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# QR code utilization in a large classroom: Higher education students' initial perceptions

Siti Nazleen Abdul Rabu[1] · Haniza Hussin[1] · Brandford Bervell[1,2]

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## Abstract

The integration of Quick Response (QR) codes in classrooms have been identified as an important tool in promoting active as well as distributed learning, especially in higher education. Even though the versatility of this technology within the educational milieu cannot be over-emphasized, the initial perceptions of students who are at the centre of QR integration are important towards achieving the prospects of this technology in the pedagogical process, particularly in a large classroom context. Against this backdrop, Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology2 (UTAUT2) were employed as theoretical foundation to study students' perceptions. A questionnaire was used to collect data from 200 students, based on a purposive sampling technique with Partial Least Squares Structural Equation Modelling (PLS-SEM) employed for statistical analysis. Initial results suggested that students had very positive attitudes towards QR code utilization for course related activities which ultimately determined their intentions to accept this technology. However, their positive attitude was anchored on their perceived usefulness and easiness towards QR code which were promoted by perceived playfulness, facilitating conditions and hedonic motivation respectively. The social influence variable was not a predictive factor of students' perception towards the usefulness of QR codes. The study provided practical examples of how QR codes can be integrated in teaching and also recommended future experimental research into QR code effectiveness as well as instructor acceptance if the technology is to be integrated on a wider national scale.

✉ Siti Nazleen Abdul Rabu
snazleen@usm.my

Haniza Hussin
hhussin@sisgroup.edu.my

Brandford Bervell
b.bervell2@gmail.com

[1] Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Gelugor, Pulau Pinang, Malaysia

[2] College of Distance Education, E-learning & Technology Unit, University of Cape Coast, Cape Coast, Ghana

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## 1 Introduction

Quick Response (QR) code has evolved from the traditional bar code which was originally used for vehicle parts inventory tracking or control in automobile manufacturing (Pillai et al. 2017; Rouillard 2008), but currently contains more information. Code information can be read by taking a picture of the QR code using a mobile phone, and users can access the internet via QR code by reading a web address to get more information on a product or service. The technology was predominantly used in the service industry such as transport, food services, hospitality, entertainment industry, financial services, and tourism, etc. (Pillai et al. 2017). In view of the potential benefits of QR code, this tool has been widely adopted around the world for product tracking, advertising, managing industrial operations and others (Rivers 2009).

So (2010) opine that this technology has become so ubiquitous and prevalent especially in the business sector. Currently, QR code system is one of the mobile device applications that is popping up everywhere and gaining popularity even in education. Even though So (2010) believes the technology is still at its infant level in education, Robertson and Green (2012) view QR code to have a potential in improving active and outdoor pedagogical practices. According to authors such as Sampson (2012) and Yusof et al. (2012), QR code can potentially add value to learning activities by encouraging students to create and share learning content, engage students with different learning needs (Chen et al. 2010), and facilitate learning inside and outside the classroom (Crompton et al. 2012; Pérez-Sanagustín et al. 2016). Hence, QR code has become an appealing technology, but the initial concern was how educators could utilize this tool creatively to create a more active and student-centered learning environment that promotes collaboration especially in a large classroom.

What is already known in the literature

- QR code has the potential and positive impact in education
- There are some suggested ways for integrating QR code in general classroom teaching
- Some initial perceptions of teachers towards QR usage in classroom have been found in the literature

Contribution of this paper to the literature

- The study modelled the initial acceptance of QR code by university students, based on a combined TAM and UTAUT2 model which explained 65% intentions of students' acceptance of QR code in a large classroom in Higher Education
- The study provides practical ways in which QR code can be utilized in a large classroom in Higher Education
- The relationships between Perceived Playfulness and Perceived Usefulness; Hedonic Motivation and Perceived Ease of Use towards QR code usage among students in a large classroom in Higher Education

Researchers such as Law and So (2010), Robertson and Green (2012), Lai et al. (2013), Saprudin et al. (2014), started to discuss examples of how QR code could be used in the classroom. For example, they noted that students could generate their own code and attach to pictures they had previously found online. Similarly, Gradel and Edson (2012) and Thorne (2016) described several QR code activities that instructors could implement in higher education. Teaching at the university level needs to be more student-centric, thus educators should integrate more appealing technology into instruction and QR code now offers a new relevant tool to be utilized in classroom, as it is mobile device friendly. However, within the literature, studies have not concentrated on the acceptability aspect of QR code in education, but have rather focused mainly on how they can be used in instruction. Most acceptance studies in QR code have been directed towards business and marketing (Eyuboglu and Sevim 2016; Santos 2015; Liébana-Cabanillas et al. 2015; Ryu and Murdock 2013) or health (Tseng and Wu 2014). Few studies such as by Latif et al. (2012), Foster (2014), Abas et al. (2015) and Ali et al. (2017), that investigated into initial perceptions and acceptance of QR code in classrooms, omitted the impact of perceived playfulness, facilitating conditions, hedonic motivation and social influence in their analysis. They also did not provide any relationships between the variables utilized in their studies nor modelled these variables to provide a better and more detailed analysis on the acceptance intentions of participants.

Within the Malaysian context, Hau et al. (2013), expressed concerns that the integration of QR code into the educational sector was still at its infant stages. This makes the researchers believe that assessment of the human factors involved in utilizing this technology is of keen interest. Thus, in order for an integration of QR code as a learning tool to be implemented successfully in a large classroom, it is necessary to investigate students' related factors that influence such integration. Literature show that Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology2 (UTAUT2) are widely used in acceptance of mobile learning studies (Zhu et al. 2012; Nassuora 2012). However, the combination of these two models is still limited in the study of acceptance of QR code, especially as a learning tool. Thus, to better understand and improve this technology integration practice, there is a need for a new research to integrate factors of TAM and UTAUT2 models to access the acceptance of QR code as a learning tool. Based on this, the study sought to answer the following research questions:

1. What are the determinants of QR code acceptance from students' perspective?
2. What is the variance explained by each endogeneous variable determining students' acceptance of QR code?
3. What is the total variance explained by the hypothesized model for assessing students' acceptance of QR code?

## 2 Theoretical basis for hypotheses formulation and a conceptual model development

The study analyzed the relationships that formulated the proposed model, based on the reviewed literature supporting such relationships.

### 2.1 Relationship between perceived playfulness (PP) and social influence (SI) on perceived usefulness (PU)

Wang et al. (2009), defined perceived playfulness as a state of mind that includes three dimensions: the extent to which the individual (1) perceives that his or her attention is focused on the interaction with the mobile learning (i.e., concentration); (2) is curious during the interaction (i.e., curiosity); and (3) finds the interaction intrinsically enjoyable or interesting (i.e., enjoyment)", p. 8). Within this context, the variable is defined as the degree to which a student perceives that his or her attention is focused on the interaction with the QR code activities; is curious during the interaction, and finds the interaction intrinsically enjoyable or interesting (Donaldson 2011).

