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Laboratory work assessment with QR code lab manual for engineering science course among Polytechnic students

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Abstract

The development of a QR code as a barcode label contains information about the item to which it is attached. However, information on QR code development in engineering science laboratories is still limited. The aim of this research is to design the QR code lab manual for laboratory work in polytechnics engineering science course. In addition, the students' views in construct of easiness of use, usefulness and enjoyment using the QR code are also investigated. The QR code lab manual involved seven steps of development under the engagement theory in teaching and learning. Learning materials are embedded into the QR code within 1 sheet of an A4 size card. A total of 64 students were chosen using purposive sampling. Data from survey questionnaires revealed that the respondents have a high level for all the constructs. It has been suggested that students perceived the QR code lab manual developed as a useful tool that is easier to use in the future. This QR code lab manual allows educators to connect the traditional teaching style and provide students with a more genuine and unforgettable educational experiences. Future studies should consider a different experiment with the new design for QR codes with additional constructs and a variety of perspectives.

Keywords: QR code, laboratory work, assessment, lab manual, polytechnic.

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1. Introduction

Engineering science is a fundamental course that must be taken by all first semester engineering students in Malaysian polytechnics. The syllabus based on the prescribed curriculum includes theories and calculations. These theories need to be understood, translated and subsequently related to the practical application of civil, mechanical or electrical engineering. The engineering science course requires the implementation of laboratory work conducted in the science laboratory as one part of the assessment. Hence, to emphasise clear understanding of these theories as the basis preparation skills needed in engineering to ensure that these goals are met, a better strategy of using QR codes, instead of conventional lab sheet methods, should be alternatively considered by the lecturer. Uchak (2019) mentioned that the prospective teachers addressed QR codes that can be frequently used in the science laboratory; help teachers support their classes with QR codes laboratory scenario; and give opportunity for student to show laboratory progress in group work with their own learning pace. The use of these QR codes has been widely used by many past researchers such as Lin et al. (2022), Shaban et al. (2021), Akbay et al. (2022), Chang et al. (2021) and Gulec and Coklar (2021). However, the study did not focus on the laboratory in the institution. This study is important because many science-based subjects require alternative QR codes to facilitate students and paperless learning.

The laboratory practises will be extremely beneficial in terms of developing scientific reasoning abilities, constructing practical skills, ramping up understanding of the concept of science, enlightening curiosity in scientific and technological fields and enhancing leadership ability. The need to develop a QR code has encouraged many studies by researchers in the context of education. Karahan and Bilici (2017) revealed participants' beliefs that QR codes can enhance students' interest and motivation in science classrooms. Moreover, Sharma (2013); Mehendale et al. (2017); and Saprudin et al. (2014) agreed that QR codes specifically were used as a powerful learning tool to enhance student knowledge in teaching and learning process. Although many previous studies have studied the QR code, the study of its use in the context of polytechnics in Malaysia is not much debated. The main objective for this research is (a) to design a QR code lab manual for the Experiment 1: Physical Quantities and Measurement in the engineering science course and (b) to examine the level of easiness of use, usefulness and enjoyment in using the QR code lab manual.

1.1. Related researches

Several studies on integrating m-learning with QR code seem similar with positive feedback from students (Law & So, 2010; Shin & Kang, 2015; Zhang et al., 2010). In education, the QR code has not been widely used as an assessment tool, instead is used to answer questions, quizzes and tests besides answer the classroom assessment question (Susono & Shimomura, 2006). In comparison, previous studies have only focused on students' assessments in the classroom. Although the assessment is very important and vital, the aspect of handling and managing students in the lab should not be taken lightly. QR code will make it easier for students compared to the conventional manuals used today. Very few quantitative studies related to the construction of manuals in the laboratory work facilitate engineering students in polytechnics. Thus, this study explores the potential use of the QR code lab manual for laboratory work assessment among engineering students in polytechnics.

