Enhancing Student Understanding via Smart and Friendly Learning Mobile Application

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Abstract
In the sphere of education, testing and enhancing students' comprehension is not a simple process. This is mirrored in the assessment results, where particular courses have a high failure rate. On the UiTM system, the high failure rate is defined as the proportion of students who fail a subject that exceeds the threshold of 25 percent. Therefore, topics exceeding this limit are deemed incapable of meeting the Academic Quality UiTM objective. In this study, Basic Hydraulic courses is chosen to be a pilot study as the failure rate is high for few semesters. A creative strategy and method of teaching and learning is being proposed to increase students' understanding of the course's content as to overcome the related issue. A smartphone application known as Sahabat Maya Pelajar (SMa2P) has been introduced and integrated into the teaching and learning process. According to the examination records of the Basic Hydraulics course at the Faculty of Civil Engineering at UiTM Johor, the failure rate of this course is decrease. This is shown by comparing results between semesters of 20204 and 20212 which indicate the course failure rate decreased by 22% in the latter semester. Therefore, it is crucial to improve students' performance and comprehension by using digital tools as this platform able to incorporate interactive teaching approaches into classroom activities through smartphone application.
Keywords: Education, Smartphone Application, Students' Higher Failure Rate Problem, Students' Performance.

Introduction
        Educators encounter several obstacles in the teaching and learning area, including student attitudes, the degree of student success and the location and atmosphere of learning spaces (Okuboyejo, 2021; Sengupta, 2022). One of the greatest obstacles is to increase students' level of comprehension so they may earn high exam scores and most importantly able to graduate on time (Mostafavi *et al*., 2021). However, difficulties may develop

particularly in challenging courses which required a high level of understanding and a solid basic foundation technical knowledge. As a result, these courses are consistently exposed to a higher failure rate which ultimately results in recurrent postponement of graduation and is harmful to the image of educational institutions. In addition, this issue is one of the key sources of other difficulties such as financial and disciplinary issues that have arisen among a large number of students (Almaiah *et al.*, 2022).

Evidently, in today's society the contemporary technology is advancing at a quick rate and establishing a new, limitless platform that has influenced almost every element of modern life including education. Presently, the use of smartphone application for teaching and learning has been extensively debated and researched. According to studies, these applications were able to both improve students' learning experiences and develop their interest in relevant areas. Consequently, this might improve the teaching and learning process and increases the productivity of educators and students (Scaringella *et al.*, 2022).

As a Diploma in Civil Engineering students, there are courses compulsory to be taken by the students for three years study in University Technology MARA, UiTM. Among all the courses offered, several courses are facing high failure rate and become one of concerned issue need to overcome by lecturers and school administration. Basic Hydraulic course is one of courses that facing the high failure rate issue. It is considered as the worst-case scenario because of the frequency of high failure rate occur in the faculty compare to other course. Table 1 displays the proportion of students that failed in this course from semester 20192 to 20204. With the exception of semester 20202, the failure rate for this course has surpassed 25% for three consecutive semesters.

Table 1
Percentage of failures of Basic Hydraulic course for four consecutive semesters

Semester	Failure percentage (%)
20204 [1]	28.7
20202 [2]	9.42
20194 [3]	38.8
20192 [4]	30.3

Cause Affecting the Teaching and Learning Process

The high course failure rate of students is one of the primary issues facing tertiary education. Students are classified as failing if they are unable to complete their coursework on time, and this problem is growing each year (Eng et al., 2009). The high percentage of student failure is expensive for both the school and the students. In addition to lost time, money, and a high likelihood of course failure, students may also have mental-psychological and social issues (Sosu and Pneunpha, 2019; Najimi et al., 2013). There are numerous factors contributing to the high course failure rate. Individual students and the course itself account for the majority of high-failure-rate courses, according to research (Lee et al., 2021; Shaharuddin et al., 2012; Mlambo, 2011; Khan et al., 2011). The course participants came from diverse backgrounds. Some students may already be enrolled in preparatory courses,