When students find the use of this particular technology as playful, their excitement towards it gives them an impression that the technology will be useful for their simultaneous learning and playing purposes. According to Tan and Chou (2008), this increases their flow experience and has the potential of making learning very fun and promotes activeness in students. Studies from Series, Donaldson, Hashemi, Azizinezhad, Najafi and Nesari (2011), Chung and Tan (2004), established a relationship between individual perceived playfulness and perceived usefulness in mobile learning. Similarly, this study envisages a relationship between the two variables in terms of QR code acceptance. Against this premise, the study hypothesizes that:

> H1: Perceived playfulness of QR code will determine students' perceived usefulness of QR code in learning.

Social influence defines the extent to which a person perceives how vital others believe he or she should use a particular technology (Venkatesh et al. 2003). In relation to QR code, Donaldson (2011) explains the variable to be, the degree to which a student perceives that important others believe he or she should use the QR code as a learning tool. Previous researches support that social influence was significant in determining an individual's intention to use new technology (Moore and Benbasat 1991; Venkatesh & Davis 1996; Thompson et al. 1991). The views of important referent others have an effect on how individuals perceive an information system to be useful (Venkatesh & Bala 2008). According to Bervell and Umar (2017a, b), how positive or negative the views or influence from people who are deemed important, influence potential adopters of new technological systems. This view was initially indicated by Venkatesh and Davis (2000) that the social influence factor affects adopters of technology through internalization processes. According to Jiin et al. (2012), the relationship between social influence and perceived usefulness will be more significant during the initial and early stages of technology uptake. This study suggests that in using QR code, influences of peers and other important people (instructor etc.) could determine how useful QR code will be to students at this initial stage. Based on this view, the study proposes that:

> H2: Social influence will determine students' perceived usefulness of QR code in learning.

### 2.2 Relationship between facilitating conditions (FC) and hedonic motivation (HM) on perceived ease of use (PEOU)

According to Venkatesh et al. (2003), facilitating conditions refer to the extent of an individual's belief that there is availability of technical resources and support for utilizing a new technology. It can be explained as the individual's perspective of the resources and support feasible to conduct a particular behaviour (Brown et al. 2005; Venkatesh et al. 2003). Both the availability and accessibility of resources (physical facilities or human support) play a key role in the uptake of novel technologies. This is because, initial adopters of technology expect varying levels of difficulty in terms of usage (Venkatesh & Bala 2008). However, the conducive environment made available to students within this context towards the use of QR code in their learning process, has a potential to inform them of their expectations of easiness of use of this technology. If necessary resources and assistance are available and accessible to students at this initial stage, they will view the use of QR code as easier. In view of this, the study hypothesizes that:

> H3: Facilitating conditions will predict students' perceived ease of use of QR code for learning.

Brown et al. (2005), characterizes hedonic motivation as an enjoyment or fun resulting from using an information system. In non-organizational contexts, hedonic motivation was found to be a more significant factor than performance expectancy in determining behavioural intention (Venkatesh et al. 2012). It is concerned with fun, playfulness and enjoyment, experienced while using technology (Babin et al. 1994; Venkatesh et al. 2012). In fact, hedonic motivation has been found to be a key predictor of technology acceptance in much consumer use settings, especially in business. In terms of QR code in learning, Aziz (2015) defines hedonic motivation as the degree of positive motivational feeling of the student in performing the QR code activities due to the internal satisfaction gained.

Within technology research in education, Ursavaş (2015) indicated that teachers' adoption of tablet PC was influenced by their hedonic motivation which determined their perception on easiness of use of tablet PC. Similarly, Conci et al. (2009), stated that hedonic motivation makes a system easier and more useful to use. In line with the above, this study suggests that the enjoyment derived from using QR code will determine how easy the technology will be to students. Accordingly, the study hypothesizes that:

> H4: Students' hedonic motivation in using QR code will determine their perceived ease of use of QR code towards learning.

### 2.3 Relationship between perceived ease of use and perceived usefulness

Perceived ease of use has a direct effect on both perceived usefulness and technology usage (Adams et al. 1992; Davis 1989). According to ***Tajudeen*** **et al.** Tajudeen et al. (2013)**,** perceived ease of use of QR code defines the degree to which a student

perceives that using QR code as a learning tool is effortless or simply easy to do. On the other hand, perceived usefulness is defined as "the degree to which an individual believes that using a particular system would enhance his or her productivity" (Davis 1989). Similarly, Donaldson (2011) explains the variable in terms of QR code usage, as the degree to which a student believes that QR code provides access to useful information. Easiness towards use of a technology has been proven to influence how useful a technology is perceived (Davis, Baggozzi, & Warsaw, 1989; Venkatesh & Bala 2008). The easier a technology use is, the higher the perception of its usefulness to potential adopters. Studies from authors such as Farahat (2012), Fathema et al. (2015), Bervell and Umar (2017a, b), confirmed this relationship in acceptance studies of other technologies in education. According to Venkatesh and Bala (2008), the relationship between perceived ease of use and perceived usefulness is even stronger at the latter stages of technology adoption (Bervell and Umar 2017a, b). Consequently, the study proposes that:

H5: Students' perceived ease of use of QR code will determine their perceived usefulness of QR code for learning.

### 2.4 Relationship between attitude (ATTU) and Behavioural intention (BI)

Attitude towards use of systems has been identified in the literature (El-Gayar et al. 2011; Ifenthaler and Schweinbenz 2016) as a factor that guides future behaviour or the cause of intention that ultimately leads to a particular behaviour. Technology related attitude refers to individuals' overall affective reaction (whether favourable or unfavourable) towards the use of a technological novelty. Before considering future use intentions of technology, potential users form attitudinal behaviours towards it, which could be based on their perceived ease of use or usefulness of that system. As users find it easy to use a technological system, they form positive affection towards it, which leads to intentions to use that particular system (Davis 1989). The easiness associated with the technology makes it useful for job related performance. Usefulness of the system in turn creates in users a positive attitude towards using it for future purposes (Ifenthaler and Schweinbenz 2016). Within Learning Management System (LMS) acceptance research, Bervell and Umar (2017a, b) identified technology attitude as a key determinant of behavioural intention to use LMS-enabled blended learning, based on a decade systematic review. In QR context, Lo (2014), views the attitude factor as the degree of positive feeling of students about scanning QR code for learning activities. This means, the affection that new users have towards QR code has an influence on their intention to use this particular technology for classroom task related purposes. In this study, students' affective reaction towards QR code is envisaged to be a determinant of their usage intentions, anchored on both their perceived ease of use and perceived usefulness. Based on this view, the study proposes that:

H6: Students' perceived ease of use of QR code will relate positively with their attitude towards usage for learning.
H7: Students' perceived usefulness of QR code will relate positively with their attitude towards usage for learning.

