Borneo Engineering & Advanced Multidisciplinary International Journal (BEAM)
Volume 2, Special Issue (TECHON 2023), September 2023, Pages 161-168

The Development of Engineering Science App for Engineering Science Course

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Full Paper

Article history
Received
27 July 2023
Received in revised form
27 July 2023
Accepted
11 August 2023
Published online
30 September 2023

Abstract

This research paper discusses the stages in the development of the application software named Engineering Science App. The main purpose of its development is to establish an online platform that can facilitate the implementation process of the lab work for students taking the Engineering Science course (DBS10012). The application is designed to cater for both online and face-to-face learning modes, is compatible with both Android and iOS platforms, is easily shared, and is user-friendly, especially for first-time users. The application is developed to be platform-independent, thus making it accessible from any type of device. The Engineering Science App was designed as an interactive application that guides students through the correct steps to perform the experiments and produce comprehensive lab reports. The development of the application focuses on the management of lab reports by students as well as the lecturers monitoring of the on-going progress to ensure a meaningful and quality output is achieved as the product. The implementation of engineering science lab work has been rather challenging in the absence of a centralized management system in place. In this study, we have succeeded in building application software that proves to be effective based on the high scores achieved on the user satisfaction survey. The results show that the Engineering Science App has significantly improved the Engineering Science lab work implementation process.

Keywords: - Online application, software, lab work, lab report, Engineering Science

1. Introduction

Mobile learning, mobile voice, and instant messaging are just a few of the interactive multimedia networks that have emerged in recent years because of the Internet's and wireless communication technology's rapid advancement. Utilizing the convenience and popularity of the Internet for deploying digital teaching materials and accomplishing the purpose of national competitiveness would replace traditional teaching (Lin et al., 2017). After the pandemic hit around the globe by the end of 2019, most education institutions adopted various online learning methods. Nowadays, educators and students, especially at higher institutions, are becoming more familiar with digital learning, and it continues to become a popular method for delivering lessons and teaching materials.

The idea of developing an online platform is an initiative to help students taking the Engineering Science course carry out the Lab Works coursework assessment during the Movement Control Order (MCO) phase. The app was designed to provide reference materials to facilitate students' writing of quality lab reports as well as for lecturers to manage the submission of the reports during the online teaching and learning phase. Producing a well-organized, quality report has been a long-standing problem for the lecturers teaching the Engineering Science course at Politeknik Mukah. Therefore, the app was developed to solve this problem.

Students' opinions about technology in all parts of their lives are largely influenced by its usefulness and ease of use (Edmunds et al., 2012). Thus, we have designed the app with a user-friendly interface that is easy to navigate. Instructions are easy to understand, considering the student's level of mastery of English as a second language. The Engineering Science App would

also be accessible through various types of devices, and it is also compatible with both Android and iOS platforms. Effective use of online apps in science education requires careful selection and implementation of appropriate tools and strategies, as well as consideration of factors such as student access and technological literacy (Wen et al., 2019).

1.1 Problem Statement

Lab work is a part of the coursework assessment for polytechnic students taking the Engineering Science course. Prior to the MCO phase, lab work was carried out in the science laboratory. Lecturers would demonstrate the steps to carry out the experiments followed by the students carrying out the experiments in small groups. The lab sheets are distributed for the students to record the details and result from the experiments to produce lab work reports. However, during the MCO phase, where classes were fully conducted online, all face-to-face learning activities were prohibited. Hence, the lab work experiments could not be implemented which makes it difficult for the students to produce quality lab reports. Furthermore, the course lecturers faced a problem managing the online submission of the reports. Therefore, an online platform which serves as a report submission management system is required. The online platform would also facilitate the implementation of the Engineering Science Lab Works and produce comprehensive lab reports that can be used for both online and face-to-face learning modes.

1.2 Objective of Study

To develop an online application that can perform as a tool to perform the following:

1. Lab work report online submission management system.
2. Reference guide for students taking the Engineering Science (DBS10012) course to carry out lab work.
3. Online referrals point to produce comprehensive and quality Lab Work reports.