[1] Sept 2020 – Feb 2021

[2] March 2020 – Jul 2020

[3] Sept 2019 – Feb 2020

[4] Mar 2019 – Jul 2020

while others may lack even the fundamentals. Without foundational courses, students may struggle to comprehend the demanding and intricate course content, resulting in course failure (Mlambo, 2011). Ineffective teaching methods, inferior learning materials, and ineffective instruction delivery also led to student failure. Inadequate reference materials and difficulties in locating further references are also significant obstacles experienced by failing students (Shaharuddin et al., 2012). Other factors, such as insufficient study time in a single semester, disorganised course evaluation, and an excessive number of assignments and projects, can influence a student's readiness to take an exam (Lee et al., 2021; Sandhu et al., 2019; Senanayake et al., 2005).

In addition, some of the causes were gleaned through archive documents such as the continuous quality improvement report (CQI) and minutes from departmental meetings. All of these reports were generated each semester by the UiTM Faculty of Civil Engineering.

Table 1
Summary of Causes Contribute to High Failure Rate Based on Literature Review and Archival Documents

Parameter	Subject	Description
Human	Student	• Underprivileged educational background • Students are not adequately ready to take the exam • Excessive number of subjects taken in a single semester • Students are incompetent to use calculator to solve complex mathematical problems • Reluctant to consult their respective lecturers when facing difficulties • Prefer to study alone rather than conduct group study
	Lecturer	• Not well prepared to teach or lack of experience • Less engaging when conducting discussion with students • Improper or ineffective teaching method
	Personal Advisor	• Not actively involved in guiding and advice their mentee for the betterment of
Method	Knowledge Delivery Teaching	• Lack of exercises/tutorials given to students • Lack of guidance and proper training for the lecturers • Poor instruction delivery
	Assessment	• The evaluation method is ineffective to properly assess the potential of the students • Excessive number of assignments and projects
	Time span	• Duration of teaching and learning activities is insufficient
Equipment	Syllabus	• A challenging, complex course syllabus • Inadequate learning period in single semester
	Teaching Material	• Additional references are hard to find • The learning materials are incomprehensible • The reference resources offered are insufficient
Environment	Location	• Inconducive learning atmosphere in the classroom

Smartphone Application

In the era of the Industrial Revolution 4.0, the smartphone applications are recognized as one of the most important tools in numerous areas of science and technology (Cai, 2021; Choo *et al.*, 2019; Hester *et al.*, 2021). Faizatul *et al* (2020) identified four essential abilities that may be fostered by combining traditional and smart learning which are communication, critical thinking, collaboration, and creativity. By combining these two approaches, enormous possibilities are created for students to express their thoughts and collaborate and interact online with their group members. This assertion is also backed by Khalid (2014), who discovered that the majority of students are eager to utilize mobile devices and educational

programs to assist them, hence reducing their reliance on instructors for consultations. In addition, as a result of the rapid development of the mobile industry, smartphones are now outfitted with processing units that are on par with those of a computer in terms of its ability to do various and variety of complicated tasks. Thus, this is recognized as one of the primary contributors to the usage of smartphone applications in educational settings (Lay-Yee *et al.*, 2013). Moreover, as a consequence of the current Covid-19 epidemic, which has caused in the closure of schools and institutions throughout the globe, teaching is conducted remotely on digital platforms, hence increasing the need for mobile application (Finlay *et al.*, 2022).

