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The Development an Outcome-Based Education (OBE) System for Measuring Student Programme Attainment

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ABSTRACT

The advancement of Outcome-Based Education (OBE) in higher education necessitates efficient systems for assessing and managing student program outcomes. Traditional methods often fall short in providing integrated and streamlined approaches to track and evaluate student attainment, posing a significant challenge for academic institutions. This study introduces the development of the College of Engineering Academic Information Management System (CO-AIMS) in School of Electrical Engineering, College of Engineering, UiTM Pasir Gudang to address these issues. Utilizing the Rapid Application Development (RAD) model, CO-AIMS is designed to measure Program Outcomes (POs) through advanced computing technologies. The system offers robust functionalities that allow academic advisors to monitor and analyze student performance at individual, semester, and cohort levels. By enabling data-driven decision-making and fostering continuous improvement in educational practices, CO-AIMS aligns student achievements with institutional objectives more effectively. The implementation of this system not only enhances the management of academic pathways but also bridges critical gaps in current methodologies, demonstrating its transformative potential in educational assessment and management.

1. INTRODUCTION

OBE, or outcome-based education, includes competency-based learning requirements and quality control inspections that concentrate on outcomes. Within knowledge-based engineering, OBE is a crucial component of the educational process. Reaching preset learning objectives is the main objective of OBE. This kind of accreditation is particularly highlighted in engineering programs, with an emphasis on goals and outcomes that are in line with OBE principles. OBE influences assessment, teaching strategies, and curricula to guarantee that students acquire the necessary skills. This OBE version encourages consistent and significant advancement according to Pradhan (2021).

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Outcome-Based Education (OBE), a revolutionary concept that moves the emphasis from conventional teaching methods to the observable accomplishments of students, has developed in the quickly changing field of education. OBE is centered on the outcomes, or the skills, information, and attitudes that students are required to display upon program completion, as opposed to traditional education systems that place more emphasis on the input of knowledge as mentioned by Latha and Mohanamani (2022). Because of this paradigm change, it is necessary to create reliable systems for measuring and evaluating these results in order to make sure that educational programs meet industry requirements and desired competencies.

In order to implement OBE, Othman et al. (2022) stated that a system for measuring program outcomes must be developed. In addition to evaluating whether students have achieved the predefined goals, this kind of system offers insightful data on how well the curriculum and teaching techniques are working. Teachers can identify areas for growth, adjust their pedagogy, and eventually improve the quality of education by utilizing a variety of evaluation tools and data analytics.

In OBE, learning objectives are initially determined, after which learning strategies are planned and evaluations are modified in accordance with the results. The complexity of creating and executing an outcome-based education system that precisely monitors student achievement is examined in this paper. It is expected that implementing an output-oriented learning system and methodology will raise educational standards generally in School of Electrical Engineering at Universiti Teknologi Mara (UiTM) in particular. In addition, this paper aims to contribute to the ongoing discourse on educational excellence by presenting innovative strategies and practical solutions for the effective implementation of OBE in higher education.

2. LITERATURE REVIEW

Outcome-Based Education (OBE) comes from educational reforms that focus more on students' learning outcomes than on traditional teaching methods. According to Spady and Marshall (1991), OBE is a holistic approach that ensures all educational activities align with clear objectives by focusing on what students can do after being taught. OBE promotes a student-centered learning environment with defined, measurable, and achievable results within a set timeframe.

Precise evaluation of program outcomes is crucial for effective OBE implementation. Pradhan (2021) emphasizes that learning activities and assessments should align with targeted outcomes to ensure validity. Various methods, including formative and summative assessments, peer assessments, and self-assessments, measure student achievement. Standardized tests and rubrics help maintain uniformity and objectivity, while performance-based projects and presentations assess real-world knowledge application.

Assessing program outcomes in higher education is essential for evaluating OBE's effectiveness. Research suggests using comprehensive methods to measure Course Outcomes (CO) and Programme Outcomes (PO). Examples include weighing course components to determine achievement levels by Suji Prasad et al. (2023) is calculating learning outcomes through courses/modules and using course-level assessment data to improve academic quality assurance.