2. Literature Review

2.1. Smartphone with QR code is a supportive learning tool in education

Several authors have stated that QR codes are a helpful learning tool in education because they allow students to connect content and activities online (Bal & Bicen, 2016; Liaw et al., 2010; Wayase, 2015). Previous research studies have shown that unrestricted online content that can be accessed from the comfort of one's own home at any time and from any location is beneficial (Alalwan et al., 2013; Al-Khalifa, 2011; Durak, 2016). Thus, incorporating QR code with smartphone support, an enjoyable and conducive learning environment, may assist students in becoming enthusiastic and remaining motivated while performing laboratory work (Jun-Ki et al., 2012). Law and So (2010) and Abby Ashraff, Norlia & Latifah (2014) highlighted the significance of QR codes in m-learning and incentivised students to use them. M-learning and QR code have great potential as a teaching and learning tool (Rikala & Kankaanranta, 2014).

In Figure 1, the QR code lab manual was invented to replace the traditional lab sheet. The QR code lab manual outperforms the conventional approach in terms of costing, accessibility, attractiveness, participation and time consumption. The QR code lab manual also provides opportunities for both independent and cooperative learning, which inspires beginners and attracts their attention to actively participate due to its ease of use and lack of paper (Shin & Kang, 2015). Moreover, the invention of the QR code lab manual as a 'technology-based educational aid' designed as a new pedagogical approach encourages student-centred learning (Myllari et al., 2012; Sharma, 2013) and a comfortable learning environment (Al-Khalifa, 2011). The m-Learning approach offers opportunities, convenience, advantages and dynamic environment during the learning process (Liaw et al., 2010). It also highlights the concepts and benefits of technology digital mobile device growth with industry assimilation into education (Jun-Ki et al., 2012).

Figure 1. Conventional lab sheet Versus QR code Lab manual

2.2. Students' engagement with mobile learning

The alternative method in conducting laboratory work can attract students to actively engage in practical activities, hence producing critical, creative and skilful learners. Ali et al. (2017) pointed out that use of QR codes is easy and useful in learning activities. Students scanning and learning the QR code lab manual during the laboratory work process is crucial to developing thinking and imagination

skills (Zhang et al., 2010), giving students the opportunity to experience their own laboratory competency and enabling them to understand the process and know the importance of science content that is closely related to their daily lives (Jun, Lee & Kwon, 2012). The curiosity of the use of QR codes and the relevance of the existing theory of science has directed the absorption of the new concept as an indicator that the students' intellectual and emotional factors react directly to in meaningful learning (Gikas & Grant, 2013; Jones et al., 2013). Students know the importance of collaborating in groups and engaging in activities with their emotionally pleasing influences in the development of self-learning and virtual exploration. Hence, the QR code lab manual draws students' attention to engage in online learning materials that lead to positive attitudes towards effective and significant knowledge (Ali et al., 2017; Durak, 2016).

2.3. Creating new interactive laboratory workspace

The use of the QR code lab manual seeks to provide a learning experience towards the fourth Industrial Revolution. Rochmawati et al. (2018) agreed that the QR code scan makes paperless learning sessions. The experience in laboratory means they can follow virtual simulations of 2D/3D, are no longer bound by conventional lab sheets and promote the use of technology directly in the lab. This innovation helps students by internalising the theoretical knowledge of science and technology according to the lifestyle of Gen Z who are closely linked to the use of smartphones as part of everyday life (Gikas & Grant, 2013). The use of smartphones towards whole-hearted learning allows students gain experience through exploration on their own. Students have the power of learning through which they can explore the QR code lab manual to perform the laboratory work themselves and repeat the practical video demonstration on their own. Students are more motivated and show deep interest in exploring new knowledge (Jones et al., 2013; Zhang et al., 2010). Active involvement in groups where all members of the group have their respective responsibilities during the practical implementation session can prevent the sleeping partner among them. The QR code lab manual enables students to work independently with smartphones that they are already familiar with in implementing laboratory work. Students record practical data online and are reviewed by lecturers directly whether the data is correct or not. Lecturers can identify the groups of skilled students as well as those who are naïve through data access recorded by the students during the laboratory work session.