H8: Students' attitude towards of QR code will relate positively with their behavioural intentions towards usage for learning.

### 2.5 Relationship between behavioural intention (BI) and use behaviour (ACCT) of QR code

Behavioral intention to use a technology represents individuals' intention formations towards the use of a particular technology, while their use behaviour explains their actual engagement in using the technology for job related tasks (Davis 1989; Venkatesh et al. 2003). For QR code integration, Lo (2014), defines behavioural intentions as student's intention to use QR code as a learning tool, and use behaviour as the manner in which students actually scan QR code for learning. Behavioural intention is expected to positively influence use behaviour. As individuals formulate their intentions towards the use of a particular information system, it is expected that their intentions will eventually lead to the performance of the actual behaviour (Venkatesh et al. 2012; Venkatesh et al. 2003). Thus, behavioural intentions become a prelude to actual behaviour which represents the overt aspects of the covert cognitive intentions (Bervell and Umar 2017a, b). Authors such as Venkatesh et al. (2012), Ferguson (2016), and van Deursen et al. (2016) found positive relationships between behavioral intention and use behaviour. Hence, it is expected that behavioral intention could also positively affect students' acceptance of QR code usage as a learning tool. Thus, the study hypothesizes that:

H9: Students' behavioural intention towards QR code will have a positive influence on their use behaviour for learning.

Figure 1, depicts the hypothesized model for the study.

This section reviewed related literature on QR code utilization and the associated relationships of variables on technology acceptance, leading to the determination of the final hypothesized model.

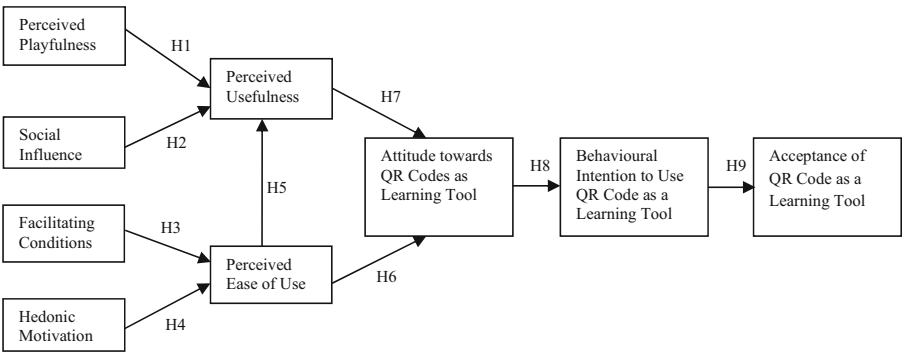



**Fig. 1** Hypothesized model

## 3 Materials and methods

### 3.1 Questionnaire design

The study adopted a quantitative survey research design, with a questionnaire employed as an instrument for data collection. The questionnaire used was developed based upon a review of existing literature on Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology2 (UTAUT2). The combination of these two models was based on the suggestion for theoretical extensions to the original models, in order to improve the variance explained in behavioural intentions (Venkatesh et al. 2012). However, only constructs relevant to the intention to adopt QR code as a learning tool were selected. The items used were modified from previous scholars' (Donaldson 2011; Tajudeen et al. 2013; Lo 2014; Abdullah and Aziz 2014) instruments, in order to reflect students' acceptance and behavioural intention to use QR code as a learning tool in a large classroom. The questionnaire consisted of two parts: the demographic section and the main section on nine constructs, with a total of 39 items. These items on students' acceptance were anchored on a five point Likert scale ranging from strongly disagree (1) to strongly agree (5). In order to ensure that the questionnaire instrument provided trustworthy data, three university faculty members were invited to review the questionnaire. A pilot test was also conducted to investigate whether the questionnaire was reliable to generate accurate results before performing the actual survey. A few changes were made according to the content experts' and students' suggestions after pilot study. The final Cronbach's Alpha value of all constructs ranged between 0.871 and 0.901, thus acceptable and reliable since the value exceeded 0.7 (Hair et al. 2011). After revision, the official survey questionnaire was later designed using Google Form. The details of the full questionnaire items can be referred from Appendix Table 8.

### 3.2 Context and participants

The participants involved in this study were Year 2 undergraduate students ($N = 204$) at the Universiti Sains Malaysia in the academic year 2017/2018. These were from two-degree programmes at the School of Educational Studies and School of Humanities, who enrolled in PGT201E Instructional Technology Practices course. Students were allowed to experiment with the new mobile learning approach (QR code-based assessment) in line with the nature of the instructional technology course.

### 3.3 QR code in-class activities

A 5 week in-class QR code activities were integrated into the 14-week curriculum of the course undertaken by students. Implemented to increase student engagement and encourage active learning in a large classroom, five in-class QR code activities were created by the researchers to help students review, engage and reflect on the videos and webpages' learning contents of the five lesson topics for this study. The researchers worked together with the instructor of the course to design and develop five QR code activities, customized based on the content of the course syllabus. The course aims to provide explanation, meaning and evolution of the overall concept of instructional

technology. Three main learning theories; behaviourism, cognitivism, and constructivism formed the basis of the course. In addition to this, instructional design models and the latest instructional technology approaches namely e-learning, m-learning, flipped learning, and twenty-first-century teaching and learning pedagogy are discussed. The first QR code activity was introduced to the students in week 3 followed by four QR code activities that were implemented in weeks 5, 8, 10, and 12. Figure 2 provides detailed explanations on the whole implementation of the five weeks QR code activities.