2. Literature Review

The usage of ubiquitous and networked mobile devices in educational settings is rising, including 3G mobile phones, PDAs, and pocket PCs. Multipurpose software, cutting-edge hardware, and network technologies open up new opportunities for fostering innovative forms of communication, learning, and collaboration (Wang et al., 2012). Most students require efficient and engaging activities that will inspire them to actively engage in the learning process (Behnamnia et al., 2020). Compared to traditional teaching and learning methods that rely on lectures, today's youth are more driven to learn something new through technology (Suryaningtyas et al., 2019). The success of online app-based learning activities depends on the quality of the instructional design, as well as the technical functionality and reliability of the apps themselves (Rotellar et al., 2016). Thus, the design of this app incorporates the materials required for students to carry out the experiments step by step via instructional videos. In addition to that, the app contains reference guides such as tutorial videos for students to produce quality reports.

The study "Development of a Web-Based Learning Platform for Engineering Education" by Shen et al., (2020) aimed to design and develop a web-based learning platform for engineering education and evaluate its effectiveness in improving students' learning outcomes. The authors found that the web-based learning platform significantly improved students' learning outcomes and was positively perceived by the students. However, the study involves a small sample size and the fact that the study was conducted in only one university in China. The authors acknowledged that more research is needed to further validate the effectiveness of the web-based learning platform in different contexts and with larger samples.

The study "Developing Online Laboratory Experiments for Teaching Engineering Science Courses" by Abdulrazzaq et al., (2020) investigates the development and evaluation of a series of online laboratory experiments for teaching an engineering science course. The authors aimed to explore whether the online laboratory experiments were effective in improving students' understanding of engineering science concepts, and their ability to apply them to real-world problems. The study employed a mixed-methods approach, using both quantitative and qualitative data collection methods. Data was collected through surveys, pre- and post-tests, and interviews. The authors found that the online laboratory experiments were effective in improving students' understanding of engineering science concepts and their ability to apply them to real-world problems. Students also found the online laboratory experiments engaging and informative. The study also identified some limitations. The authors note that online laboratory experiments may not be suitable for all engineering science courses and that there are technical and logistical challenges to developing and implementing them. Additionally, the authors acknowledge that online laboratory experiments cannot completely replace hands-on laboratory experiences, which are still an important part of engineering education.

The study "Using an Online Platform for Collaborative Learning in an Engineering Science Course" by Kock et al., (2021) explores the effectiveness of an online platform for promoting collaborative learning among engineering science students. The authors aimed to investigate whether the online platform could improve students' understanding of course material and enhance their problem-solving skills. The study found that the online platform was successful in achieving these objectives. However, there are limitations in this study. Firstly, the sample size was small, limiting the generalizability of the findings. Secondly, the study was conducted during the COVID-19 pandemic, which may

have influenced the results due to changes in the learning environment. Additionally, the study did not compare the effectiveness of the online platform to traditional classroom learning methods.

The study "Online Learning for Engineering Students: Evaluating the Effectiveness of an Interactive E-Learning Platform" by Ng et al., (2021) aimed to evaluate the effectiveness of an interactive e-learning platform in enhancing the learning outcomes of engineering students. The study employed a quasi-experimental design to compare the learning outcomes of a group of students who used the e-learning platform with those who received traditional classroom teaching. The study suggests that the e-learning platform significantly improved students' understanding of engineering concepts and knowledge retention compared to traditional classroom teaching. The e-learning platform also provided a flexible and convenient learning environment for the students, allowing them to study at their own pace and time. The students reported positive perceptions of the e-learning platform, with many indicating that they would prefer to use it in future courses. However, the study has certain limitations, including the small sample size, the short duration of the study, and the lack of a control group. Therefore, the authors suggest further research with a larger and more diverse sample, longer study duration, and control groups to further validate the findings.

The study "An Online Platform for Teaching Engineering Ethics" by Adams et al., (2020) evaluated the effectiveness of an online platform for teaching engineering ethics. The study suggests that interactive features, such as case studies and discussion forums, can be effective in promoting ethical reasoning and decision-making skills in engineering students. The study also found that the online platform was effective in promoting collaboration and peer-to-peer learning. While the study demonstrated the effectiveness of the online platform, it also had some limitations. The sample size was relatively small, and the study was conducted at a single institution. Therefore, the generalizability of the findings to other contexts may be limited.

In our study, we intend to build an online application that is meant for facilitating students to conduct lab work and produce quality lab work reports by providing reference materials for the course in the app. The app would also allow proper submission management of lab reports. Overall, the Engineering Science App would be a relevant online learning tool suitable for both remote and face-to-face learning mode.