Improving student understanding during teaching and learning activities is a difficult endeavor. It requires a high degree of commitment and constant work from both educators and learners. Educators at the elementary, secondary, and tertiary levels have employed a variety of activities and strategies to enhance students' comprehension. However, the question of student comprehension remains unanswered. This is due to the fact that each learner has a unique degree of proficiency and needs individualized attention. In addition, new issues in the education field such as Covid-19, required a shifted from face-to-face instruction class to the online learning platform. Recognizing the obstacles which exist in the world of education today, it is necessary to seek solutions to guarantee that students' knowledge and comprehension continue keep growing. Therefore, the aims of this study is to develop a digital tool which can be adopted in a teaching and learning process. Since approach based on creative smartphone application is widely implemented in today's education, this method is being adopted in a course which recorded high failure rates. This smart and friendly learning mobile application is used to enhance students understanding in learning the course. This also may help the students to increase the potential of passing the course as the course is a pre-requisite course. The course chosen as pilot study of the smartphone application is Basic Hydraulic course. This course focuses on two learning outcomes which are applying mathematical knowledge, natural sciences, engineering fundamentals, and engineering specialization to a wide range of practical procedures and practices and identifying and analyzing engineering problems defined by good for reaching solid conclusions using analytical methods coded specifically for a particular field of activity.

Methodology

There are several steps included in this study in order to achieve the objective, including a review of the relevant literature and archival records, data gathering via questionnaire survey, data analysis, and application development. The study's methodology is depicted in Figure 1 below. Diploma in Civil Engineering student enrolled in Basic Hydraulics course at UiTM Pasir Gudang Campus constitutes the sample. This course was chosen because it has the highest failure rate, which approaches or exceeds 25 percent for a number of semesters.

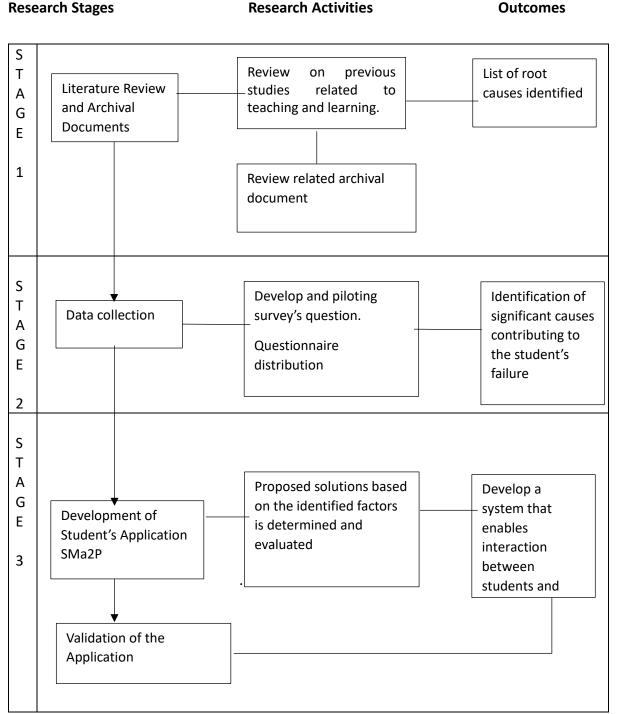| Research Stages	Research Activities	Outcomes

Figure 1: Methodology Process for the Study

A. Questionnaire Survey

The questionnaire was administered to discover the factors that may have contributed to the subject's high failure rate. For each selected semester, lecturers from the Faculty of Civil Engineering and students enrolled in the course Basic Hydraulic were selected as respondents. The questions were tailored to the respondent's history but remained focused on identifying the causes of the high rate of failure. From the literature review and secondary sources, such as academic meeting minutes and a report on continuous quality improvement, we compiled a list of causes that may or may not contribute to the failure rate. We then asked

respondents, based on their personal experience, whether each of these causes contributed to the failure rate.

B. Analysis of Results

The causes from the questionnaire were analyzed based on the respondents' perspectives, as shown in Table 2, where causes with more than 50% agreement from respondents were considered significant, while causes with agreement between 25% and 50% required additional analysis to determine whether they were significant or not. Whereas causes with less than 50% agreement from respondents will be deemed insignificant.

As shown in Table 3, only ten out of twenty-two factors for the high student failure rate were deemed significant by respondents, while the other causes fell into the non-significant group. Humans, methods, equipment, and the environment are the four aspects that are classed as major components. The high failure rate of the Basic Hydraulics course has been attributed to the 10 factors listed below. Each factor is assigned a unique identifier code to be utilized in creating the correlation for the subsequent procedure.