Integrating technology in educational assessment has greatly improved the ability to measure learning outcomes. Hutchings (2016) discusses how learning management systems (LMS) and digital portfolios track and analyze student performance data in real time. Advanced data analytics and educational data mining provide deeper insights into student learning patterns and outcomes, helping to continuously improve teaching strategies and curriculum design.

In the fast-paced world of modern technology, Ali et al. (2020) introduced the theoretical framework and development of mobile Outcome-Based Education (OBE). Their creation, i-MOBE, targets higher education students and academia. The study presents an OBE Program Outcome Attainment (POA) analysis tool for academic advisors to monitor and plan student achievement in line with each Program Outcome

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(PO) defined by the curriculum. The system is specifically designed for Engineering Programs following the twelve POs set by the Engineering Technology Accreditation Council (ETAC).

Despite its benefits, implementing OBE faces several challenges. One major issue is ensuring the reliability and validity of assessment tools. Heer (2012) highlights the difficulty of creating assessments that accurately measure complex thinking skills. Educators also need extensive training to develop and use OBE-aligned assessment tools effectively. Additionally, resistance to change among faculty and administrators is a significant barrier to adopting OBE frameworks widely.

Looking at successful OBE implementations offers valuable insights into best practices. Hutchings et al. (2015) present case studies from higher education institutions that have effectively integrated OBE into their programs. These institutions have improved student engagement and learning outcomes through systematic assessments and continuous feedback. For example, capstone projects and real-world problem-solving tasks effectively measure and enhance student skills in various disciplines.

As education changes, OBE will probably include more personalized and adaptive learning environments. Using artificial intelligence and machine learning to create customized educational experiences and assessments can improve OBE systems. Ongoing research and innovation are needed to overcome challenges and fully realize OBE's potential for educational excellence. The system has been continuously upgraded from its first version, adding new features to meet growing needs. This paper also explores the social and technical methods used during development, highlighting important factors for creating an effective in-house accreditation support system.

3. RESEARCH METHOD

3.1 Overview of RAD model

The Rapid Application Development (RAD) model was selected for this project due to its ability to facilitate quick development and iteration, which is crucial for adapting to the evolving needs of OBE systems. The RAD model emphasizes active user involvement, iterative development, and rapid prototyping, making it an ideal choice for creating a system that must be both functional and responsive to user feedback by Safiudin et al. (2020).

3.2 Phases of RAD model

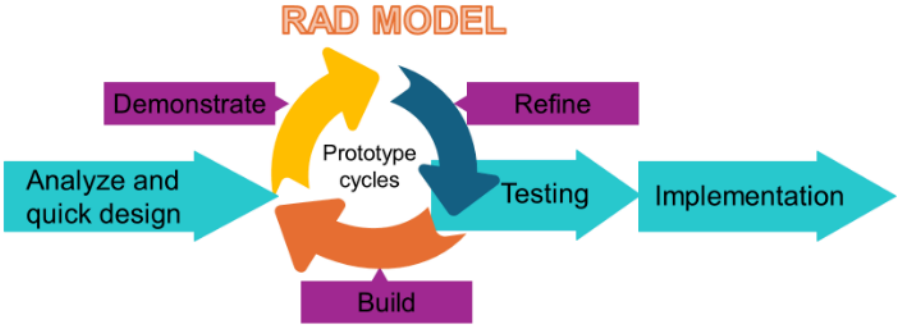

Fig.1. RAD model

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Requirements Planning:
In the first phase of our research methodology, the objective is to define the scope and objectives of the CO-AIMS system. We initiated this phase by conducting workshops and focus groups with stakeholders, including academic advisors and faculty staff especially OBE team, to gather detailed requirements. Through collaborative discussions, we identified the essential functionalities needed to assess and manage Program Outcomes (POs) effectively. Additionally, we outlined constraints and objectives to ensure alignment with institutional goals. The output of this phase is a comprehensive requirements document that details system specifications, user needs, and project scope, laying the foundation for the subsequent phases of system development.

User Design:
After planning the requirements, our research moves to the user design phase, aiming to develop prototypes that show the CO-AIMS system's interface and functions. Using insights from stakeholders, we created initial prototypes with sketches and models. These prototypes were reviewed by stakeholders to ensure they met user needs. Through repeated refinements based on feedback, we developed detailed design specifications and refined prototypes that will guide system development.

