Mechanical Engineering Design and FYP courses.

Restructure The Diploma Program in Mechanical Based on Etac

The Engineering Technology Accreditation Council (ETAC) functions as a delegated body under the support of the Board of Engineers Malaysia (BEM). Its pivotal role ensures a smooth transition in accrediting Engineering Technology and Engineering Technician education programs. Acknowledged as the exclusive accrediting body for engineering technology bachelor degrees, engineering diplomas, and engineering technology diploma programs in Malaysia, ETAC plays a crucial role in upholding the quality and standards of these educational offerings.

The authority for accreditation arises from the BEM's responsibility to ensure that the education programs for engineers, engineering technologists, and technicians meet global standards. ETAC, in alignment with BEM's objectives, will uphold high accreditation standards and serve as a platform for positive change within Malaysia and the broader region. ETAC's dedication to Outcome-Based Education (OBE) principles and the incorporation of Continuous Quality Improvement (CQI) methodologies highlights the commitment to the accreditation process (Council, 2020). ETAC seeks to ensure that graduates from accredited programs meet the minimum academic requirements for registration and foster a culture of continual improvement in higher learning institutions. Figure 2 shows the difference in qualifying requirements and accreditation criteria between MQA and ETAC. The requirements, criteria, and approach differ for both bodies. However, the aims and objectives remain the same.