2.4. Smartphone with QR code is a beneficial learning tool for education context

Several authors have stated that QR codes are a helpful learning tool in education because they allow students to connect teaching materials online (Bal & Bicen, 2016; Liaw et al., 2010; Wayase, 2015). Previous research has shown that unrestricted online content that can be accessed from the comfort of one's own home at any time and from any location is beneficial (Alalwan et al., 2013; Al-Khalifa, 2011; Durak, 2016). Thus, incorporating QR codes with smartphones supports an enjoyable and conducive learning environment, which may help students become enthusiastic and stay motivated while performing laboratory work (Jun-Ki et al., 2012). Law and So (2010) and Abby Ashraff, Norlia & Latifah (2014) highlighted the significance of QR codes in m-learning and encouraged students to use them. M-learning and QR code have great potential as a teaching and learning tool (Rikala & Kankaanranta, 2014).

2.5. The engagement theory

Greg Kearsley and Ben Schneiderman developed the engagement theory. They believe technology can assist interaction in aspects that would otherwise be difficult to achieve. The theory can be used for gaining knowledge in technology-enabled environments and synthesising elements from previous learning theories. The engagement theory provides a concept for using technology to teach and learn. The fundamental concept is that students should be substantively engaged in the learning exercises via

interplay with others and meaningful tasks. The engagement theory's underlying premise is that students must be substantively implicated in their studying via engaging and valuable tasks. Even though the use of innovation is not needed, it has been found that it can encourage participation that would be hard to achieve otherwise. Working collaboratively, project-based learning, and having an authentic focus are three elements promoted by the engagement theory.

2.6. Easiness of use, usefulness and enjoyment in learning

The elements of easiness of use, usefulness and enjoyment in learning using QR code are vital to be measured. However, the code development is not enough if the students cannot feel the fun of using it. Thus, the definition of these three elements will be explained in the context of this study. The easiness of use can be defined as a simple and convenient tool in the easiest way to access the link/website just by scanning it. Mehendale et al. (2017) pointed those students will be more excited to use it and make the environment of the laboratory work session full of fun and emotionally loved. The usefulness can be defined as the function of QR code as an independence guidance manual for the user to explore information by implementing laboratory work. Mousa and El-Salam (2016) reported that teachers approved a guide that provides different learning resources represented as a QR code for each scientific and mathematical concept in the curriculum. Moreover, students were able to work actively and independently by repeating the steps prepared in sequence embedded QR code and enabling learning-based scenarios. The enjoyment can be defined as the use of QR code is seen to be enjoyable in context of perceived pleasure and attractiveness concerning the intention to encourage others to use it. Mehendale et al. (2017) emphasised that QR code is able to increase the students' interest and motivation to engage in instructional activities.

Based on these three definitions, it can be concluded that a student should find it easy to use the QR code. In addition, the factors of usefulness and enjoyment also need to be emphasised to show that the QR code does not burden the user. Thus, this study explores the potential use of the QR code lab manual for laboratory work assessment among engineering students in polytechnics. The main objective for this research is (a) to design a QR code lab manual for the Experiment 1: Physical Quantities and Measurement in DBS1012 engineering science course and (b) to examine the level of easiness of use, usefulness and enjoyment using the QR code lab manual.

3. Method and Materials

3.1. Research model

For the first objective, the development of this QR code is based on six steps, namely (a) prepare embedded document by generating a QR code with a specific text/image/YouTube/Google Sheets; (b) enable the required text/URL into QR code using QR code generator; (c) insert the proposed information into the QR code generator (graphic, video); (d) the QR Code will be generated by the QR code generator; (e) save the generated image file QR code; and

3.2. Participants

To achieve the second objective of this research stated – to examine the level of easiness of use, usefulness and enjoyment using the QR code lab manual – the study took a quantitative approach, employing a cross-sectional quantitative survey strategy with 64 respondents selected using purposive sampling. The quantitative approach was used in this study due to its ability to collect and analyse data in a quantitative setup to explain the phenomenon that were studied (Gay & Mills, 2018). The data was collected using a self-administered online questionnaire because it is less expensive; there is no cost for

copying questionnaires; and no coding is required. As a result, the results are almost directly available for statistical analysis (Hair et al., 2013).