In terms of the instructional procedure, the participants were first given instructions and guidance regarding the basic requirements on how to use QR code in class. They first needed a smartphone or computer tablet with a built-in camera; install a QR code

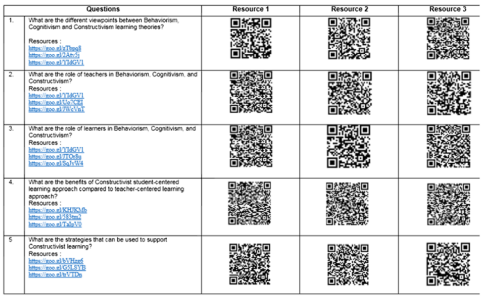
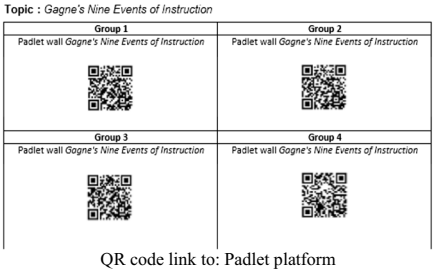
| Week | QR Code Activities | Example of the QR Code Sheet Given to the Participants |
|---|---|---|
| Week 3 | **QR Code Activity 1**<br>Topic: Behaviorism, Cognitivism, Constructivism<br>QR code provided to participants will navigate them to questions:<br>1. What are the different viewpoints between Behaviorism, Cognitivism and Constructivism learning theories?<br>2. What are the role of teachers in Behaviorism, Cognitivism, Constructivism?<br>3. What are the role of learners in Behaviorism, Cognitivism, Constructivism?<br>4. What are the benefits of Constructivist student-centered learning approach compared to teacher-centered learning approach?<br>5. What are the strategies that can be used to support Constructivist learning? |  <br>QR code link to: Youtube videos and websites |
| Week 5 | **QR Code Activity 2**<br>Topic : Learning Theory<br>QR code provided to participants will navigate them to questions:<br>1. Create a minimum of FIVE (5) questions for each video using the Edpuzzle platform.<br>2. Share/Paste the link to your group Google Doc. |  <br>QR code link to: Youtube videos |
| Week 8 | **QR Code Activity 3**<br>Topic: Gagne's Nine Events of Instruction<br>QR code provided to students will navigate them to questions:<br>1. List and explain 9 events in the Gagne's Nine Events of Instruction model.<br>2. Propose and develop ONE (1) instruction and explain how Gagne's 9 events are used in the instructional design process with appropriate examples. |  <br>QR code link to: Padlet platform |

**Fig. 2** QR Code implementation activities

| Week | QR Code Activity 4 |
|---|---|
| 10 | Topic: Flipped classroom<br>QR code provided to students will navigate them to questions:<br>1. What are the advantages of flipped classroom?<br>2. What are the challenges in implementing flipped classroom?<br>3. Explain student-led and instructor-led flipped classroom models.<br>4. Explain collaborative learning activities for in-class time. |


QR code link to: Padlet platform

| Week | QR Code Activity 5 |
|---|---|
| 12 | Topic : 21st-century Teaching and Learning<br><br>QR code provided to students will navigate them to questions:<br>1. Explain FIVE (5) essential skills that are in demand for the 21st-century.<br>2. Explain FIVE (5) active learning strategies based on technology that can be used to combine face-to-face learning with online learning to generate the learning environment for the 21st-century.<br>3. Suggest FIVE (5) Web 2.0 tools that can be incorporated into technology-based active learning strategies and discuss how they can be used to facilitate the implementation of technology-based active learning strategies for the 21st-century. |


QR code link to: Padlet platform

**Fig. 2** (continued)

reader, and their device must be connected to the university's wifi. There were various free QR code reader apps available for each type of smartphone or computer tablet operating system. Students were free to select and install any appropriate app for iOS or Android. With 5 to 6 students per group, they were given 1 h and 15 min to solve each in-class QR code activity assigned to them. During each QR code activity, the instructor projected the designated QR code sheet on the projector screen, and also distributed the printed version of the QR code sheet to each group representative. The QR code sheets contained the assessment questions and provided immediate access to the central learning resources related to the assessment questions. These were linked to Youtube videos, webpages and Padlet platform for students' references in order to facilitate group discussion. Students were required to collaborate with their group members and write their answers in their group's Google Docs, shared with the instructor or in a Padlet, according to each activity. For example, Fig. 3 shows students scanning the QR code projected on the screen using their smartphones and how they engaged with the QR code activities for instructional purposes.

After the intervention period, the Google Form link questionnaire was then posted on the PGT201E course Facebook group page to be administered to the


**Fig. 3** QR code scanning and QR code activities engaged by the participants for instructional purposes

participants. A total of 200 responses were gathered from the data collection process. The data were then screened in an SPSS software version 22 and converted into a csv file which was exported into PLS software version 3.2.6 for measurement and structural model analysis.

## 4 Results

### 4.1 Demographic data

The study initially assessed the demographic characteristics of students who provided responses to the questionnaire items. Table 1 shows their demographic characteristics.

From Table 1, male respondents were 37 and females 163 representing 18.5 and 81.5% respectively, indicating that there were more female students within this study than their male counterparts. In terms of age, majority of the students were within the range of 21–23 years representing 99% of the total sample. Almost all the students (n: 194, 97%) also indicated that they used varying types of electronic gadgets. Smart phone usage was more dominant amongst respondents as 181 of them answered 'Yes' to this gadget, followed by 116 who possessed laptops. The least category of gadget use was the iPad, having only 4 responses.

### 4.2 Measurement model

For reflective measurement model, the initial assessment is based on convergent validity, composite reliability and average variance extracted (Hair et al. 2017). These estimates are achieved from an initial PLS algorithm for confirmatory factor analysis (CFA). Figure 4 shows the results of factor loadings.

Based on the CFA analysis, the following subsections provide detail information on internal consistency (reliability and validity), discriminant validity and collinearity indices.

**Table 1** Demographic data of respondents

| Gender | Frequency | Percentage | Total |
|---|---|---|---|
| Gender | | | |
| Male | 37 | 18.5 | |
| Female | 163 | 81.5 | 200(100) |
| Age | | | |
| 18–20 | 0 | 0 | |
| 21–23 | 198 | 99 | |
| Above 23 | 2 | 1 | 200(100) |
| Gadget use | | | |
| Yes | 194 | 97 | |
| No | 6 | 3 | 200(100) |
| Gadget Type | | | |
| PC | 54 | 27 | |
| Laptop | 116 | 58 | |
| iPad | 4 | 2 | |
| Other tablet | 8 | 4 | |
| Smartphone | 181 | 90 | |