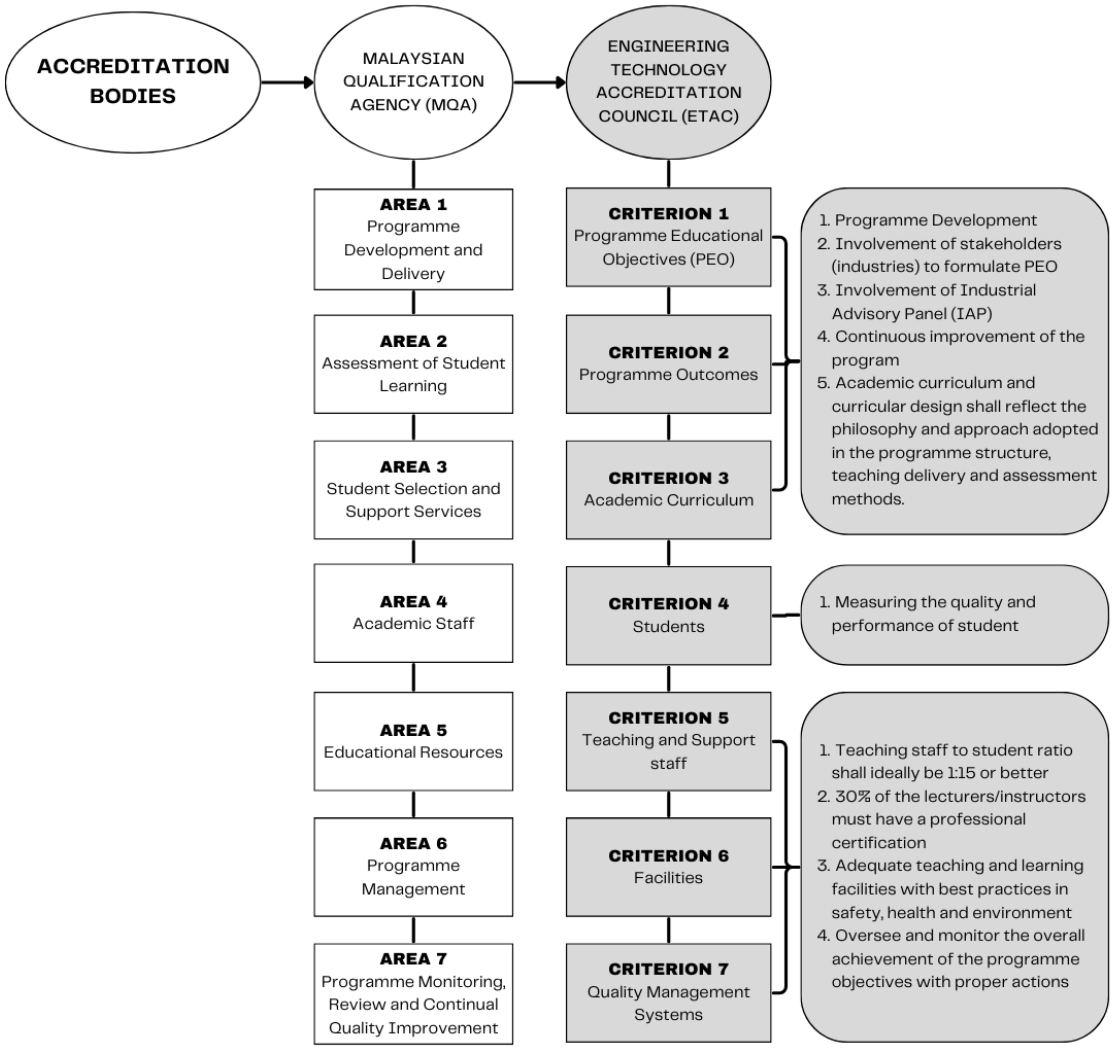

Figure 2. There is a difference in qualifying requirements and accreditation criteria between MQA and ETAC.

A new course structure was introduced to FYP to allow students to apply and integrate theoretical knowledge and principles taught in the diploma study in solving engineering problems. It also provides the opportunity for the students to demonstrate independence and originality, as well as to plan and organise a project over a certain period.

The registered students adhere to 6 credit hours, two (2) credit hours for FYP1 and four (4) credit hours for FYP2, respectively. The assessment occurs throughout the learning semester, and the designated evaluation session lasts 14 weeks. The course carries a total of 6 credits, equivalent to 80 student learning hours for FYP1 and 160 student learning hours for FYP2. The evaluation was divided into two parts: Supervisor and panel evaluation. The supervisor was assigned to monitor student's performance and their reported logbook. At the same time, panel evaluations evaluate students' presentations and final report, also known as a thesis. The aim of having several FYP evaluators assess the project is to ensure there is no bias in giving the project marks.
Further evaluation consideration for result moderation will be carried out if there are 25 per cent differences between the panel's marks. In addition, for the FYP, there is a requirement

to make sure each student is evaluated individually for most of the evaluation session. Compare this to the program based on the MQA explained in the previous section.

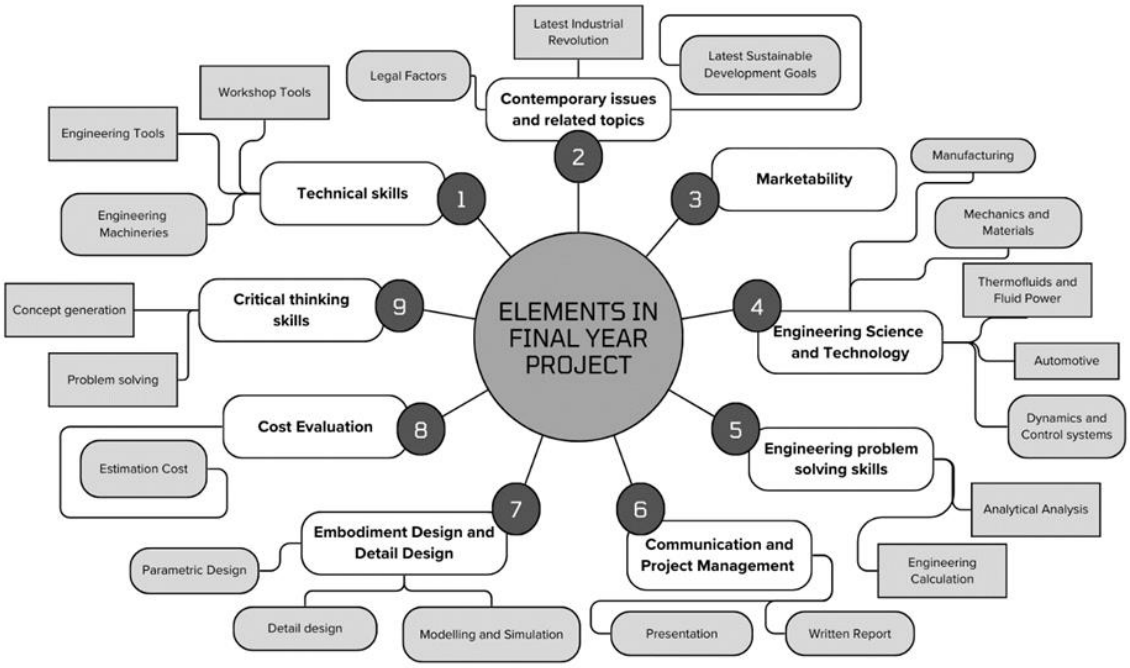

Figure 3. UiTM Pasir Gudang implemented elements in the Final Year Project.