Table 2

Analysis of Data Based on Respondent Perspective

Agreement Percentage (%)	Category	Description
> 50.0	Root of Problems	Considered as significant factor
25.0 – 50.0	Uncertain	Required Additional Analysis to Determine Whether They Were Significant or Not
< 25.0	Not a Root of Problems	Considered as insignificant factor

Table 3

Significant Causes Gathered from Questionnaire Survey

Parameter	Subject	Description of Causes
Human	Student	• Students are not adequately ready to take the exam (P1)
	Lecturer	• Improper or ineffective teaching method (P2)
Method	Knowledge Delivery Teaching	• Poor instruction delivery (P3)

Table 3 (cont')
Significant Causes Gathered from Questionnaire Survey

Parameter	Subject	Description of Causes
Method	Time span	• Duration of teaching and learning activities is insufficient (P4)
	Assessment	• The evaluation method is ineffective to properly assess the potential of the students (P5) • Excessive number of assignments and projects (P6)
Equipment	Teaching Material	• The learning materials are incomprehensible (P7) • The reference resources offered are insufficient (P8) • Additional references are hard to find (P9) •
	Syllabus	• A challenging, complex course syllabus (P10)

Based on the selected causes, ten possible solutions that may be employed in solving the causes of failure has been derived. Each possible solution is given identification codes to address the problem's root causes via solution process analysis (pros and cons). The possible solutions are as follows

- Multiply sample questions (CP1)
- Mechanisms of increasing motivation (CP2)
- Teaching monitoring is done weekly (CP3)
- Timetable Rescheduling (CP4)
- Glossary for less clear terms in the scoring rubric (CP5)
- Scoring rubric improvement and refinement mechanism (CP6)
- Limiting the number of tasks given (CP7)
- Access to sample assignments and task assessment scoring rubrics (CP8)
- Glossary of unclear terms in notes (CP9)
- Access to additional reference sources (CP10)

Problem Solving Proposal Identification

A solution proposal to the issue of causes identified were derived by using tree diagram solution. Using the root cause identification approach (P), a tree diagram of the issue solution proposal was built to assess the merits and downsides of the offered possible solutions (CP). It is then matched to the identified causes of the issue before a test to assess its effectiveness is conducted. The testing procedure consists of two distinct phases. The first step is to assess the solution's suitability and sufficiency for achieving its objectives which is to overcome the causes. The aesthetic value and intricacy of implementation of offered solutions are the focus of the second stage. Figure 2 shows the correlation between the causes of high failure problems with the propose solution.

Based on the techniques, it indicates that the development of smartphone application is the most appropriate response. This is owing to the fact that smartphone applications may successfully aid students in communicating with their individual lecturer, serving as an additional learning resource and facilitating their virtual or physical learning processes. Once

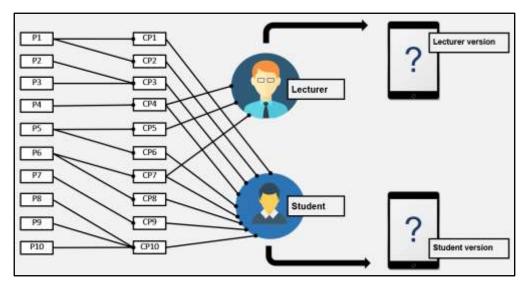the proposed solution has been determined, the development of a smartphone application is conducted.

Figure 2: Correlation between the causes of high failure problems with the proposed solution

The solution path of the problem-solving suggestion is assessed to indicate its effectiveness. For this, a google form has been developed as a survey tool to determine the satisfaction of respondents who are using the smartphone application. A series of questionnaires has been distributed to the students who enrolled in the Basic Hydraulics course and the lecturer appointed to teach the course during semester involved. This is to determine the effectiveness of the smartphone application in enhancing the degree of student's understanding and to discover the elements that contribute to the difficulties amongst students and lecturer during using the application.