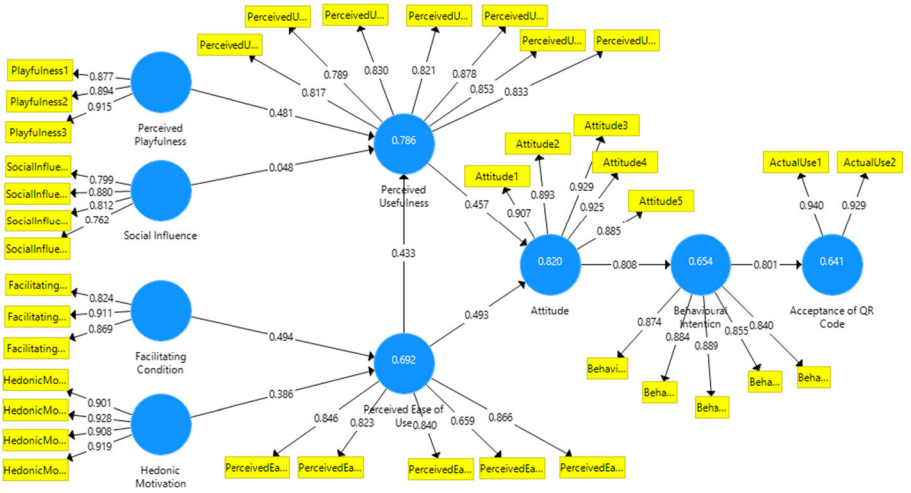



**Fig. 4** PLS Algorithm for CFA

### 4.2.1 Internal consistency (reliability and validity)

From Fig. 4, all outer loadings (Confirmatory Factor Analysis (CFA) with PLS Algorithm were higher than the 0.708 recommended value by Hair et al. 2017. Additionally, values for rho_A and composite reliability exceeded the 0.7 (between 0.839 to 0.947) and (0.887 to 0.959) threshold respectively, confirming the achievement of reliability for the model. In relation to average variance extracted, the obtained values ranged between 0.656 to 0.873, which were all greater than the 0.5 criterion Hair et al. (2017). The analysis of the figures for the measurement model indices as depicted in Table 2, shows that internal consistency was achieved for the measurement model.

### 4.2.2 Discriminant validity: Fornell-Larcker criterion

Discriminant validity defines how each construct within the model discriminates or is different from other variables in terms of what it measures Hair et al. (2017) Within this

**Table 2** Results for internal consistency measures

| Constructs | rho_A | Composite Reliability | Average Variance Extracted (AVE) |
|---|---|---|---|
| ACCT | 0.858 | 0.932 | 0.873 |
| ATTU | 0.947 | 0.959 | 0.824 |
| BI | 0.921 | 0.939 | 0.755 |
| FC | 0.839 | 0.902 | 0.755 |
| HM | 0.935 | 0.953 | 0.835 |
| PEOU | 0.888 | 0.904 | 0.656 |
| PP | 0.877 | 0.924 | 0.801 |
| PU | 0.927 | 0.94 | 0.692 |
| SI | 0.846 | 0.887 | 0.663 |

study, the Fornell and Larcker criterion was employed. Results obtained are shown in Table 3.

From Table 3, the bolded figures show that the correlation between each definite construct is higher than with other constructs within the model. According to the Fornell and Larcker criterion, correlation ratio between the same construct should be greater than that of the construct and other different constructs (Fornell & Larcker 1981). The results achieved within this study indicate that discriminant validity was achieved for the constructs in the model.

#### 4.2.3 Collinearity

In solving for common method bias, the study followed the criterion by Kock (2015) who suggests assessing the variance inflation factor (VIF) for Multicollinearity. Kock (2015) and Hair et al. (2017) suggest a threshold of VIF figures less than 3.3. The results in Table 4 report figures ranging between 1 to 2.983, indicating that there was no collinearity issue with the measurement model.

### 4.3 Structural model

In assessing the structural model, Hair et al. (2017) recommend the analysis of the paths relationships, confidence interval, effect size ($f^2$), co-efficient of determination ($R^2$) and predictive relevance of model ($Q^2$).

#### 4.3.1 Path analysis

For path analysis, an initial bootstrapping sequence of 5000 samples were run in PLS. Figure 5 depicts the graphical results.

**Table 3** Results for Fornell-Larcker test

| Constructs | ACCT | ATTU | BI | FC | HM | PEOU | PP | PU | SI |
|---|---|---|---|---|---|---|---|---|---|
| ACCT | **0.934** | | | | | | | | |
| ATTU | 0.813 | **0.908** | | | | | | | |
| BI | 0.801 | 0.808 | **0.869** | | | | | | |
| FC | 0.744 | 0.823 | 0.736 | **0.869** | | | | | |
| HM | 0.765 | 0.821 | 0.753 | 0.784 | **0.914** | | | | |
| PEOU | 0.745 | 0.866 | 0.786 | 0.796 | 0.773 | **0.845** | | | |
| PP | 0.747 | 0.785 | 0.721 | 0.761 | 0.852 | 0.720 | **0.895** | | |
| PU | 0.786 | 0.859 | 0.759 | 0.796 | 0.827 | 0.815 | 0.827 | **0.832** | |
| SI | 0.733 | 0.764 | 0.707 | 0.775 | 0.744 | 0.758 | 0.733 | 0.729 | **0.814** |

Diagonals (bolded) represent the square root of the average variance extracted while the off-diagonals are correlations among constructs

**Table 4** Results on multicollinearity test

| Constructs | VIF | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ACCT | ATTU | BI | FC | HM | PEOU | PP | PU | SI |
| ACCT | | | | | | | | | |
| ATTU | | | 1 | | | | | | |
| BI | 1 | | | | | | | | |
| FC | | | | | | 2.595 | | | |
| HM | | | | | | 2.595 | | | |
| PEOU | | 2.983 | | | | | | 2.724 | |
| PP | | | | | | | | 2.504 | |
| PU | | 2.983 | | | | | | | |
| SI | | | | | | | | 2.838 | |

### 4.3.2 Paths coefficients

The significance of the path relationships within the hypothesized model are shown in Table 5.

From Table 5, we assessed the determinants of perceived ease of use and perceived usefulness. The results indicate that perceived ease of use was significantly determined by facilitating conditions ($t = 4.905$, $p < 0.01$) and hedonic motivation ($t = 3.746$, $p < 0.01$), while perceived usefulness was significantly predicted by perceived playfulness ($t = 8.306$, $p < 0.01$) and perceived ease of use ($t = 6.558$, $p < 0.01$). However, social influence did not have a significant relationship with perceived usefulness ($t = 0.653$, $p > 0.05$). For attitude towards QR integration, both perceived ease of use ($t = 6.91$, $p < 0.01$) and perceived usefulness ($t = 5.892$, $p < 0.01$) were significant predictors. Behavioural intention on the other hand was significantly predicted by attitude ($t = 16.154$, $p < 0.01$) with actual use of QR code also significantly predicted by behavioural