3.3. Materials and data collection process

QR code lab manual has been developed to improve and replace conventional methods using lab sheets for practical implementation of the Experiment 1: Physical Quantities and Measurement in DBS1012 engineering science course. This method combines m-learning technology that encourages students to actively participate during the laboratory's practical session. Learning materials are embedded into the QR code within 1 sheet of A4 size card, as shown in Figure 1. QR code lab manual displays objectives, procedures, tools, data recording tables and video tutorials on how to conduct the experiment. The research design used was developmental with a survey in describing the overall testing of QR code effectiveness. The data collection for the second objective was carried out through an online questionnaire, which needed people to answer all items before submission; this dismissed the possibility of incomplete information. After completing the experiment, students were given a link to fulfil the questionnaire on Google Forms. Thus, all the 64 students who are using the QR code lab manual gave feedback through the Google Forms. Before the actual study, the total of 16 items was developed with 3 main constructs for the questionnaire to test: the easiness of use, usefulness and enjoyment.

3.4 *Data Analysis*

The reliability for all items in the pilot test is 0.953 and consider as good and acceptable. The resulting mean score then was divided into three categories, namely low (mean score ranges from 1.00 to 2.33), moderate (mean score ranges from 2.34 to 3.67) and high (mean score ranges from 3.68 to 5.00). Table 1 presents the data and revealed that the respondents have a high level of all the constructs on using the QR code lab manual. Tables 2–4 present the data for each item according to a 5-point Likert scale in the range of 1 (Strongly Disagree – SD), 2 (Disagree – D), 3 (Neutral – N), 4 (Agree – A) and 5 (Strongly Agree – SA). For each item for Likert-type data, the descriptive statistics recommended for ordinal measurement scale items include a mode or median for central tendency and frequencies for variability. For the construct or Likert scale data, the items were analysed using the mean for central tendency and standard deviations for variability (Boone & Boone, 2012). Figure 2 shows the flow chart design in preparing the QR code lab manual. The QR code lab manual contains content that is appropriate for mobile learning. As shown in Figure 2, the teaching activities embedded in QR codes accompanied the sequence of the laboratory process from beginning to end.

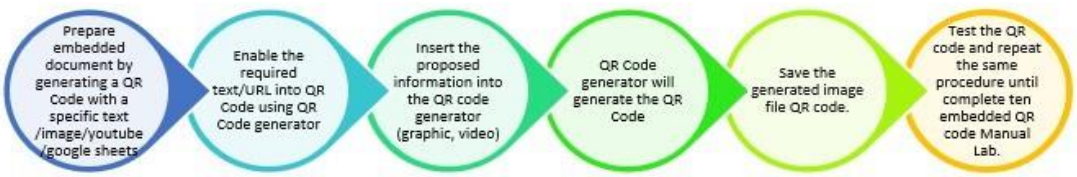

Figure 2. Flow Chart shows the process in preparing the QR Code Lab manual

For the first step in designing QR code lab manual, the information to be presented needs to be prepared. The title, objectives inferences and hypotheses, procedures, list of apparatus, equipment diagram, demonstration video or tutorial and data are embedded in the code either in the form of URL of the embedded item, such as image, videos or related items. Each of information embedded has a different design of the code. The second step is in preparing the QR codes; we use the QR code generator app to generate the QR codes. This application can be downloaded for free at Google Play Store, as

shown in Figure 3. Thirdly, the students enable the required text/URL into QR code using QR code generator and insert the proposed information into the QR code generator (graphic/text/video URL). Fourthly, the QR code generator will generate the QR code after inserting all the needed information. The fifth step is once the QR code is generated, the image of the QR code will be saved in the document or work sheet. The last step is to test the QR code. Once the QR code is saved, the QR code must be test to make sure the QR code produces the right content that we have already embedded. To test the QR code, we use the lighting QR code reader. All steps are as shown in Figure 4 to 6. This application can be downloaded via Google Play Store for free. Students need to scan the QR code using the lighting QR code app to see the information for laboratory purpose. Figure 7 shows that the appearance of content after scanning the embedded QR lab manual sequence #3, as shown in Figure 8.