Construction (Prototype Cycles):
With the user design phase complete, our research methodology transitions to the construction phase, characterized by iterative development cycles. The objective of this phase is to build the CO-AIMS system iteratively, incorporating user feedback into each cycle. We developed the system in successive cycles, with each cycle producing a working version of the system. Regular testing and user feedback sessions were conducted to identify issues and areas for improvement, and changes and enhancements were implemented based on feedback. The output of this phase is a functional version of the CO-AIMS system that has been refined through multiple iterations and user feedback.

Implementation:
The final phase of our research methodology is implementation, where the objective is to deploy the fully developed CO-AIMS system and ensure its operational readiness. We finalized the system based on the last round of feedback and testing, conducting comprehensive testing to ensure it met all requirements and was free of critical issues. Training sessions were provided for users, including academic advisors and faculty, to ensure they could effectively use the system. Additionally, user documentation and support materials were developed to facilitate ease of use. The output of this phase is a fully deployed CO-AIMS system, with trained users and supporting documentation, ready for use in monitoring and managing student program outcomes.require a long development time. This aligns with the objectives of the RAD model, which aims to shorten the time between designing and implementing information systems.

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3.3 Implementation Planning and Execution CO-AIMS

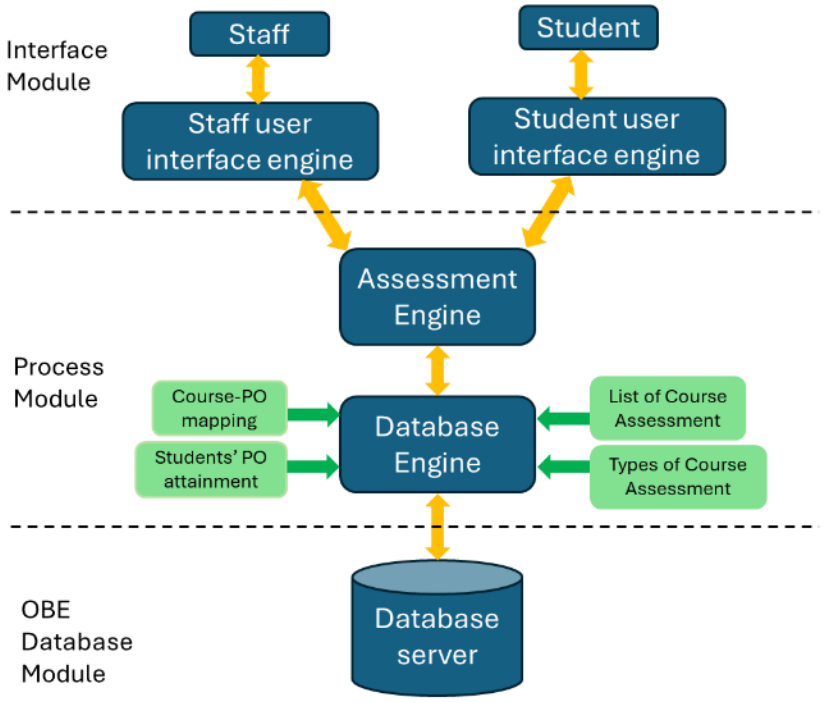

Fig.2. CO-AIMS paradigm system

CO-AIMS system consists of 4 different types of engine; staff user engine, student user engine, assesment engine and database engine. The architecture diagram as in Fig. 2 illustrates the CO-AIMS which comprises several interconnected components aimed at monitoring and evaluating the assessment and management of course outcomes for students.

At the top are two user interface engines: one for staff and one for students. These interfaces enable staff members and students to interact with the system, respectively. In the center lies the Assessment Engine, responsible for dispalying the values of the students' PO attainment.

The Database Engine serves as the central repository, storing and managing data concerning course-PO mapping, students' PO attainment, a list of course assessments, and types of assessments.The Database server likely hosts the physical storage system, housing the database that the Database Engine interacts with.

