# ANALYZING THE ATTAINMENT OF COURSE OUTCOMES IN STATICS COURSE FOR DIPLOMA IN MECHANICAL ENGINEERING PROGRAM UiTM CAWANGAN PULAU PINANG DURING THE COVID-19 PANDEMIC

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**Article history**
Received
*3rd March 2023*
Revised
*29th September 2023*
Accepted
*6th November 2023*
Published
*1st December 2023*

## ABSTRACT

*The outbreak of Covid-19 in 2020 had a significant impact on the delivery of educational courses, including lectures, labs, workshops, and assessments. In this study, the focus was on the Statics course, which is mandatory for all Diploma in Mechanical Engineering UiTM Cawangan Pulau Pinang students. The primary aim was to determine the achievement of course outcome (CO) during the pandemic. Three course outcomes were mapped for the methodology. The findings revealed that there were variations in the attainment of all COs, particularly CO3. Therefore, it can be concluded that the assessment of COs might have influenced the overall achievement rates for each CO.*

**Keywords**: *Covid-19, program outcome, course outcome, assessment*



## 1.0 INTRODUCTION

Outcome-based education (OBE) has become increasingly important in the field of engineering education, as demonstrated in the four papers under review. A.A. Mutalib et al. [1] described a study on measuring programme outcome (PO) in Civil Engineering programmes at Universiti Kebangsaan Malaysia (UKM). The authors investigated six programme objectives and twelve programme outcomes, measuring them in five specific courses. They used various methods to evaluate PO achievement, including assessments, surveys, and analysis of course materials. The study concluded with a comparison between the measurements of PO achievement by lecturers and by final year students, providing a useful reference for lecturers in the future. J.S. Thomas et al. [2] explored the use of an asynchronous format for teaching mechanics of materials in a problem-solving course. Asynchronous delivery relies heavily on internet delivery of instructional materials, making it a viable option for instructors with large classes or heavy workloads. The authors found that student performance remained high with the use of asynchronous delivery and suggest that it can be an effective way to teach engineering courses. Although the study identified some differences in performance between higher and lower-ability students, these differences were not statistically significant.

S.A. Osman et al. [3] evaluated the achievement of programme outcomes (POs) for a Reinforced Concrete Design course at UKM. The authors compared the PO achievement of students in two different sessions and assessed the effectiveness of the Continuous Quality Improvement (CQI) approach. The study found that PO achievement increased by 9-39% in the second session compared to the first, demonstrating the effectiveness of the CQI approach. The authors also identified the importance of real-world projects in achieving POs, since the Reinforced Concrete Design course requires students to work on design projects related to actual structural design


DOI: https://doi.org/10.11113/jm.v46.483

projects. Then, S.A. Osman et al. [4] focused on assessing course outcomes (COs) for Civil Engineering Design II at UKM. The authors measured the achievement of eight COs, which were assessed based on students' performance on written reports, bill of quantities reports, presentations, and peer assessments. The study found that CO6 and CO8 achieved the highest overall levels of achievement, while CO7 had the lowest achievement level among all the COs. The study highlighted the importance of continuous assessment and evaluation in improving teaching and learning methods.

C. Boulatoff and T.L. Cyrus [5] addressed the challenges of large introductory courses and proposed strategies to enhance student outcomes. They observed that active learning methods, such as group activities and discussions, improved student engagement and performance. Similarly, R.A. K. and A.M. Hunashyal [6] investigated the use of contextual learning to enhance students' understanding of mechanics of material concepts. The authors concluded that real-world examples helped students better comprehend complex theories and improve their learning outcomes. Furthermore, L. Gutierrez-Bucheli et al. [7] reviewed the literature on sustainability in engineering education and identified the learning outcomes associated with this field. They stated that incorporating sustainability topics in engineering courses improved students' critical thinking and problem-solving abilities. In addition, M.R. Jadhav et al. [8] evaluated the impact of outcome-based education in engineering and found that it helped students develop their practical skills and problem-solving abilities.