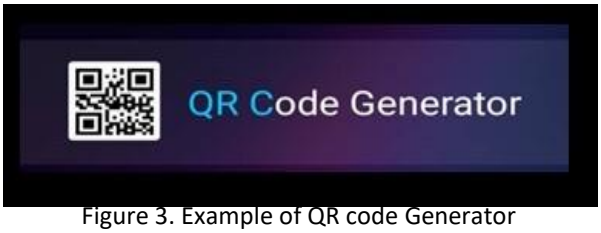

Figure 3. Example of QR code Generator

Figure 4. Text or related image/video URL inserted into QR generator

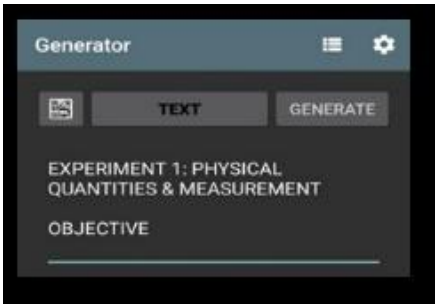

Figure 5. Example of QR Code

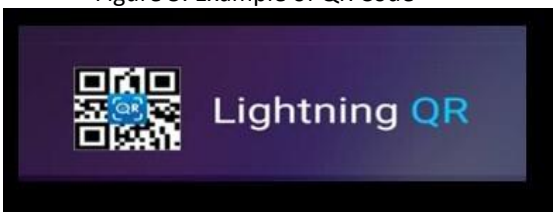

Figure 6. Lighting QR code reader used to test QR Code Lab Manual.

For measuring the feedback from the students for the second objective, three constructs, namely easiness of use, usefulness and enjoyment, were assessed. The items were adapted by previous research and literature searching. The items' reliability was checked with Cronbach's alpha with a reported value of 0.962 for all items and easiness of use (0.893), usefulness (0.902) and enjoyment (0.906). The items' validity was also evaluated by the two experts from the related field.

4. Results

The results will be reported based on these two objectives, which are (a) to design a QR code lab manual for the Experiment 1: Physical Quantities and Measurement in the engineering science course and (b) to examine the level of easiness of use, usefulness and enjoyment using the QR code lab manual. The output design is as shown in Figure 7b.

Figure 7. (a) QR code been test by scanning a QR code; (b) Output from the QR code

Figure 8. Complete QR code lab manual

4.1. The implementation phase of QR code lab manual: description of the approach

Before the laboratory session, students should install the QR code scanner and Google Sheet apps on their mobile devices. Students must install a set of QR codes, each representing one lab work sheet, from the CIDOS e-learning portal, a WhatsApp group or other file transfer platform. Student used a smartphone as a QR code display, as shown in Figure 9. Students need to scan 10 embedded QR codes by sequence, as shown in Figure 8, to ensure that the laboratory work going well with proper manner and correct procedure.

Figure 9. Students using the phone as a QR code display

Figure 10. (a) Using Vernier callipers; (b) watching a video on how to use a measuring instrument

They scan a QR code to read the objective, procedure and to watch a video on how to read a measuring instrument for the experiment of physical quantities and measuring instrument, as shown in Figure 10. During the experiment, they were able to scan QR codes more than once to see the tutorial and demonstration video to establish an understanding of laboratory work. Thus, all students in the groups became active learners. All of them had their own task as a participant in the group in order to conduct the experiment within the time and obtained a correct data. The process of scanning the QR code is continuous to avoid the wrong way of using the instrument. As a result, observing data such as guidelines, illustrations, tables and full guide and demo videos assisted them in staying focused on the experiment. During the coaching session, the rest of the group referred to the video tutorial step by step on how to read Vernier calliper and micrometre screw gauge. This teaching approach gives the students their own space and opportunity to be involved with the technology and enhances their knowledge of mobile learning. The results of the experiment will be posted online by the students. The data is key in online by insert the group members ID, name and group number.