Results and Discussion

The findings indicate that the high number of failures in Basic Hydraulic course may be factored to students who are unprepared for the assessment especially the test due to a range of causes including a lack of foundation knowledge. The syllabus of the course is challenging and requires ability to gain high degree of knowledge from prior courses which related to the mathematical and physic concept. In addition, the cause which might contribute to the failure is due to a lack of engaging teaching materials and inadequate teaching references. The second issue is related to human aspect that includes the lecturers' uninspiring delivery methods. This problem is exacerbated by the short learning time allocated in a semester along with unsystematic course assessment techniques. All these causes contribute to results of a high failure rate. In addition, a stressful learning environment in which students are continually overburdened by many course deadlines and tests give a significant impact on the students' academic performance and achievement. Therefore, from the analysis conducted it is recommended that smartphone application is the proposal solution of this issue.

Sahabat Maya Pelajar (SMa2P) Smartphone Application

A smartphone application is developed as a solution of the high failure rate issue. The name of the application is Sahabat Maya Pelajar or known as SMa2P. The SMa2P is offered in two distinct versions which are lecturer and student version. These two versions are

connected each other's as to ensure the ways of communication in the teaching and learning process. All related information such as the course syllabus material, degree of difficulty and accomplishment for each topic, learning plan for each semester and list of lecturers who teach the course of the semester also been provided in the application. Students able to access to many learning resources and all lecture notes in the form of PowerPoint presentations, videos, and other interactive format. There are no restrictions to access to any of the educational materials. Meanwhile, text and voice messaging technologies are also implemented to facilitate effective communication between lecturers and students via the provision of direct instructions and comments. This allows lecturer to adopt various smart and friendly method of presenting and exchanging learning materials through the platform.

In addition, the information on lecturers' knowledge and experience is also provided in SMa2P. This is to provide students with some information regarding the background of lecturers. Students may identify the causes of the lecturer which suit to student's style of learning before enrolled to any group of the course. Moreover, students are also required to provide their basic personal and educational information onto the SMa2P application. This is important as the application also integrated the attendance feature for recording the student's attendance and able to record all learning activities throughout the semester. As for monitoring purposes, academic advisor for the respective student's group and other lecturers also has the capability to access the recorded teaching and learning activities in this application as this may increase its flexibility. Students also are able to review each submitted note and other learning resources in order to facilitate the development of excellent two-way communication between student and lecturer who used this application. The SMa2P will also automatically remind students of the upcoming course works assessment and the deadlines of submission. These features allowing the students to remain informed and focus about the course assessment which includes quiz, assignments, and test. This assessment determines the amount to which students grasp the concepts, allowing lecturers to improve their teaching skills and take appropriate action to remedy the lack aspects. This application places a great deal of focus on the efficiency of virtual and digital communication between lecturers and students, since it is one of the most important aspects in the educational teaching and learning process. In addition, it offers precise information on the performance and grade of each student thus enabling the lecturer to determine the strengths and shortcomings of all elements involves in the process. Figure 3 displays the suggested paradigm of students tackling high failure problems using SMa2P smartphone applications-based learning. Meanwhile, Table 4 shows graphic user interface for each screen of SMa2P app either student or lecturer version including its functions.
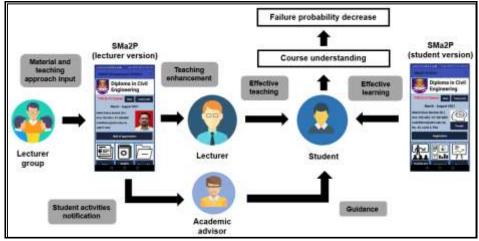
Figure 3: Modelling of SMa2P smartphone applications in solving the problem of high failure rate