G. Na et al. [9] assessed the effectiveness of laboratory courses in achieving program outcomes. They found that structured evaluation of laboratory content improved students' understanding of fundamental concepts and their practical skills. Furthermore, T. Hernandez et al. [10] evaluated the outcomes of remote pathology instruction and found that it did not have a significant impact on students' performance or course evaluation. Previously, W. Bosshardt and E.P. Chiang [11] investigated the long-term impact of online principles courses on students' outcomes. They observed that students who took online courses performed as well as those who took in-person courses, and their long-term outcomes were not negatively affected. Lastly, X. Wei et al.[12] conducted a systematic review of the literature on massive open online courses and found that these courses can be effective in achieving cognitive, behavioral, and affective learning outcomes.

However, the global landscape was jolted by the unexpected advent of the Covid-19 disease, which swiftly transitioned from being an epidemic to a pandemic, affecting a considerable portion of the global population [13]. As a result, the conventional in-person approach to teaching and learning underwent a paradigm shift, replaced by the widespread adoption of online technology. In response to these circumstances, international organizations like the United Nations' scientific and cultural bodies advocated for the utilization of diverse technologies to ensure the continuity of education, despite the challenges faced by both educators and students due to the nationwide pandemic. Educators were encouraged to employ online learning platforms for instructional delivery, interactive sessions, and virtual training opportunities [14]. Similarly, the evaluation process, a vital component of education, could be effectively executed through online means, including assignments, projects, quizzes, and examinations. Nevertheless, reservations persist regarding the complexity of conducting assessments in an online environment. In addition to these concerns, maintaining the standards of privacy and confidentiality in virtual education is imperative for ensuring successful evaluations, even though the online methods might appear novel in light of the directive from the Kementerian Pengajian Tinggi (KPT), the Ministry of Higher Education. Furthermore, the evaluation of practical skills presents greater challenges in a virtual assessment setting [15].

In their 2023 study, D.R. Selvam et al.[16] examined the stress levels of higher education students using e-learning during the Covid-19 pandemic. The research highlighted a significant increase in stress, attributed to sudden academic changes and personal factors. While cognitive and social stress were evenly distributed, greater stress emerged from academic adaptations, family dynamics, and individual circumstances. In a distinct investigation, D. Wang et al.[17] conducted an extensive survey focusing on sub-Saharan African adolescents. The study unveiled persistent challenges caused by the pandemic on education and mental well-being. Collaborative cross-sector

 DOI: https://doi.org/10.11113/jm.v46.483

efforts were underscored as essential to counteract these adverse effects, preventing further setbacks in education and mental health among sub-Saharan African adolescents during the ongoing pandemic.

During the global Covid-19 pandemic, educational institutions were forced to transition to online teaching, highlighting challenges like inadequate skills, resources, and technological limitations. E.F. Okagbue et al.[18] investigated the pandemic's impact on Nigeria's education system, revealing that students' and teachers' lack of digital proficiency hindered their acceptance of web-based learning and smart educational tools. In another study, F. Recch et al.[19] examined worldwide school closure trends during the pandemic, using examples from Brazil and India. Their insights underscored the need for improved data across governmental, educational, and household domains to aid educational recovery and informed policymaking. Additionally, Salsabila Isha and Bambang Wibawarta [20] explored Japan's elementary schools during the pandemic, uncovering a technology gap between basic and higher education levels. Basic education in Japan struggled to integrate technology effectively, as evidenced by their data-driven analysis.

Family background significantly influenced education during the Covid-19 pandemic. H. Akabayashi et al.[21] examined factors impacting online education access, both within and beyond formal settings, and parental preferences for in-school online learning. They found that children from privileged families had more access to both in-school and extracurricular online education. The pandemic had a profound impact on students. In another study by J Ferrer et al.[22], an analysis investigated academic changes in university students as they transitioned to in-person learning after Covid-19 restrictions. Active tutorial participation and positive perceptions of online teaching correlated with improved academic performance. Conversely, those with Covid-19 effects and limited resources saw declines.

Reviewing pandemic effects on higher education, R. Imran et al.[23] analyzed 68 studies, revealing blended teaching (combining online and in-person) as promising for post-Covid-19 education. Similarly, R. Mahajan et al.[24] reviewed management education research (2020-2022), identifying themes like digital learning, collaboration, and embracing uncertainty. They emphasized improved educational quality and preparing future business leaders. Presently, A. Abidemi et al.[25] introduced a non-linear model to assess Covid-19's impact on higher education students, simulating various control combinations to reduce infections.