3. Methodology

The Engineering Science App was developed using the available online applications such as Google Docs, Google Sheet, AppSheet, and Autocrat. Fig. 1 shows the flowchart for the development of the Engineering Science App. The flowchart shows how the components (online apps) are incorporated to form the Engineering Science App. The flowchart starts with designing the Lab Sheets which would be the report template (output). Three Lab sheets were designed to produce three different types of labs reports: Linear Motion, Archimedes Principle and Energy in Thermal System. The database is designed using Google Sheets based on the input fields in the Lab Sheets. A google add-in component, Autocrat is added to the database to enable PDF file generation from user input. Finally, the app is created using AppSheet. This part will be the front end of the app where it serves as the online platform for students to key in and update data for the lab reports. The app also includes videos on the lab procedures for students' reference.

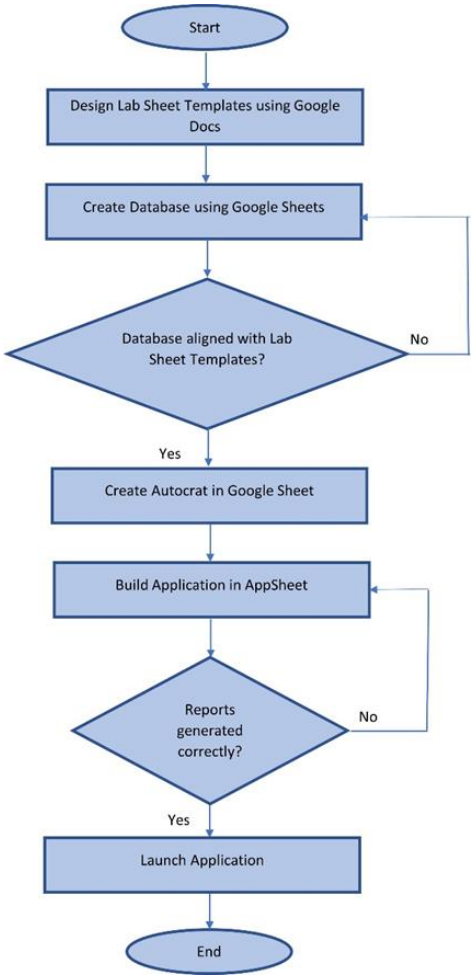


Fig. 1. Flowchart for the development of the Engineering Science App

The Software Development Life Cycle (SDLC) implemented for the development of the Engineering Science App is the Iterative Model (Fig. 2). This approach was the most suitable due to the requirements being already established prior to the design and development phase. The first prototype of the app was built during the MCO phase and tested by the students taking the Engineering Science course via online teaching and learning mode. Feedback from students was taken via

google survey which will be further discussed in the Finding and Analysis section. Comments and feedback were reviewed and taken into consideration for continuous improvements on the app functionalities and features.

Fig. 2. Iterative model

The development process starts by designing the Lab Sheet templates. Tags are added to the templates where they will later be mapped to the corresponding fields in the database. The database is designed using Google Sheets. The required fields in the lab sheet templates must match those in the database to ensure that data will be mapped correctly once the report is generated. After the database is finalized, Autocrat is launched into the Google Sheet. Autocrat is a Google Sheet add-on which will merge the information in Google Sheet into PDF format reports. The final process of development is building the front-end of the app that will function as the interface for user interaction. The features included in the design of the interface are data input, update and delete, display report and related materials. The interface is built using AppSheet, a Google application that provides development platform for application software. The database created in Google Sheet becomes the source data for building the interface in Appsheet.

The sequence diagram shown in Fig. 3 explains the interaction of the user with the app. In the diagram, there are two actors involved, Student and the Database Admin. When students launch the app, the menu screen is displayed. There are three types of interaction between users and the app; 1. Key-in data, 2. Update/delete report and 3. Generate reports. The database admin can be appointed from any of the course lecturers or coordinator. The students will be granted access as app users. To use the app, the student must have a google account/email, which will be registered into the app. Once access is granted, the student must install the app on his mobile phone or launch the app in a google browser. The app is accessible if the user is signed in to his google account. Once the app is launched, students can view the Menu page. In the first process, the Lab Work data input page will be displayed upon selection of a Lab Work from the Menu. Students then will be able to key in the data into the Lab Work page. The data will be updated into the database. The process of Updating Lab Work will be triggered when student selects the Update Lab Work menu. Students select to update their own data which will be automatically updated into the database. The process of generating reports is triggered in the database environment where the admin runs Autocrat in the Google Sheet. The report will be available once the merging process is triggered.