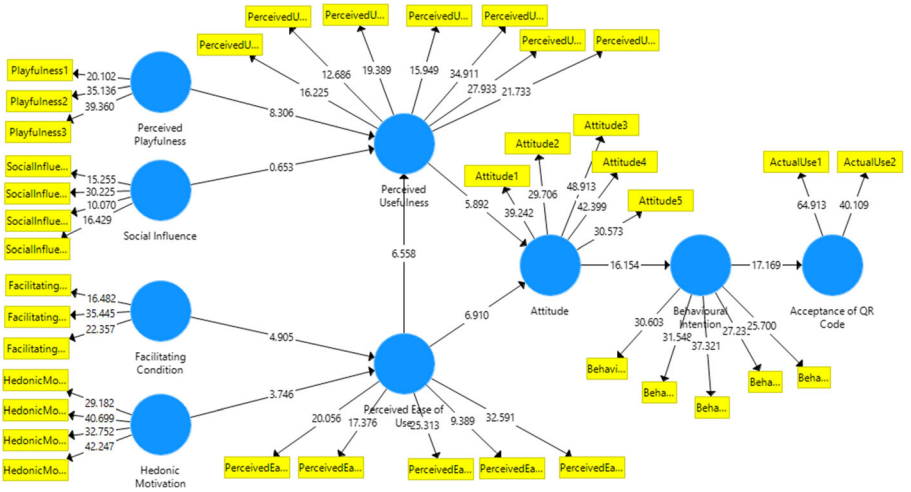



**Fig. 5** Bootstrap results for path relationships

**Table 5** Results on Path Analysis

| Relationships | Beta Values | Std. Error | t- Values | $f^2$- Values | Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | LL | UL |
| ATTU- > BI | 0.808 | 0.05 | 16.154** | 0.887 | 0.681 | 0.882 |
| BI- > ACCT | 0.801 | 0.047 | 17.169** | 0.784 | 0.691 | 0.877 |
| FC - > PEOU | 0.494 | 0.101 | 4.905** | 0.305 | 0.294 | 0.673 |
| HM - > PEOU | 0.386 | 0.103 | 3.746** | 0.187 | 0.180 | 0.562 |
| PEOU - > ATTU | 0.493 | 0.071 | 6.91** | 0.452 | 0.355 | 0.633 |
| PEOU - > PU | 0.433 | 0.066 | 6.558** | 0.321 | 0.274 | 0.544 |
| PP- > PU | 0.481 | 0.058 | 8.306** | 0.431 | 0.354 | 0.588 |
| PU - > ATTU | 0.457 | 0.078 | 5.892** | 0.388 | 0.314 | 0.604 |
| SI - > PU | 0.048 | 0.074 | 0.653 | 0.004 | −0.095 | 0.188 |

**$p < 0.01$

intention ($t = 17.169$, $p < 0.01$). Assessment of the confidence intervals for each significant path, showed unidimensionality which indicates a high confidence in the significant paths. Additionally, the effect sizes for the significant paths ranged between 0.187 to 0.887 indicating medium to large effect sizes for all significant predictions Hair et al. (2014).

### 4.3.3 Derived model

Figure 6 depicts the derived model with the significant paths. From Fig. 6, social influence has been excluded from the model because its effect was insignificant towards influencing students' perception on the usefulness of QR code in learning.

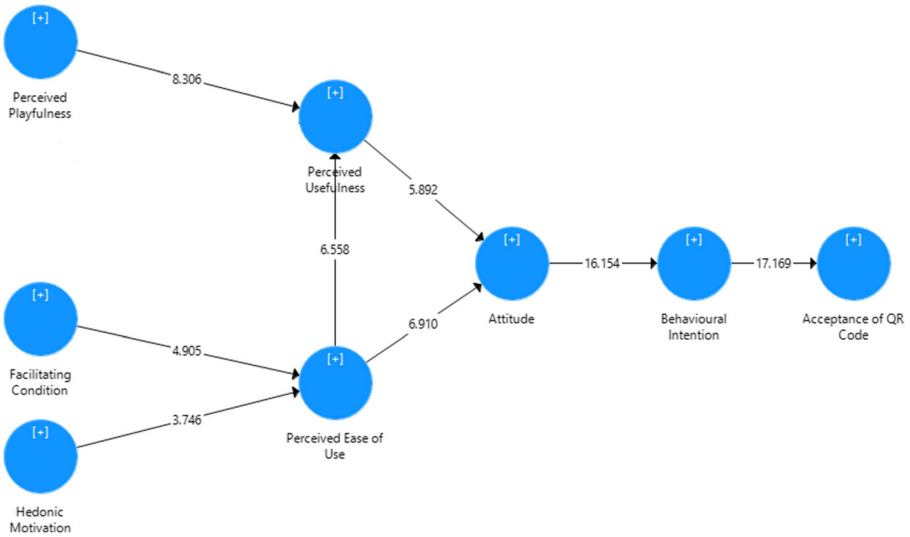



**Fig. 6** Derived model

**Table 6** Results on coefficient of determination for endogeneous factors

| Constructs | R Square |
|---|---|
| ACCT | 0.641 |
| ATTU | 0.82 |
| BI | 0.654 |
| PEOU | 0.692 |
| PU | 0.786 |

#### 4.3.4 Coefficient of determination ($R^2$)

Table 6, contains the results on the coefficient of determination for the endogeneous constructs within this study.

Coefficient of determination which is the variance explained by each of the predictor variable on the endogeneous factor, ranged from 0.641 to 0.82. The values from Table 6 indicate that for each endogeneous variable, the variance explained was relatively high. According to the criteria by Hair et al. (2017) and Kline (2015), coefficient values of 0.25, 0.50 and 0.70 indicate weak, moderate and high respectively.

#### 4.3.5 Model relevance ($Q^2$)

Results obtained from the blindfolding process of Stone-Geisser Test are shown in Table 7.

From the table, each endogeneous construct obtained a value that was higher than 0.4, indicating high model predictive relevance for the hypothesized model of the study. Predictive relevance ($Q^2$) is said to be strong, moderate or weak, when the values are 0.02, 0.15 and 0.35 respectively (Hair et al. 2017; Kline 2015).

## 5 Summary of findings and discussions

Outcome from the relationships proposed in this study, revealed that the main factors explaining perceived usefulness towards QR code usage were students' perceived playfulness and perceived ease of use. The significant direct effect of perceived playfulness on perceived usefulness shares parallelism with findings from Donaldson, Hashemi, Azizinezhad, Najafi and Nesari (2011), Chung and Tan (2004) who found a similar significant relationship in relation to general mobile learning amongst students. Students within this study viewed their experiences with QR code as very interesting

**Table 7** Results on Stone-Geisser test for model relevance

| Constructs | $Q^2$ (=1-SSE/SSO) |
|---|---|
| ACCT | 0.522 |
| ATTU | 0.616 |
| BI | 0.451 |
| PEOU | 0.407 |
| PU | 0.487 |

and play related. This feeling promoted fun and enjoyment in their learning activities with QR code. In this vein, students attached the fun aspect of QR code usage with being useful for their learning activities which often reduces their cognitive load. Their enjoyment related flow experience results in active and meaningful learning (Tan and Chou 2008). When learning becomes meaningful, it supports usefulness as well as the medium that was used in promoting this kind of learning experience.