Overall, these literature reviews present significant findings regarding the assessment and evaluation of course outcomes (COs) in engineering education. These findings highlight the effectiveness of active and contextual learning methods, as well as outcome-based education, in enhancing students' outcomes in diverse fields of education. The reviews also highlight the potential of online courses to achieve long-term learning outcomes. The studies emphasize the importance of incorporating real-world projects, utilizing outcome-based education (OBE) and continuous quality improvement (CQI) approaches, and implementing continuous assessment and evaluation in improving students' performance and attaining program outcomes. The authors used a variety of assessment methods, including final and mid-semester exams, tutorials, group projects, written reports, presentations, peer assessment, and bill of quantities reports, to evaluate program or course outcomes. Furthermore, all the studies aimed to enhance the quality of teaching and learning in their respective programs. In general, these studies collectively provide insights into the challenges, opportunities, and strategies associated with higher education during the ongoing Covid-19 pandemic.

In the current study, the Course Outcomes attainment for the course Statics are discussed. The study focuses on the group of individuals who registered for the Statics course between February 2020 and February 2023. The course is compulsory for first-year, second-semester students studying Diploma in Mechanical Engineering at UiTM Cawangan Pulau Pinang. Additionally, the evaluation of the assessment during this period is also examined.

 DOI: https://doi.org/10.11113/jm.v46.483

## 2.0 METHODOLOGY

This study pertains to students who enrolled in the Statics course from February 2020 to February 2023, which is mandatory for first-year, second-semester students Diploma in Mechanical Engineering. To be eligible for the course, they must have attained a minimum grade of C in the Fundamental Physics course in the previous semester. Statics serves as a prerequisite for three other courses. Statics is a crucial course, consisting of seven chapters that need to be covered in 14 weeks of lectures, with 3 credit hours. Each week, students have three hours of lectures and one hour of tutorials. The average number of students attending a lecture range from 20 to 30. Failing Statics could result in an extended semester for students.

Table 1 outlines the program outcomes (POs) and course outcomes (COs) for Statics. The course focuses on three POs and three COs. PO1 emphasizes the application of knowledge in mathematics, science, and engineering to practical procedures and practices. PO2 focuses on the identification and analysis of well-defined engineering problems, with substantiated conclusions based on relevant analysis methods specific to their field of activity. Lastly, PO3 stress on solutions for technical problems and aiding in the design of systems, components, or processes that meet specified needs, considering public health and safety, societal, cultural, and environmental considerations.

The COs include CO1, which emphasizes the description of basic engineering concepts and principles. CO2 and CO3 focus on applying basic principles of engineering statics to solve problems in simple engineering structures and evaluate engineering statics problems using systematic and logical approaches, respectively. The cognitive domain represents the domain for Statics, as shown in Table 2, which indicates the percentage of assessment questions for each assessment type, including quizzes, tests, assignments, and final exams.

**Table 1**: PO-CO mapping

| | PO1 | PO2 | PO3 |
|---|---|---|---|
| CO1 | / | | |
| CO2 | | / | |
| CO3 | | | / |

**Table 2**: Cognitive domain in statics

| Cognitive Level | Percentage (%) |
|---|---|
| C1-C2 | 30 |
| C3-C4 | 60 |
| C5-C6 | 10 |

## 3.0 RESULTS AND DISCUSSION

### 3.1 Introduction

This section covers the assessment method and CO attainment from February 2020 to February 2023, with the July intake consisting of newly enrolled students in Statics. However, the February intake caters to repeat students. It is worth noting that in some instances, students who repeat the Fundamental Physics course may register for Statics with repeaters, even if it is their first-time taking Statics. As for PO attainment, it reflects the attainment of CO since CO-PO mapping is one-to-one as tabulated in Table 1.

 DOI: https://doi.org/10.11113/jm.v46.483

### 3.2 Assessment

The assessment methods employed in the course were quiz, test, assignment, and final exam, with all assessments conducted online except for February 2023 (quiz was assessed by online method and the rest was face to face) as tabulated in the Table 3. The use of online assessments was due to the Covid-19 pandemic, which affected the world in 2020. Quiz was used as an assessment tool from February 2022 until February 2023, and represented 20% of the overall assessment weightage.