The following are hardware/software requirements to access the Engineering Science App:

- Mobile phone/Laptop/Desktop Computers (any other devices).
- Internet access.
- Google account.

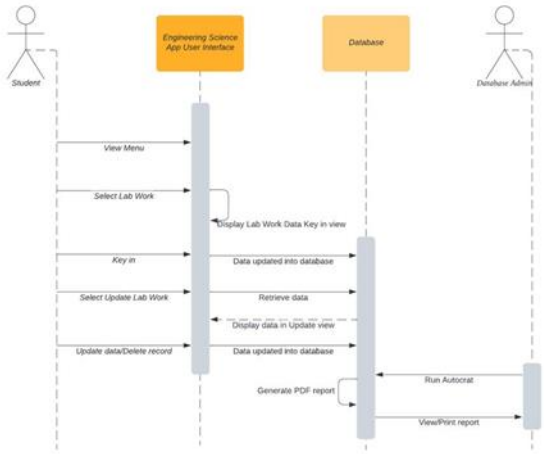


Fig. 3. Sequence diagram for Engineering Science App

4. Result and Discussion

The Engineering Science App was successfully built and launched to carry out Engineering Science (DBS10012) Lab Works. The app contains reference materials for performing the experiments, helps students to key in the data into the report properly, displays the report and enables them to update the report online. Course lecturers can manage the reports easily. The Engineering Science App produces proper and organized reports in PDF format.

Upon launching of the Engineering Science App, the menu page will be displayed (Fig. 4) where students can select the Lab Work desired. Selecting a Lab Work will take them to the Lab Work input view where they can watch online video showing step by step procedure to perform the experiment (Fig. 5). Fig. 6 shows the data input view for the Lab Work (Linear Motion).

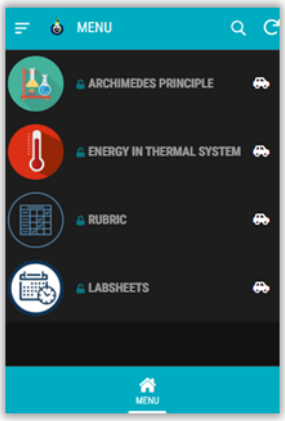


Fig. 4. Engineering Science App menu

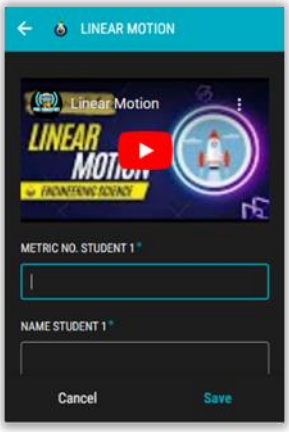


Fig. 5. Video showing steps to perform experiments in the Lab Work input view

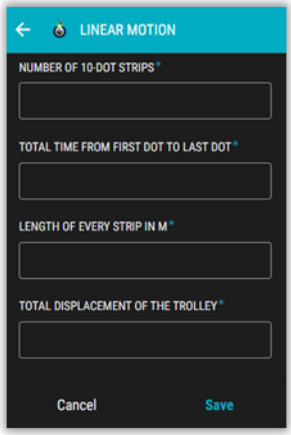


Fig. 6. Lab Work (Linear Motion) data input view

The data key-in by the students will be updated into the database (Google Sheet) as shown in Fig. 7. The database is only accessible by the admin. Students will only be able to update or delete the record via the Update detail's view (Fig. 8) from the app's menu. The updated data will be automatically synced into the database. Students are allowed to make amendments to their reports until the submission due date (as advised by course lecturers). This feature allows proper management of reports by lecturers before the reports are generated.