Arrows indicate the flow of data and interactions between components. For instance, data from the staff and student user interface engines likely undergo processing by the assessment engine, which interacts with the database engine for storing or retrieving relevant data.

Overall, CO-AIMS is structured to facilitate course outcome assessment and management for both staff and students, providing a systematic approach to mapping courses to program outcomes, tracking student attainment, and managing various types of assessments for each subject.

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4. RESULTS AND DISCUSSION

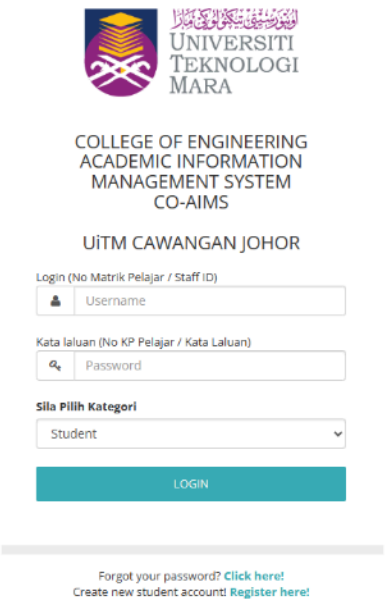

Fig.3. Feature CO-AIMS login page

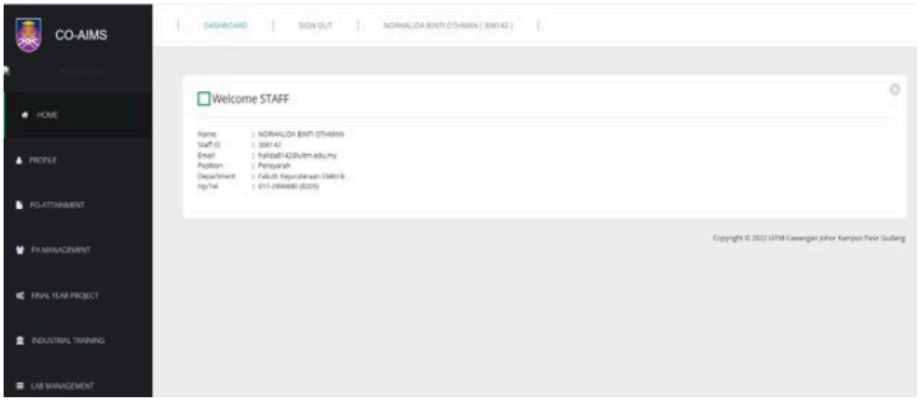

Fig.4. Feature dashboard CO-AIMS

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Fig.5. Feature MY-PA PO attainment