The ETAC assessment related to the diploma involves seven criteria, which FYP includes in Criterion 3 Council (2020), for the academic curriculum can be an industry-based or practice-oriented project to introduce a real professional approach to the practice. ETAC recommends implementing modern technology in FYP and allowing such a computer simulation to analyse the design. UiTM Pasir Gudang implemented the recommendation by providing guidelines for students to fully utilise all the elements that must be included in FYP, as shown in Figure 3. Note that the SolidWorks software package available on campus designs and analyses the simulated products based on the finite element approach.

Good supervisor-student communication is important to establish during the course. Some marks are dedicated to the supervisor as a performance assessment to ensure students feel supported and guided Sánchez et al (2014), besides for continuous progress monitoring. Classical face-to-face or online meetings can be used to discuss and share with their supervisor. A handwriting logbook ensures students apply a systematic way of managing the project. All the required information regarding the project will be recorded logically and in detail.

1. Project planning: *Include project title, background study, problem statement objective, scope, significance of the study*
2. Literature review: *Include analysis of the literature and previous studies, data collection and product benchmarking, and identify gap and solving method*
3. Detailed prototype design and fabrication: *Include design generation, fabrication process, testing, and improvement*
4. Completion of the prototype and final report and presentation: *Include report submission, prototype demonstration, project presentation, and evaluation*

It encourages the student to select a project related to the industry for the project. The selection of an industrial project could connect higher learning institutions and industries by providing a platform for general and specific industrial-related knowledge and nurturing technical skills. Besides, it also introduces the student to industrial work situations based on the real problem. In addition, the related project will also expose students to the proper method and technique in handling machines and equipment as required.

The Conclusion Example of Fyp Project and Implementation

Execution of the FYP involves three main steps: project proposal, fabrication, and evaluation. The tasks are divided into two parts, FYP 1 and FYP 2, carried out for two semesters. Figure 4 shows an example of the prototype produced by the student. For FYP 1, the student must produce the proposal after the identified problem statement. While completing the proposal, students produce the prototype design using Solidworks, as in Figure 4(a). Complete prototype assembly and part drawing are required for the student to submit.

Figure 4. An example of the FYP prototype produced by the student

FYP 2 focused more on the fabrication process. Students were required to produce prototypes, as in Figure 1(b). It expected students to apply all related manufacturing processes such as welding, metal forming, lathe, milling, drilling, and cutting. The aim is to make sure students apply the process that they learned. Besides all the mentioned processes, students can also

use 3D printing and laser engraver for certain parts. One of the initiatives is to prepare students with new technology as the technologies widely used in precision cutting and engraving processes.

The design and prototype are reported in the FYP dissertation as academic reports. The report does typically not exceed 100 pages, including relevant prototype design and drawing, flow chart and figure, explanation, and discussion. The assessment method is based on a dissertation divided into an Introduction and literature review, methodology, result, discussion conclusion, and recommendation section.

Continued assessment was carried out to ensure students stayed supervised by the supervisor systematically for the whole semester. The continuous evaluation is carried out based on the weekly meeting and logbook. All the progress captured and how students implement the project can be acknowledged. Professional manner captured through presentation included content and presentation skills, including critical thinking and analysis, problem-solving, and communication. To answer the question, the students will recall and relate all the knowledge and theory gained from the first semester to the present semester to their FYP prototype.

An important element of sustainability was included as one of the important elements in the final year project. The objective is to prepare university graduates for future employment, focusing on the technical aspects suitable for diploma level and helping students adapt to the needs of fast-changing industries.

Discussion

Skills development is critical to students as it equips them with the tools necessary for success in engineering and life. ETAC emphasises the need for graduates to be equipped with diverse skills beyond academic knowledge to prepare for the industrial challenge (Mateo et al., 2012). The FYP at UiTM Pasir Gudang is conducted entirely based on prototype fabrication to cope with practical-orientation project assessment. The prototype-based FYP required the student to utilise the CAD software for 3D modelling and analyse the prototype before fabrication. The students must then present their project and submit the FYP dissertation and logbook, following the formats and guidelines provided. Having these approaches to complete the FYP helps the students enhance their skills and acquire new knowledge and experience in project work related to mechanical engineering and other related technical areas. In addition, this course provides the students with informal training on the critical elements of project management, such as time management, problem-solving, critical thinking, communication, technological proficiency, lifelong learning, financial literacy, and teamwork and leadership for those who perform the project in the group. By cultivating these skills, graduates can enhance their employability, adaptability, and overall success as they enter the workforce and progress.