For Test 1, the weightage of the assessment was only 10% in February 2020 and February 2022 until February 2023, but increased to 30% in July 2020 and February 2021. The weightage of Test 1 assessments dropped to 0% in July 2021, indicating no Test 1 in that semester. Test 2 was only conducted in February 2020 and represented 10% of the assessment weightage.

The weightage of Assignment 1 decreased from 20% in February 2020 to 10%-20% in the following semesters, except for July 2021 where it increased significantly to 30%. The weightage of Assignment 1 remained constant at 20% in the subsequent semesters. The weightage of Assignment 2 fluctuated between 20% and 35%. It was 35% in the July 2020 and February 2021 semesters but decreased to 20% in the July 2021 semester. Assignment 3 was conducted only twice, in the July 2020 and February 2021 semesters, representing 25% of the assessment weightage.

For the final exam assessment, the weightage was 60% in February 2020, but was 50% in the July 2021, February 2022, July 2022, and February 2023 semesters. This indicates that the final exam had an equal weightage as other components in determining the final grade for these semesters.

**Table 3**: Assessment for statics

| Sem | Quiz (%) | Test 1 (%) | Test 2 (%) | Assignment 1 (%) | Assignment 2 (%) | Assignment 3 (%) | Final Exam (%) |
|---|---|---|---|---|---|---|---|
| Feb 2020 | - | 10 | 10 | 20 | - | - | 60 |
| July 2020 | - | 30 | - | 10 | 35 | 25 | - |
| Feb 2021 | - | 30 | - | 10 | 35 | 25 | - |
| July 2021 | - | - | - | 30 | 20 | - | 50 |
| Feb 2022 | 20 | 10 | - | 20 | - | - | 50 |
| July 2022 | 20 | 10 | - | 20 | - | - | 50 |
| Feb 2023 | 20 | 10 | - | 20 | - | - | 50 |

The COs assessed for each evaluation are presented in Table 4. It can be observed that only CO1 was evaluated in the quiz during the period from February 2022 to February 2023, whereas it was not assessed before this time frame. CO2 and CO3 were not evaluated in any of the quizzes. Regarding the tests, CO1 was evaluated in either Test 1 or Test 2 during the February 2020 and February 2022 semesters only, and not in the other semesters. CO2 was evaluated in four instances, which were February 2020, February 2022, July 2022, and February 2023. All COs were evaluated in the assignments for all semesters, except for CO1 in the February 2022 to February 2023 semester. Finally, CO1 and CO2 were evaluated in the final exam for all semesters, whereas CO3 was evaluated in the February 2020, February 2022, and July 2022 semesters.


DOI: https://doi.org/10.11113/jm.v46.483

**Table 4**: Details of CO in assessment

| | Quiz | | | Test | | | Assignment | | | Final Exam | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sem | CO1 | CO2 | CO3 | CO1 | CO2 | CO3 | CO1 | CO2 | CO3 | CO1 | CO2 | CO3 |
| Feb 2020 | | | | / | / | | / | / | / | / | / | / |
| July 2020 | | | | | | | / | / | / | / | / | |
| Feb 2021 | | | | | | | / | / | / | / | / | |
| July 2021 | | | | | | | / | / | / | / | / | |
| Feb 2022 | / | | | / | / | | | / | / | / | / | / |
| July 2022 | / | | | | / | | | / | / | / | / | / |
| Feb 2023 | / | | | | / | | | / | / | / | / | |

### 3.3 CO1 Attainment

Figure 1 presents notable fluctuations in the attainment of CO1 over time. For instance, the CO1 attainment for February 2020 was 65.8%, whereas it reduced to 55% in February 2023. Despite this, there was a rise in CO1 attainment from July 2020 to February 2022. However, the attainment for February 2023 dropped significantly from the preceding semester in July 2022. February 2022 recorded the highest CO1 attainment at 95%, and July 2021 saw a significant increase in attainment at 72.4%, compared to the previous semester in February 2021 with 58.3%. The data suggests that the CO1 attainment has experienced considerable variation over recent years, with some semesters recording higher pass rates than others. Nonetheless, there is an overall upward trend of pass rates over time. The instructional approach remained consistent throughout all semesters, utilizing online methods. Students appeared to adapt well to this approach during the period from April 2021 to April 2022.