Additionally, the positive and significant relationship between perceived ease of use of QR code and perceived usefulness resonates with findings from Farahat (2012), Fathema et al. (2015), Bervell and Umar (2017a, b), in acceptance studies of other technology usage in the educational setting. The usefulness of QR code in teaching and learning can only be ascertained by students, when they are able to utilize this technology. Utilization, however depends on the easiness or otherwise of QR code by students. As students find the usage of QR code to be easier, they are better placed to fully utilize it and further judge how useful it is to them. Malaysian higher education students agreed to the fact that, usage of QR code was easier and hence found it useful for collaborative and distributed learning. This implies that, the more students perceived the use of QR code to be easier, the more useful it becomes to them towards their learning process. This relation is stronger, almost throughout students' QR code usage (Venkatesh & Bala 2008; Bervell and Umar 2017a, b).

Conversely, the views of other important referent others were not influential on students' QR code usefulness perceptions. This result contradicts earlier findings by Venkatesh and Bala (2008) as well as Jiin et al. (2012) but supports recent findings by Bervell and Umar (2017a, b). Even though, it is believed that social influence is very effective in persuading new users of technology towards its usefulness (Jiin et al. 2012), students within this study thought otherwise. This could be attributed to the relative younger generation of the sample used in this study. The students were mostly a digital native generation who are used to technological innovations and possessed the characteristics of innovators. According to Rogers (2003), innovators often have high self efficacy believes towards technology use and are keen on trying out new technology at will, just for curiosity. This is indicative of the large majority who possessed laptops and smart phones for various use purposes. The digital nativity of the students made them opened to this new instructional technology without coercion from their peers or important referent others. They will any way use it even without being convinced by an external force just to sate their technological curiosity.

Students' perceived ease of use was however anchored on two factors, hedonic motivation and facilitating conditions. These two variables defined how easy or otherwise, students perceived the use of QR code. The significant positive relationship between hedonic motivation and perceived ease of use of QR code implies that, as students acquire a higher hedonic motivation towards QR code usage, it results in a greater sense of easiness towards using the technology for pedagogical practices. As indicated by Conci et al. (2009), the enjoyment and fun students derived from using QR code, made the technology easier and more appealing to use. This view was shared by Ursavaş (2015) who also found the relationship significant with teachers' intention to adopt tablet PC. The easiness of QR code usage was further boosted by the resources put in place for use. The impact of facilitating conditions on the perception of students towards how easy QR code usage is for learning, was very significant in this study. Human and technological resource availability, support the uptake of every novel

system. These facilities enhance the use environment through the provision of ready assistance to students when needed. How available and accessible these resources are, created in students a sense of relief towards using QR code. This is evident in the significance of the relationship between facilitating condition and their perception on ease of use, a result earlier supported by Brown et al. (2005), Venkatesh and Bala (2008), and recently by Bervell and Umar (2017a, b).

Consequently, students' positive perception on ease of use and usefulness of QR code, resulted in a positive attitude towards the technology use in learning. This is based on the significant results for the relationships between perceived ease of use and perceived usefulness on students' attitudes towards QR code. As their perceptions towards easiness of use and usefulness of QR code improved, it culminated into favourable affection towards usage of the technology. Similar results were shared by El-Gayar et al. (2011) as well as Ifenthaler and Schweinbenz (2016). This indicates that when students' perception of easiness and usefulness of QR code are high, they positively influence their attitude towards usage intentions. This is because, students' attitude towards QR code in turn predicted significantly their intention to use the technology in their learning practices. A favourable attitude towards QR code resulted in positive intentions towards its acceptance. The result was consistent with findings obtained by Bervell and Umar (2017a, b) on instructors and LMS-enabled blended learning uptake. Ultimately, the positive intentions formed by students towards QR code, significantly predicted their acceptance (use behaviour) of QR code. Authors such as Venkatesh et al. (2012), Ferguson (2016), and van Deursen et al. (2016), agree that once cognitive based intentions are formed towards the execution of a particular behaviour, individuals perform that behaviour to confirm their covet intentions. As a result, once students formed positive intentions towards QR code usage, their intentions finally led to the acceptance and use of the technology for learning purposes.

Furthermore, the unidimensionality of the confidence interval, and the effect sizes for all the significant relationships within this study, confirm the reliable nature of the results in forming policy for a practical approach towards QR code technology integration in large classrooms. Finally, the average variance explained by all endogeneous constructs proved very large enough to be acceptable, as well as the overall model's intention prediction value (65%).

## 5.1 Implications of findings

### 5.1.1 Theoretical implications

The study revealed that the combined models (UTAUT2 and TAM) have a better variance explanation performance than the individual UTAUT2 and TAM models. This provides a basis to suggest that combining both models for research into QR code acceptance is highly constructive.

Additionally, perceived playfulness alone explained 78.6% of how useful QR code is in the modified model for the study. This presupposes that the inclusion of perceived playfulness in the model has a very large explanatory effect on how users view the usefulness of such systems and their integration in classrooms. It then becomes imperative for model development in this direction to consider its inclusion.

The combination of perceived ease of use and perceived usefulness continue to highly explain attitude towards technology use as indicated in the TAM models. Together, both explained 82% of QR code uptake attitude of students. This suggests that the exclusion of the attitude factor in the UTAUT model is to be reconsidered in model development, as the variable is dependent on both perceived ease of use (i.e. effort expectancy) and perceived usefulness (performance expectancy) towards intention formation.

### 5.1.2 Implications for policy and practice

The derived model describes a set of factors affecting university students' use of QR code. This understanding can aid educators' efforts when promoting QR code especially in a large classroom with the intention to encourage active and collaborative learning. Thus, universities or colleges decision-makers especially educators may manipulate those factors identified to facilitate students' involvement and use of QR code as a learning tool. In order for students to accept the integration of QR code; demonstrate a positive attitude and intention to use QR code as a learning tool in the future; educators must make sure that students perceive QR code as an easy and useful application to support their active learning activity.