The FYP run by UiTM Pasir Gudang consists of two phases: FYP1 and FYP2. BEM requires the student to independently demonstrate up-to-date knowledge and information about the project through the entire FYP. Individually, the FYP1 allows students to apply knowledge and skills acquired in all previous courses to undertake problem identification, formulation, and solution of a well-defined engineering problem. The course is aimed at fostering independent thinking and develop problem-solving skills. It focuses on the ability of the students to identify a problem of their interests and then formulate it for further development in the following semester. The students will have to do a literature review and develop project planning.

On the other hand, the FYP2 allows students to apply knowledge and skills acquired in earlier courses to solve an engineering problem. It focuses on the execution of the project by performing and implementing the appropriate tasks based on methodologies stipulated in the

FYP1 systematically and effectively toward the completion and achievement of the project objectives. Students will have to evaluate the results from analyses performed critically and further interpret project outcomes through effective communication in a structured format and in a professional manner.

ETAC demands that the FYP is compulsory for all students and shall be assessed individually and independently. The superiority of an individual final-year project provides potential advantages compared to a group project. In an individual project, a student assumes complete responsibility for the entire project. This can instill a strong sense of ownership, as the success or failure of the project rests solely on the individual's efforts. This level of accountability may be beneficial for personal and professional growth. Besides, it allows the student to focus on developing a wide range of skills, including research, analysis, project management, and presentation skills. This holistic skill development can benefit future career endeavors besides knowledge transfer.

Skills development instils a mindset of lifelong learning. Students need to learn and adapt continuously to complete the project. Progressive feedback from peers, assistant lecturers, and lecturers plays a crucial role in executing this project. Active involvement and participation tend to increase when execution students are not only specifically involved in their project but also receive, respond, and manage the feedback from other related persons, indirectly exposing students to the important work's context element of collaboration.

To score a good grade in FYP, students should demonstrate their capability to their supervisor and panel of examiners by considering the following items:

1. Final fabricated prototype: The *prototype must be fully functional and consider several aspects, such as safety, quality, aesthetics, and novelty.*
2. Presentation: *Always deliver ideas confidently and effectively, and be capable of answering/responding to the question asked.*
3. Dissertation: *Provide informative, sufficient, specific, and detailed information related to the content and follow the format accurately*.
4. Logbook: *The logbook is exceptionally detailed information on the project/research and progress.*
5. Good relations with supervisor: *Always update and discuss the current progress of the project with the supervisor.*

Conclusion

In conclusion, a well-structured assessment framework for the Final Year Project (FYP) is important to engineering education, shaping the culmination of acquired knowledge and skills. Traditionally accredited by the Malaysia Qualifications Agency (MQA), the FYP at UiTM Pasir Gudang emphasised group projects, prototype fabrication, and adherence to mechanical engineering principles with designated class. The shift to the Engineering Technology Accreditation Council (ETAC) standards in 2020 marked a transformative period, emphasising Outcome-Based Education (OBE) principles and Continuous Quality Improvement (CQI) methodologies. ETAC's accreditation, mandatory for graduates' Board of Engineering Malaysia (BEM) registration, ensures alignment with global standards, enhancing the credibility of engineering programs nationwide.

Under the MQA, the focus was on comprehensive mechanical engineering design, utilising computer-aided engineering software. The course covered essential aspects such as problem

identification, market demand analysis, and detailed design tasks, guided by eight key elements. Evaluation encompassed common and FYP-specific evaluations, aiming for creative problem-solving and engineering software application. Transitioning to ETAC brought significant changes, including a revamped FYP structure aligning with ETAC's criteria. The emphasis on academic curriculum, industry-based projects, and modern technology integration reshaped the FYP. UiTM Pasir Gudang implemented ETAC recommendations, incorporating computer simulation tools like Solidworks for design and Finite Element Analysis for strength analysis. Effective communication between supervisors and students and systematic project management through logbooks became crucial components.

FYP phases evolved to include project planning, literature review, detailed prototype design, fabrication, and a comprehensive final report and presentation. Industry-related projects gained prominence, nurturing practical skills and connecting students with real-world challenges. The assessment process, spanning FYP 1 and FYP 2, involved continuous monitoring, weekly meetings, logbooks, and a final dissertation. The continuous assessment ensured systematic progress, while the dissertation included key sections like introduction, methodology, results, discussion, and recommendations. The assessment extended to presentations, evaluating critical thinking, problem-solving, and communication skills.

Sustainability emerged as a vital element in FYP, preparing graduates for evolving industries. The objective remains to equip students with technical proficiency at the diploma level and encourage adaptability to meet industry demands. The transition from MQA to ETAC reflects a commitment to global standards, ensuring the relevance and excellence of engineering education in Malaysia.

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