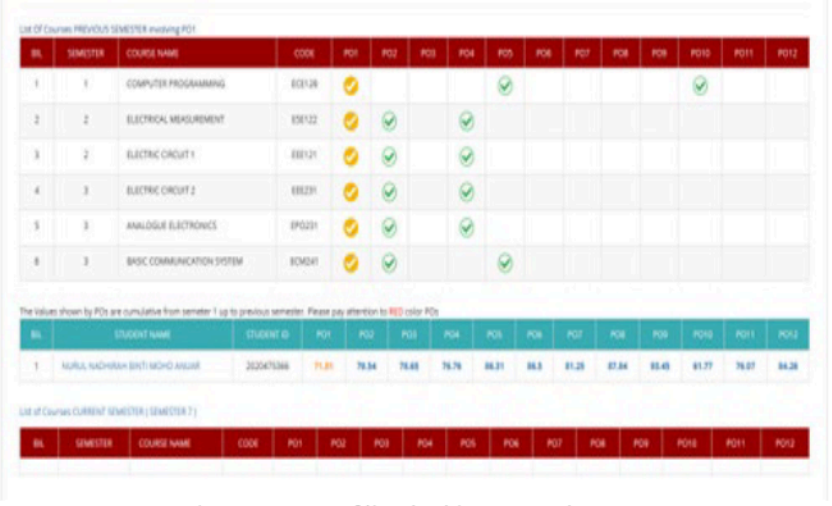

Fig. 6. Features of listed subject mapped to PO1

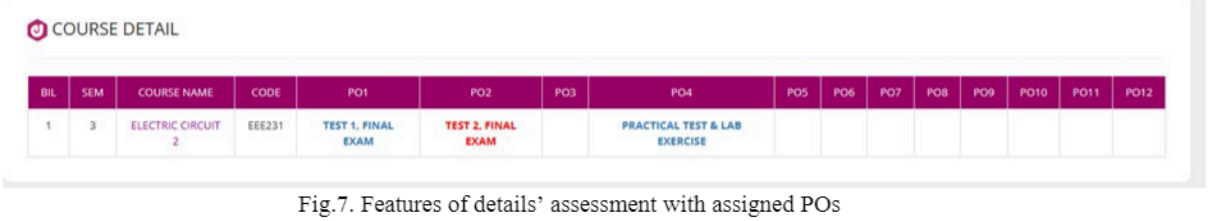

Fig.7. Features of details' assessment with assigned POs

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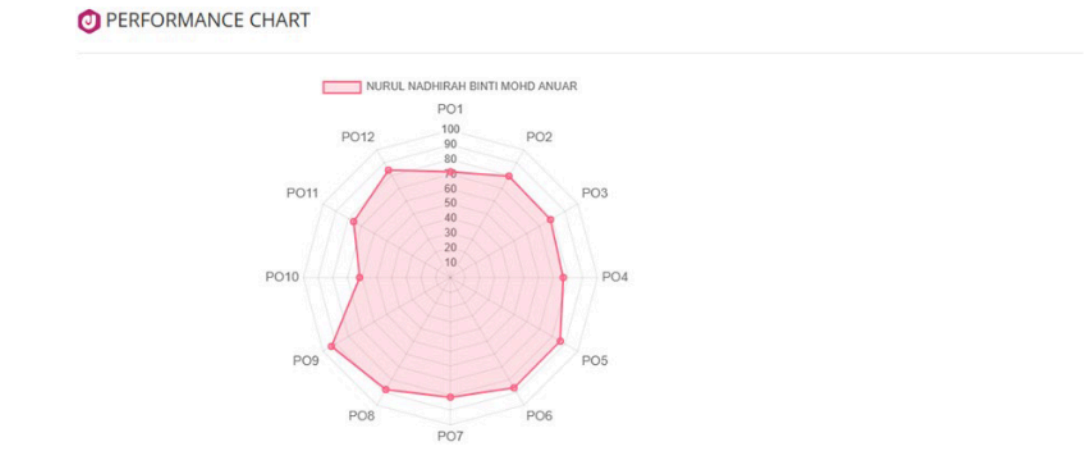