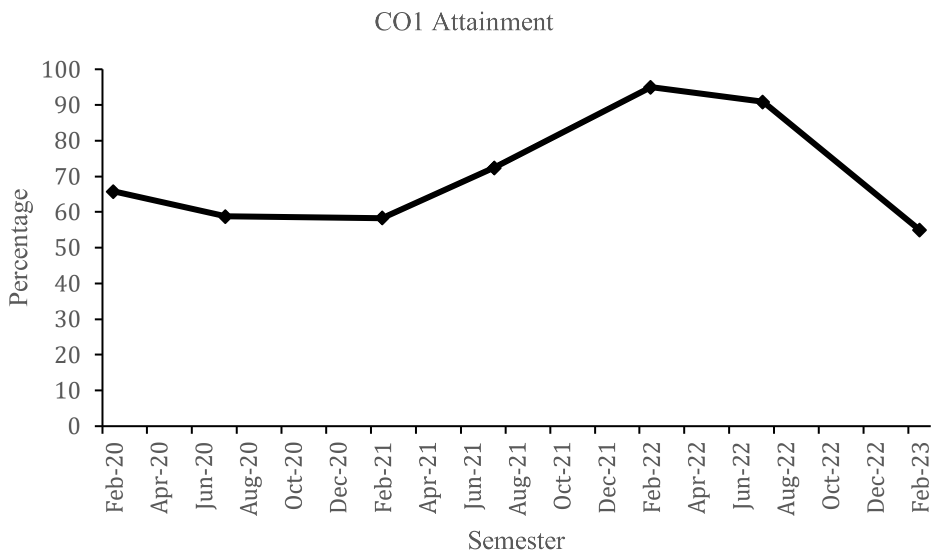


**Figure 1:** CO1 Attainment at different semester

 DOI: https://doi.org/10.11113/jm.v46.483

### 3.4 CO2 Attainment

The attainment levels presented in Figure 2 exhibit substantial fluctuation over time. Notably, there was a remarkable disparity between the pass rates of July 2020, which stood at 90%, and February 2023, which was a mere 45%. Although July semesters generally showed higher attainment than February semesters, apart from February 2020 and February 2022, there was a significant difference between the pass rates of July 2020 and February 2020. Furthermore, the attainment levels of February 2023 represented the lowest recorded during the period analyzed. Overall, the data reveals that there has been notable variation in attainment over the past few years, with some semesters displaying substantially higher pass rates than others. As previously stated, the instruction was conducted through online classes. However, there were fluctuations in the achievement of CO2 targets.

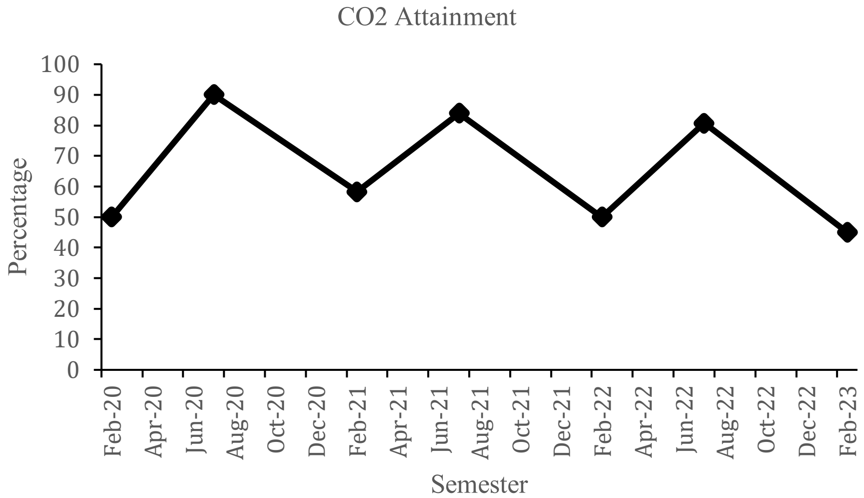


**Figure 2:** CO2 Attainment at different semester

### 3.5 CO3 Attainment

The achievement rate for most semesters has been disappointingly low in February 2021, with a meagre attainment of 34.2% in February 2020 and a further drop to 20.2% in July 2020 as depicted in Figure 3 Additionally, there were no instances of CO3 attainment in both February 2021 and February 2022. It is due to the fact all students were not able to answer correctly in the assessments. Furthermore, the cognitive level is for the question is C5-C6 and it is relatively high. However, the attainment rate in July 2021 marked a significant improvement with a rate of 78.7%. Nevertheless, the attainment rate dipped again in July 2022 to 15.9%, like that of July 2020. Overall, the data suggests that the attainment rate has remained consistently low, with certain semesters experiencing no achievement whatsoever. Consistently, from the February 2020 semester to February 2023, the instructional approach remained unchanged, utilizing online classes.