Tables 1–4 show the results for second objective which examined the level of easiness of use, usefulness and enjoyment using the QR code lab manual. The findings in Table 1 show that the highest mean value recorded was for easiness of use, followed by enjoyment and usefulness. The findings in Tables 2–4 show that the mode value is 4. This proves that most of the respondents agreed with all the measurement items for all constructs.

Table 1. Descriptive Statistics

Constructs	Mean	Std. Deviation
Easiness of use	4.0688	.61331
Usefulness	3.9557	.64532
Enjoyment	4.0250	.63396

Table 2. The level easiness of use while using the QR code lab manual

No	Items	SD	D	N	A	SA	Mode/Median
1	The QR codes made access to website links easy	0 (0%)	2 (3.1%)	9 (14.1%)	35 (54.7%)	18 (28.1%)	4.00
2	I found it easy to scan the QR codes	1 (1.6%)	2 (3.1%)	6 (9.4%)	33 (51.6%)	22 (34.4%)	4.00
3	It was easy to learn how to scan QR codes using my mobile device	0 (0%)	1 (1.6%)	10 (15.6%)	36 (56.3%)	17 (26.6%)	4.00
4	The speed of scanning a QR code was sufficient	0 (0%)	2 (3.1%)	15 (23.4%)	31 (48.4%)	16 (25%)	4.00
5	QR codes were simple and convenient to use	0 (0%)	2 (3.1%)	11 (17.2%)	30 (46.9%)	21 (32.8%)	4.00

Note: SD – Strongly disagree; D – Disagree, N – Neutral, A – Agree, SA – Strongly disagree

Table 3. The level of usefulness using the QR code lab manual

No	Items	SD	D	N	A	SA	Mode/Median
1	QR codes provided access to a variety of useful information towards laboratory work	0 (0%)	2 (3.1%)	14 (21.9%)	32 (50%)	16 (25%)	4.00
2	The video provided in the QR codes helped me complete the activities	1 (1.6%)	1 (1.6%)	17 (26.6%)	26 (40.6%)	19 (29.7%)	4.00
3	The QR codes were useful as an independent guidance manual	0 (0%)	3 (4.7%)	15 (23.4%)	30 (46.9%)	16 (25%)	4.00
4	It enables active participation in the laboratory work.	0 (0%)	1 (1.6%)	16 (25%)	32 (50%)	15 (23.4%)	4.00
5	It enables scenario-based learning	0 (0%)	1 (1.6%)	17 (26.6%)	32 (50%)	14 (21.9%)	4.00
6	Learning object (linked to Internet access) can be reach faster.	0 (0%)	1 (1.6%)	17 (26.6%)	26 (40.6%)	20 (31.3%)	4.00

Note: SD – Strongly disagree; D – Disagree, N – Neutral, A – Agree, SA – Strongly disagree

Table 4. The level of enjoyment while using the QR code lab manual

No	Items	SD	D	N	A	SA	Mode/Median
1	QR activities are a very interesting way to learn	0 (0%)	2 (3.1%)	12 (18.8%)	30 (46.9%)	20 (31.3%)	4.00
2	I enjoyed interacting with the QR code lab Manual	0 (0%)	2 (3.1%)	15 (23.4%)	32 (50.0%)	15 (23.4%)	4.00
3	I have positive feelings towards using QR codes in conducting laboratory work.	0 (0%)	0 (0%)	13 (20.3%)	35 (54.7%)	16 (25%)	4.00
4	I would like to do QR activities again	1 (0%)	0 (0%)	12 (18.8%)	36 (56.3%)	15 (23.4%)	4.00

5	I will encourage other student to use QR codes to support in-class activities	0 (0%)	0 (0%)	14 (21.9%)	31 (48.4%)	19 (29.7%)	4.00

Note: SD – Strongly disagree; D – Disagree, N – Neutral, A – Agree, SA – Strongly disagree