Fig.8. Features of performance chart for the students

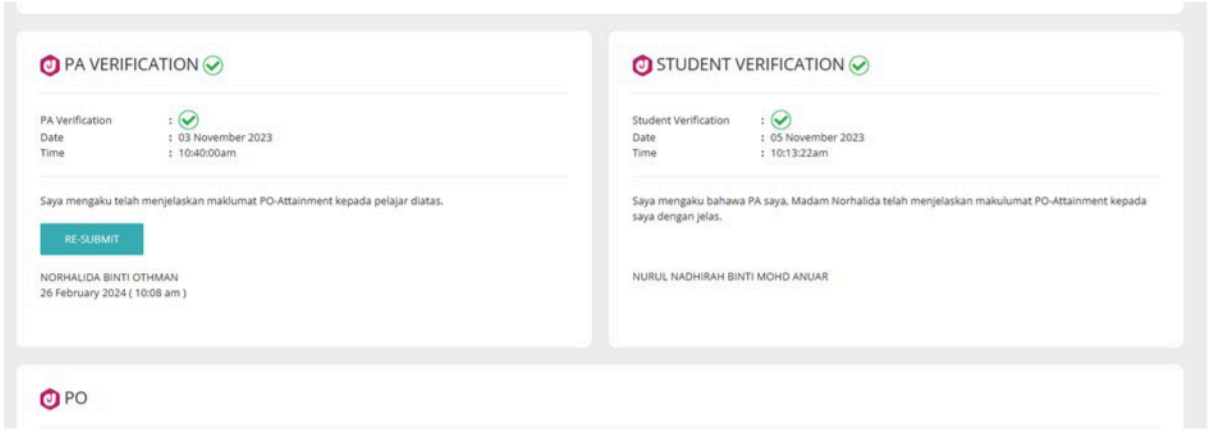

Fig. 9. Features of PA and student verification

Fig. 3 through 9 provide screenshots illustrating various features of CO-AIMS. Fig. 3 and 4 display the login screen for CO-AIMS at the UiTM Johor branch, Pasir Gudang Campus, which is used to manage and access academic information specifically for the School of Electrical Engineering. This system is accessible to three user groups: staff, students, and administrators. Staff members, referred to as academic advisors (PA), and administrators, who include the management team and the OBE team, are among the key users of the system. It enables PAs and administrators to monitor students' progress across a variety of courses and semesters.

Fig. 5 displays the 'MY PA PO Attainment' screen, which lists the subjects the student is enrolled in for the current semester. Additionally, it shows the overall PO attainment up to the current semester. The student's PO attainment is highlighted in blue, indicating that the school KPI has been met. A thorough evaluation of program outcomes over time is provided by the values displayed for each PO, which are cumulative from semester 1 to the preceding semester. In an OBE framework, this table is a crucial tool for tracking and assessing program outcome attainment.

The table shown in Fig. 6 is an effective tool for understanding the curricular structure and evaluating students' progress toward achieving their learning objectives because it graphically illustrates how each

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subject contributes to selected POs. For instance, Fig. 4 reveals that Student X's PO attainment for PO1 is below the KPI level, along with the courses pertinent to PO1. In an OBE framework, this table is crucial for tracking and assessing program outcome attainment.

Fig. 7 represents the types of assessments mapped to each PO. Students and PAs can check which assessments need focus. For example, Student X needs to improve their PO1 attainment. In this case, the assessments for Electric Circuit 2 that impact PO1 are Test 1 and the final exam. Therefore, Student X must strive to achieve high marks and grades in these assessments to meet the PO1 KPI.

The radar chart in Fig. 8 visually represents Nurul Nadhirah Binti Mohd Anuar's performance of attainment across all POs, with higher values indicating greater attainment. PO8 shows the highest attainment at 100%, while PO11 shows the lowest at 50%. This chart is useful for quickly identifying areas of strength and areas that may need improvement.

Fig. 9 serves as a formal declaration of accuracy by both the PA and the student. This process evaluates and verifies their discussion on the program's alignment with the defined outcomes and the student's attainment. This verification ensures that students are aware of their attainment levels and understand the areas where they need to improve their skills.

Our development approach for CO-AIMS follows the Rapid Application Development (RAD) model, which emphasizes quick development and iteration. In the RAD model, the user design phase is critical as it involves creating prototypes that stakeholders can interact with and provide feedback on. This iterative process ensures that the final product closely meets user requirements and expectations. The RAD model allows for flexibility and rapid adjustments based on user feedback, which is particularly beneficial in educational settings where needs can evolve quickly. By utilizing the RAD model, we were able to rapidly develop and refine the CO-AIMS system through continuous stakeholder engagement and feedback. This approach not only accelerated the development process but also ensured that the system was highly user-centric and effectively addressed the needs of its users.

5. CONCLUSION

In conclusion, the development and implementation of the College of Engineering Academic Information Management System (CO-AIMS) using the Rapid Application Development (RAD) model has successfully addressed the inefficiencies and integration challenges of traditional methods for assessing and managing student program outcomes in higher education. CO-AIMS provides robust functionalities for academic advisors to monitor and analyze student performance, facilitating data-driven decision-making and continuous improvement in educational practices. This system not only aligns student achievements with institutional objectives more effectively but also demonstrates its transformative potential in educational assessment and management, thereby enhancing the overall management of academic pathways and bridging critical gaps in current methodologies.

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7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

8. AUTHORS' CONTRIBUTIONS

Norhalida Othman carried out the research, wrote and revised the article. **Ezril Hisham Mat Saat** designed, developed and tested all the components of the OBE system. **Nur Amalina Muhamad** conceptualised the central research idea. **Noor Hafizah Khairul Anuar** designed the research and supervised research progress. **Masmaria Abdul Majid** anchored the review, revisions and approved the article submission.

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