Table 4

Graphic User Interface SMa2P App and Screen Functions

SMa2P (student version)		SMa2P (lecturer version)	
Screen	**Function**	**Screen**	**Function**
	• Main screen • A screen that places a button to other screens, network linkages, course difficulty level, inspirational quotes from lecturer and syllabus topics evaluation		• Main screen • A screen that places a button to other screens, network linkages, course difficulty level and reference sources of documents related to the course
	• Teaching and learning screen • A screen to identify the common mistakes in assignments or written tests and tips on how to solve the problem effectively		• Student report screen • A screen to record and store comprehensive details on the students' background
	• Teaching week screen • A screen that links to various forms of references according to weekly learning slides		• Attendance warning screen • A screen for reporting students who were absences to academic advisors, so that immediate action can be taken accordingly
	• Ask screen A screen for typed or spoken queries during class that can be shared with other students without disrupting the lecturer.		• Class activities screen • A screen to record the learning activities of a student while in class

Table 4 (Cont'd)

Graphic User Interface Sma2p App and Screen Functions

SMa2P (student version)		SMa2P (lecturer version)	
Screen	Purpose	Screen	Purpose
	• Appointment screen • A screen for meeting appointment planning with lecturers and a reminder of meeting date and time		• Attendance observation screen • A screen for monitoring student absences to avoid errors in attendance records
	• Take a note screen • A screen to note the important contents of the lesson which can also be shared with other students		• Fill up information screen • A screen for the collection of reference sources in various forms
	• Q and A whiteboard screen • A screen to record the questions on the whiteboard and the students' responses, which may be shared among them		• Student question/common mistake/tip screen • An interface for the collecting of questions from students, common errors in assignments or written exams, and learning strategies
	• Wall of fame screen • An interface displaying the list of students who received an A+ and the top three students overall.		• Rubric mark assessment screen • A screen for discussion forum on the rubric marks to avoid confusion and improvements

Project Achievement

During two consecutive semesters, 20204 and 20212, the SMa2P was integrated into the teaching and learning activities of the Basic Hydraulics course for Diploma in Civil Engineering students at the UiTM Pasir Gudang Campus. The implementation of SMa2P is planned in accordance with the weekly lesson plan and teaching and learning techniques. The effectiveness of the SMa2P application was measured by assessing the course failure rate and comparing the two semesters. The percentage of failing students has reduced dramatically from 28.7% in semester 20204 to 6.7% in semester 20212. (Figure 4). This indicates that the percentage of failing students has fallen by 22%. This accomplishment demonstrates the efficiency of SMa2P application in the teaching process. In addition, it illustrates SMa2P's

potential as an alternate digital tool that could be used in the upcoming semester. The implementation can also be expanded to include additional key courses with a high probability of student failure.
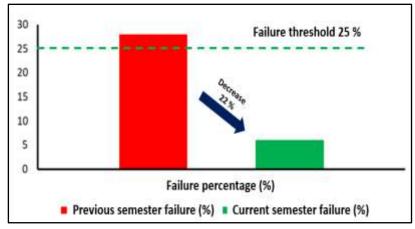

Figure 4: Comparison of the percentage of failing students for the semesters 20204 and 20212

Between the semesters of 20204 and 20212, a more thorough comparison of student performance was conducted. This is accomplished by assessing the student's performance based on the types of course assessment. The Basic Hydraulics course includes four types of assessment: a quiz, assignments, and a test. Figure 5 depicts the grading of all assessment categories for both semesters. After integrating SMa2P in the teaching and learning process for both semesters, a perfect score on a quiz implies that students achieved a high level of success compared to other types of evaluation. Moreover, student assignment evaluations increase by nine percent, from 91 percent in semester 20204 to 100 percent in semester 20212. In addition, the exam pass rate increases by 25%, from 60% to 85%, from the semester 20204 to the semester 20212. As a result of SMa2P introduction, the overall student accomplishment increased by 25%, from 70% in semester 20204 to 95% in semester 20212.
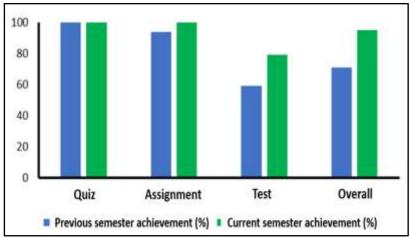