5. Discussion

The results in Table 1 clearly show positive perceptions of easiness of use using the QR code lab manual in implementing laboratory work. Based on the median and mode, it shows that most of the respondents agree with all the statements. The easiness of use constructs, with a mean score of 4.0688, show that the QR code is easy to achieve by the students. Students demonstrate excitement, interest and seriousness in conducting practice. Students are more positive and open to the changes. Students who are usually silent will begin to speak because the communication that exists between them makes the learning environment more appealing and fairer to all the students. This approach encourages students to be positive, to move themselves and intelligently distribute tasks in ensuring smooth running of the process. Students are collaborated, compromise and prepare before (downloading software), current (using QR scanners) and after practicing (practical reports). Practical data recorded online may continue to be achieved by lecturers in identifying whether the recorded data is accurate or otherwise. Results from the group's inquiry have successfully recorded the data correctly. This shows that the skill aspect is successfully absorbed into the students' ability to observe how to practice the practice of referring to the video embedded into the QR code.

Questionnaire analysis shows the findings of the 'usefulness of manual QR code lab' constructs with a mean score of 3.9557. The active involvement of the students in collaboration with all the members of the group with the respective roles ensures that the practical implementation process is successfully implemented. No passive student as the QR code lab manual requires the automatic active involvement of all members of the group. The 'enjoyable' constructs questionnaire had a mean score of 4.0250. This method focuses on new learners who have strong cognitive abilities, who are strong analytical thinkers and are capable of problem-solving and reasoning, as well as being able to use technology, applying values to life as a foundation and being able to serve the society, country and world, contributing to the nation's socio-economic development. The students were asked about their response to using QR codes by doing the reflections. Some of the responses were given by the students at the end session of laboratory work. The students mentioned the following:

- 'The code is very user-friendly and creates cooperation between team mates. Need more practice to use it wisely'.
- 'This QR code is very good as all the data and information has been correctly ordered and this will prevent students from becoming confused'.
- 'This method helps me finish my report faster and quicker. QR code will make my work easy to send to my lecturer. They also can track my progress in her phone'.

Based on the observation throughout the practical implementation process, practical data record is more accurate using manual QR code lab manual compared to conventional methods. Students are delighted to try new things as they strive to increase their knowledge, promoting the creation of new concepts of their cognitive exploration. Therefore, they managed to follow the QR lab manual setting and then practice with the right method. The results from questionnaire show that the students feel the

QR code lab manual is a 'technology-based educational aid' that helps them improve their knowledge of practical and meaningful practical exercises.

6. Conclusion

This paper has investigated the new approach for laboratory practice that gives more flexible space for pedagogy and student learning style nowadays for DBS1012 engineering science course. The design phase of QR code lab manual is imperious to ensure the sequence of the lab manual of Experiment 1: Physical Quantities and Measurement achieves the objective of the experiment. This finding has important implications that may be important for policy, practice or theory. An implication of this is the possibility that the interactive display generated by scanning a QR code brings an exciting experience and contributes a happy mode during a practical laboratory process for students because of deep exploration feelings to know the content of embedded QR codes. Students perceived QR code lab manual as a useful tool that is easier to use in the future. The positive reflection of students shows that the design of the QR code lab manual reflects the objective of the experiment goals. The study showed these findings support the engagement theory that believed the technology like QR code in lab can facilitate engagement for learning in technology-based environments. Through meaningful interaction, the learning must always be substantively engaged in learning activities. Based on the study's findings and discussion, it is recommended that there should be further study on the different experiments with the new design of QR codes and addition of construct of students' attitude and educator's perspective to strengthen the results. In addition, in-depth study should be carried out by using augmented reality to create a 3D content embedded in QR code. With augmented applications, users will be able to scan QR codes to view 3D models in augmented reality. A researcher needs to inform students to install related applications such as lighting QR code reader, Google Sheet and augmented application before the laboratory practice session starts. Sufficient mobile data should be prepared by each of the students, although free Wi-Fi is provided by the institution. Moreover, it is better to have a data entry system for online experiment data. The innovative teaching practice will serve the enthusiastic learning environment which concerns students to engage with online learning material and enhance their awareness on the technology growth.

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