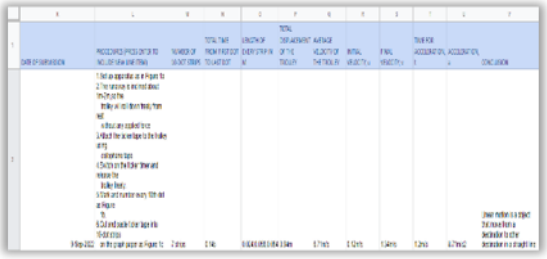


Fig. 7. Google Sheet (database) view.

Fig. 8. Update detail's view.

Once the report is finalized, the database admin (lecturer) will run Autocrat in the Google Sheet which will merge the records to generate PDF documents, the Lab Work reports (Fig. 9).

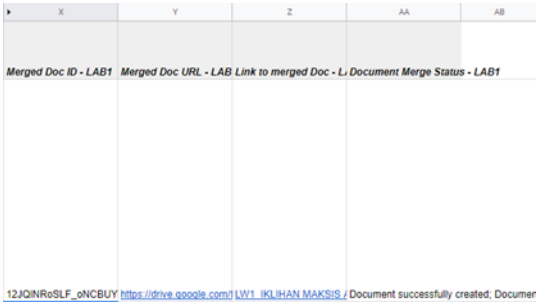
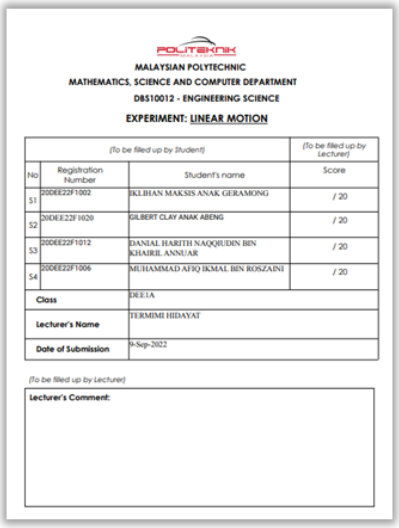


Fig. 9. Document merged to PDF format report.

Fig. 10 shows the front cover of the report while Fig. 11 shows some parts of the report content after the document is merged in Google Sheet.

The design of the Engineering Science App user interface is purposely made to be simple and easy to navigate. The app's functionality and ease of use are also critical factors in user satisfaction. Apps that are

difficult to use or do not perform well are likely to be abandoned by users. Navigation design is crucial in ensuring that users can easily access app features and content. Clear and intuitive navigation design can enhance user satisfaction and engagement (Ahmed et al., 2020). According to Ullah et al., (2021), an app's interface should be simple, intuitive, and easy to navigate. Users should be able to quickly access the information they require without being overwhelmed by complex features or jargon.

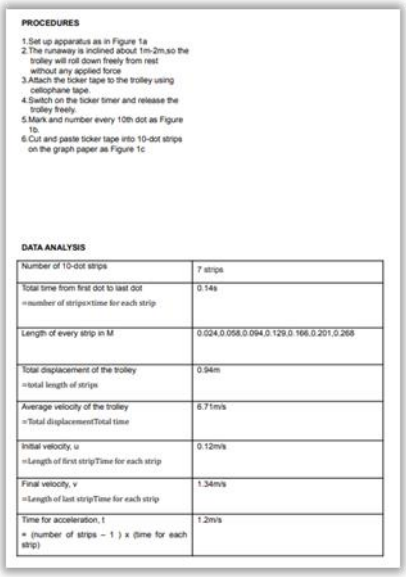


MALAYSIAN POLYTECHNIC
MATHEMATICS, SCIENCE AND COMPUTER DEPARTMENT
DBS10012 - ENGINEERING SCIENCE
EXPERIMENT: LINEAR MOTION

		(To be filled up by Student)	(To be filled up by Lecturer)
No	Registration Number	Student's name	Score
51	20DEE22F1002	IKLIHAN MAKSIS ANAK GERAMONG	/ 20
52	20DEE22F1020	GILBERT CLAY ANAK ABENG	/ 20
53	20DEE22F1012	DANIAL HARITH NAQQIUDIN BIN KHAIREL ANNUAR	/ 20
54	20DEE22F1006	MUHAMMAD AFIQ IKMAL BIN ROSZAINI	/ 20
Class		DEE1A	
Lecturer's Name		TERMIMI HIDAYAT	
Date of Submission		9-Sep-2022	

(To be filled up by Lecturer)
Lecturer's Comment:

Fig. 10. Front Cover of PDF report



PROCEDURES

1.Set up apparatus as in Figure 1a
2.The runaway is inclined about 1m-2m,so the trolley will roll down freely from rest without any applied force
3.Attach the ticker tape to the trolley using cellophane tape.
4.Switch on the ticker timer and release the trolley freely.
5.Mark and number every 10th dot as Figure 1b.
6.Cut and paste ticker tape into 10-dot strips on the graph paper as Figure 1c

DATA ANALYSIS

Number of 10-dot strips	7 strips
Total time from first dot to last dot =number of strips×time for each strip	0.14s
Length of every strip in M	0.024,0.058,0.094,0.129,0.166,0.201,0.268
Total displacement of the trolley =total length of strips	0.94m
Average velocity of the trolley =Total displacementTotal time	6.71m/s
Initial velocity, u =Length of first strip/Time for each strip	0.12m/s
Final velocity, v =Length of last strip/Time for each strip	1.34m/s
Time for acceleration, t = (number of strips – 1) x (time for each strip)	1.2m/s

Fig. 11. Report content

The Engineering Science App has been utilized by the Science Unit in the Department of Mathematics, Science and Computer to facilitate the implementation and management of the Lab Work coursework assessments since the MCO phase. The app has proved to be user friendly and easy to use by students and managed by the course lecturers.

Other than using the app for remote learning, the Engineering Science App continues to become a useful learning aide for both lecturer and students in the current setting of face-to-face learning mode. According to Chen et al., (2017), online apps can be used to enhance student engagement in classroom instruction by allowing students to interact with course content and with each other in new and meaningful ways. It can also be used to promote active learning in the classroom by providing opportunities for students to collaborate on projects, participate in discussions, and engage in hands-on activities.

To measure the effectiveness of the app, a testing phase was carried out by selecting a group of students taking the Engineering Science course to use the Engineering Science App. A total of 44 students from the Mechanical Engineering department and Civil Engineering department of Politeknik Mukah were chosen to use the app to produce and submit their Lab Work reports. The students' feedback was collected through a questionnaire containing their perspectives on the app's contents and interactive features. A total of 10 questions requiring feedback on the app's content while 10 questions were asked on the app's interactivity. The questionnaire was assessed using a five-point Likert format: Strongly Disagree (5), Disagree (4), Moderate (3), Agree (4) and Strongly Agree (5). Responses were collected online via Google Form. The results for the average overall mean score for Engineering Science App's content is 4.33 while the average overall mean score for its interactivity is 4.34. These results indicate the user's high satisfaction level with the Engineering Science App.

Table 1. Mean and standard deviation for application's content.

No	Item	Mean	Standard Deviation
1	The content of the application corresponds to every lab work.	4.34	.479
2	The details are easy to understand.	4.34	.479
3	The demonstration video were shown are in order.	4.43	.501
4	The demonstration video shown are easy to follow.	4.30	.553
5	The details of the demonstrated video are arranged in systematic way.	4.32	.471
6	All the details provided are sufficient.	4.30	.462
7	This application's language is simple to understand.	4.32	.471
8	All the details are well presented and interesting.	4.41	.497
9	Data/ Reports are easy to submit.	4.30	.509
10	This application is facilitate the submission process.	4.25	.438

Table 2. Mean and standard deviation for application's interactivity.

No	Item	Mean	Standard Deviation
1	This application is easy to install.	4.34	.479
2	This application can be used by android and iOS systems.	4.34	.479
3	This application is user friendly.	4.36	.487
4	This application can be installed by using smartphone, tablet and laptop.	4.45	.504
5	The application interface is good.	4.32	.518
6	This application is useful during COVID-19 pandemic.	4.45	.504
7	The instructions in the application make it easy for the user to explore the content of the application.	4.34	.479
8	The icons available on this application are easy to use.	4.34	.526
9	The elements contained in this application are interactive.	4.23	.476
10	Overall, this application is easy to use.	4.32	.471

Overall, the Engineering Science App appears to be a useful tool for students who are facing challenges in completing their coursework assessments. By leveraging online applications, the app provides a flexible and accessible platform for students to carry out their assessments remotely.