In particular, our findings on the importance of perceived ease of use, suggest that educators should facilitate the technical integration knowledge of QR code usage and design fun, enjoyable, and interesting activity with QR code as an intrinsic motivation to attract and entertain students. QR code should be introduced to students at the beginning of the semester, while educators explain to students the educational value and benefits of QR code that can support both independent and collaborative learning to motivate, attract and engage learners. Students should be directed to download any QR code reader onto their smartphone or preferred device and encouraged to become familiar with the functions of QR code. Whenever they have difficulties using QR code, the educator should be able to provide technical support and assistance when problems encountered with the QR code activity. The contents and activities embedded in the QR code should be designed creatively so that they are contextually relevant to the topics of the subject matter. A high-quality Wi-Fi connectivity also needs to be provided for speedy access to information or learning materials upon scanning the QR code, which potentially contributes to ease of use.

As educators are now challenged to redesign their teaching strategies, QR code offers a way to allow students in a large classroom to participate actively, dynamically and provide immediate answers. In order for students to perceive that QR code is useful, educators could enhance students' perceived playfulness towards QR code by providing QR code activities that will stimulate students' curiosity with an enjoyable learning environment that leads to exploration. In the lecture hall, QR code could be projected on the screen at the same time as students work in groups on the QR code activity. Handout or printed QR code sheet could also be distributed to each group, in order to direct students to the activity instruction and resources related to the activity undertaken. By using QR code, students can save time by directly accessing necessary information selected by the instructor quickly and easily without searching through volumes of unnecessary materials. For instance, if a student gets stuck with a particular problem and needs assistance, they can scan the QR code to help them complete the learning activity.

Quick access to a variety of useful information (website links and videos that are connected to the code) save students a lot of time, thus increasing their learning productivity. With the aim to develop creative learning experiences with technology, QR code could also be linked to various platforms such as Padlet, Google Docs, Edpuzzle, Play Posit or any relevant Web 2.0 tools to create more engaging, meaningful and interesting activity that also encourage peer interaction and collaboration. Most notable is that the QR code could allow student flexibility with self-assessment of knowledge by providing immediate access to learning materials and expand students' ability to construct their own learning. Innovative educators can promote students' acceptance of QR code with smartphones in the classroom by enhancing the ease of use and usefulness of the QR code to facilitate students' positive attitude towards using and scanning the code. This results into continuance intention to use this 'new' emerging technology.

### 5.2 Suggestions for future studies

Future studies could investigate the relationship between perceived playfulness and social influence. Again, there could be an inquiry into the existence of any relationship between facilitating condition and hedonic motivation. Furthermore, a comparative study on students' and instructors' acceptance could be subsequently conducted. Additionally, the study recommends future work that draws sample from students enrolled on various courses who are employing QR code for large class activities. Finally, future research can consider conducting an experimental study to assess the effectiveness QR code in teaching and learning.

## 6 Limitations

The study was limited to students on a particular course within a university, which makes it difficult to generalize the results. Secondly, no moderators were tested within this study for significance. Finally, the results are based on only the views of students without considering that of instructors.

## 7 Conclusion

Students have shown some good level of acceptance towards mobile learning through mobile tags and QR codes due to their higher ownership of mobile devices and greater familiarity with the use of technology in learning contexts. However, the key to successful adoption of QR code as a learning tool in a large classroom is to understand why students might use this technology. Results identified in this research indicate that, to majority of the participants, their perceived playfulness and perceived ease of use influence their perceived usefulness towards positive attitude formation which determines their acceptance of QR code as a learning tool. However, an important factor predicting their perceived ease of use was their hedonic motivation in using QR code. By knowing and understanding how students act and react towards QR code, instructors could better design and adopt QR codes that are more precisely targeted and tailored to

students preferences and more useful in the learning process. Applying QR codes in education represents a step forward towards integration of a new technology in learning process. To make learning more meaningful, the use of QR code is a creative and positive way to integrate technology into the classroom by adding value to the traditional teaching methods. However, educators need to be familiar with this new technology and be ready to learn how to effectively integrate this application in teaching.

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## Appendix

**Table 8** Questionnaire items

| Constructs | Items |
|---|---|
| Perceived playfulness | Using QR code as a learning tool gave enjoyment to me. |
| | Using QR code as a learning tool stimulated my curiosity. |
| | Using QR code as a learning tool lead to my exploration. |
| Hedonic motivation | Using QR code as a learning tool is fun. |
| | Using QR code as a learning tool is enjoyable. |
| | Using QR code as a learning tool is entertaining. |
| | Using QR code as a learning tool is interesting. |
| Social influence | I respect and put into practice my lecturer's recommendation to scan QR code for learning. |
| | My lecturer supported the use of QR code as a learning tool. |
| | My lecturer has been helpful in the use of QR code for learning. |
| | My friends supported the use of QR code as a learning tool. |
| Facilitating condition | I have the knowledge necessary to use QR code as a learning tool. |
| | My lecturer provided the necessary resources to use QR code as a learning tool. |
| | My lecturer was available for assistance when problems encountered with QR code activities. |
| | I can get help from others when I had difficulties using QR code as a learning tool. |
| Perceived usefulness | QR code is useful for learning. |
| | QR code provides access to a variety of useful information (website links and videos). |
| | The information provided in the QR code help me completed the learning activities. |
| | Using QR code as a learning tool enable me to access resources provided by the lecturer during learning. |
| | Using QR code as a learning tool enable me to accomplish learning activities more quickly. |
| | Using QR code as a learning tool save me a lot of time. |

**Table 8** (continued)

| Constructs | Items |
|---|---|
| | Using QR code as a learning tool increased my learning productivity. |
| Perceived ease of use | It was easy to learn how to scan QR code using my mobile device. |
| | It was easy to become skillful in using QR code for learning. |
| | It was easy to access learning materials (website links and videos) from QR code. |
| | The speed of scanning a QR code was sufficient. |
| | QR code was convenient to use for learning. |
| Attitude towards using QR code as a learning tool | It is a good idea to use QR code as a learning tool. |
| | It is beneficial to use QR code as a learning tool. |
| | It is interesting to use QR code as a learning tool. |
| | I enjoyed interacting with the QR code learning activities. |
| | I have positive feelings toward using QR code as a learning tool. |
| Behavioral intention to use QR code as a learning tool | I intend to continue using QR code as a learning tool in the future. |
| | I predict that I would use QR code as a learning tool in the future. |
| | I plan to continue using QR code as a learning tool in the future. |
| | I intend to recommend other students to use QR code as a learning tool. |
| | I will encourage other lecturers to use QR code as a learning tool. |
| Actual use of QR code as a learning tool | Using QR code for learning purposes has improved my knowledge. |
| | Using QR code for learning purposes has improved my skills. |

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