DOI: https://doi.org/10.11113/jm.v46.483

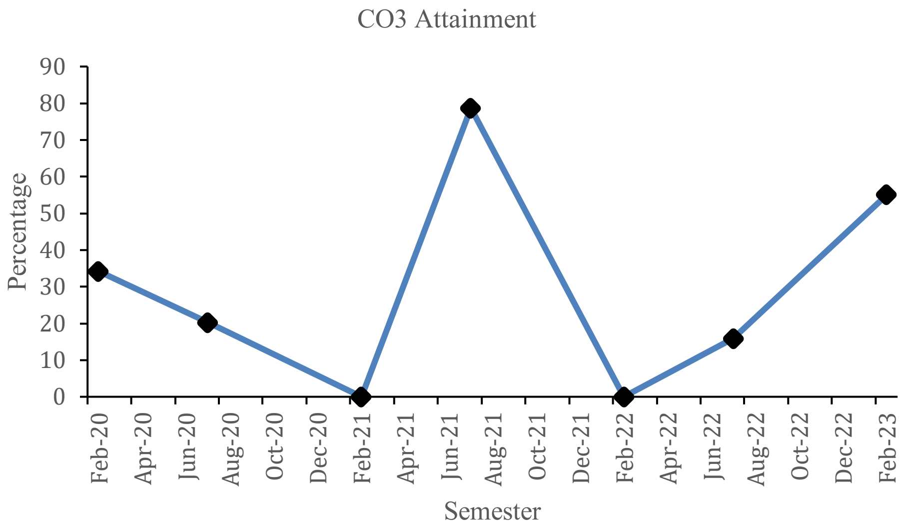


**Figure 3:** CO3 Attainment at different semester

## 4.0 CONCLUSION

From the study, it can be concluded that:

- There have been significant fluctuations in the attainment of CO1 over time, with some semesters recording higher pass rates than others. However, despite the fluctuations, there is an overall upward trend in CO1 attainment over the years. This suggests that efforts to improve the attainment of CO1 have been successful overall, although more work may be needed to address the fluctuations and maintain consistent pass rates in the future.
- For CO2 attainment, there has been a general downward trend in attainment over the years, as evidenced by the low pass rates in February 2023. The significant difference between the pass rates of July 2020 and February 2020 also suggests that there may be seasonal factors influencing attainment levels.
- The attainment rate for CO3 has been consistently low, with some semesters experiencing no achievement at all. The data shows a disappointing attainment rate of 34.2% in February 2020, followed by a further drop to 20.2% in July 2020, and no attainment in February 2021 and February 2022. Although there was a significant improvement in July 2021, with a rate of 78.7%, the attainment rate dipped again in July 2022 to 15.9%. Overall, the data suggests that there may be significant challenges or factors hindering the attainment of CO3.
- Based on the assessment methods and weightage, it can be observed that the course had a mix of formative and summative assessments. Quizzes and assignments, which were conducted frequently and had a lower weightage, were the formative assessments that helped students to learn and improve their understanding of the course content. Test 1, Test 2, and the final exam were the summative assessments that were conducted less frequently but had a higher weightage, and aimed to evaluate students' knowledge and skills acquired throughout the course.
- Furthermore, the evaluation of COs varied across different assessments and semesters. CO1 was evaluated in all types of assessments, whereas CO2 and CO3 were not assessed in some semesters or assessments. This variation in the evaluation of COs might have affected the overall attainment rates for each CO. Additionally, the change in weightage of some assessments, such as Test 1, and the absence of certain assessments, such as Test 2 in most semesters, might have influenced the attainment rates for each CO as well.

 DOI: https://doi.org/10.11113/jm.v46.483

## ACKNOWLEDGMENTS

The authors would like to thank Mechanical Engineering Studies, Universiti Teknologi MARA, Cawangan Pulau Pinang for the support.

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