Figure 5: Comparison of student achievement based on types of assessment between semesters 20204 and 20212

Table 5 summarizes the student responses regarding SMa2P. Students express a high level of agreement with all aspects of feedbacks. Students are unanimous that utilizing the SMa2P app can aid in achieving course objectives. In addition, students firmly believe that

SMa2P is a suitable teaching tool because the application's features are user-friendly and it provides a platform for student-lecturer interaction, hence enhancing the teaching process. However, students only concur that SMa2P is an excellent, methodical, and comprehensive learning instrument. This is indicated by the respective score values of 4.4, 4.2, and 4. Given that SMa2P is a newly built program, it is thought that many features can be enhanced periodically, hence boosting SMa2P's future utility as a digital teaching and learning tool.

Table 5
Students Feedback on SMa2P Application

Students feedback	Score	Results
Able to achieve objectives	5.0	Strongly agree
Effective	4.4	Agree
Systematic	4.2	Agree
Holistic	4.0	Agree
User friendly	4.6	Strongly agree
Simple technology for interaction between lecturers and students	4.6	Strongly agree
Give an advantage in the teaching process	4.6	Strongly agree
Appropriate teaching tools	5.0	Strongly agree

The lecture feedback for the SMa2P application is presented in Table 6. Most instructors strongly agree that SMa2P can aid in attaining the course's purpose. In addition, regarding the element of user-friendly tools that operate as an acceptable teaching tool and provide advantages in the teaching process, the lecturer's and students' feedbacks are consistent. The same student response demonstrates the tool's usefulness, systematization, and holistic nature, with scores ranging between 4 and 5. However, lecturers only agree that SMa2P is a straightforward tool for student-lecturer interaction. Since a result, all comments and feedbacks were considered, as they offer insight into how to enhance the application, which could lead to a better performance.

Table 6
Lecturers Feedback on SMa2P Application

Lecturers feedback	Score	Results
Able to achieve objectives	4.8	Strongly agree
Effective	4.2	Agree
Systematic	4.4	Agree
Holistic	4.0	Agree
User friendly	4.6	Strongly agree
Simple technology for interaction between lecturers and students	4.0	Agree
Give an advantage in the teaching process	4.6	Strongly agree
Appropriate teaching tools	4.6	Strongly agree

Figure 6 depicts the outcomes of a t-test analysis comparing the responses of respondents before and after the introduction of SMa2P in the teaching and learning process. The Sig. (2-tailed) value of 0.000 indicates that the SMa2P application should be adopted by

both students and instructors. Moreover, this digital application helps significantly to the academic success of students.

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Before – After	-1.67000	.58138	.13000	-1.94209	-1.39791	-12.846	19	.000

(table title: **Paired Samples Test**)

Figure 6: A t-test analysis of SMa2P application before and after implementation from the perspective of students and lecturers

Conclusion

The problem of student achievement in all courses can be addressed if the lecturer in charge is able to identify the underlying causes of poor student achievement. It is also possible to offer specific proposals for solutions in order to solve past issues. In order to evaluate the efficacy of the suggested solution, it is necessary to ensure that the selected proposal is effective and efficient through the use of testing methods. Evidently, the causes of the problem have been recognized, and practical solutions have been proposed, so that the issue of a high failure rate can be approached more methodically. A smartphone application called Sahabat Maya Pelajar, also known as SMa2P, has been developed and suggested as a solution to the problem. The installation of SMa2P in the Basic Hydraulics course has had a favorable effect on the number of students and their failure rate. This is evidenced by the student's performance when using the online learning platform. This innovative learning technique will not only be able to identify bad student performance, but it can also be expanded and updated on a regular basis as a smart and user-friendly mobile application alternative in the teaching and learning process. This is crucial in order to ensure that the teaching and learning approach is adaptable to the challenges given by the current Education Revolution 5.0 (IR 5.0), which has significantly strengthened the learning environment using digital tools.

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