5. Conclusion

The Engineering Science App is an online application that is user-friendly and easily accessed on any type of device. It was developed using combinations of *Google* online applications. The main components of the app consist of *Google Doc, Google Sheet, Autocrat and AppSheet*. The Engineering Science App facilitates the Lab Work implementation process for the Engineering Science (DBS10012) course as well as the coursework management system. The product of this app is quality Lab Work reports by students taking the course as well as to enhance their learning process through an accessible online platform. Students can access the app using any type of device at any time with the presence of the Internet.

However, we do note that there are some limitations in our study. Firstly, the app developed covers a small part of the Engineering Science curriculum, which is the coursework assessments covered in the three topics: Linear Motion, Archimedes Principles and Energy in Thermal System. Secondly, the app is built using a free version of the app development tool (prototype version) which limits the user to a small group of students. We hope to enhance the app in the future by expanding the usage and incorporating other useful features and references into the app to improve the user experience.

Acknowledgement

We would like to express our sincere gratitude to the Head of Department of Mathematics, Science and Computer, Course Leader and the lecturers of Science Unit and the Course Coordinator of Engineering Science for the continuous support in development of the Engineering Science App and for providing useful feedbacks.

References

Abdulrazzaq, F. H., Ghazy, A. M., Abdulrazzaq, H. T., & Othman, M. F. (2020). Developing online laboratory experiments for teaching engineering science courses. *IEEE Access*, *8*, 199135-199146.

Adams, B., Henry, S., & McAdams, E. (2020). An online platform for teaching engineering ethics. *IEEE Transactions on Education*, *63*(3), 236-244.

Ahmed, M. D., Uddin, M. Z., Hossain, M. N., & Hossain, M. A. (2020). Designing User-Friendly Apps: An Investigation into User Experience Design for Mobile Applications. *International Journal of Computer Science and Network Security*, *20*(10), 66-76.

Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, A. (2020). The effective components of creativity in digital game-based learning among young children: A case study. *Children and Youth Services Review*, *116*, 105227.

Chen, J., & Stavridis, C. M. (2017). Using online apps to enhance classroom instruction in higher education. *Journal of Educational Technology Development and Exchange*, *10*(1), 1-14.

Edmunds, R., Thorpe, M., & Conole, G. (2012). Student attitudes towards and use of ICT in course study, work and social activity: A technology acceptance model approach. *British journal of educational technology*, *43*(1), 71-84.

Kock, N., Sherry, A., & Wulf, J. (2021). Using an online platform for collaborative learning in an engineering science course. *Journal of Interactive Learning Research*, *32*(1), 1-22.

Lin, M.-H., Chen, H.-G., & Liu, K.-S. (2017). A Study of the Effects of Digital Learning on Learning

Motivation and Learning Outcome. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(7), 3553-3564.

Ng, T. M., Tan, K. C., & Lu, W. F. (2021). Online learning for engineering students: Evaluating the effectiveness of an interactive e-learning platform. *European Journal of Engineering Education*, 1-15.

Rotellar, J. R., & Cain, M. J. (2016). Using online apps to promote active learning in large lectures. *Journal of Educational Technology Development and Exchange*, *9*(1), 1-14.

Shen, W., Yu, W., Gao, X., Wang, H., & Shi, Y. (2020). Development of a web-based learning platform for engineering education. *IEEE Access*, *8*, 185002-185010.

Suryaningtyas, V. W., Nugroho, R. A., Cahyono, S. P., Nababan, M. R., & Santosa, R. (2019, September). Translation Learning Enrichment Using Smart Application Creator 3.0: An Attempt to Design a Mobile Application in Translation for Tourism Purpose Course. In *2019 International Seminar on Application for Technology of Information and Communication (ISemantic)* (pp. 542-547). IEEE.

Ullah, S. S., Islam, M. S., Zaman, S., & Uddin, M. Z. (2021). Designing a User-Friendly Interface for Cybersecurity Awareness: A User-Centered Approach. *Journal of Cybersecurity Education, Research and Practice*, *1*(1), 1-15.

Wang, R., Wiesemes, R., & Gibbons, C. (2012). Developing digital fluency through ubiquitous mobile devices: Findings from a small-scale study. *Computers & Education*, *58*(1), 570-578.

Wen, C. J., Chang, C. Y., Yeh, T. K., & Sung, Y. T. (2019). Using online apps to enhance classroom instruction in science education. *Journal of Educational Technology & Society*, *22*(1), 62-73.