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QR Codes: A Technologically Enhanced Learning Tool for Large Classroom Settings

Siti Nazleen Abdul Rabu*
snazleen@usm.my
Centre for Instructional Technology and Multimedia
Universiti Sains Malaysia, Malaysia

Haniza Hussin
haniza.hussin@penangsisgroup.edu.my
Centre for Instructional Technology and Multimedia
Universiti Sains Malaysia, Malaysia

Siti Khadijah Mohamad
sitikhadijahmohamad@usm.my
School of Distance Education
Universiti Sains Malaysia, Malaysia

Corresponding author*

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ABSTRACT
This study investigated how students viewed Quick Response (QR) codes as a teaching aid for active-learning classroom activities. A total of 140 students enrolled in the Instructional Technology Practices course were selected as respondents. This study looked at the students' impressions of QR codes using the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) models. Using a survey questionnaire, data were gathered. The findings of this study reveal that perceived usefulness (PU), social influence (SI), and perceived ease of use (PEU) are the three characteristics that have the greatest impact on students' willingness to embrace QR codes for learning. With the help of their friends and the instructor, students thought that using QR codes to enhance active learning activities in a big classroom was simple and helpful. Additionally, they showed favorable attitudes towards QR codes and expressed a desire to employ this tool in their future education. This study offered real-world examples of how QR codes could be used in the classroom. Overall, it is proposed that because students are generally accepting of the adoption, it is possible to use QR codes as a teaching tool in a big classroom.

Keywords: Quick Response (QR) codes; Technology Acceptance Model (TAM); Unified Theory of Acceptance and Use of Technology 2 (UTAUT2); Acceptance

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INTRODUCTION

The original bar code has evolved into the Quick Response (QR) code, which may hold more data. To trace the components used in the production of automobiles, the QR code was originally developed. Users can access the internet and acquire richer material by browsing through the code after taking a picture of it with their phone, which stimulates the development of a new mobile business model. Due to the potential advantages of QR codes, they have been widely embraced globally for controlling industrial processes, advertising, and product tracking (Rivers, 2009).

Due to its potential to enhance educational activities, QR codes are currently becoming more and more popular. This technology tool is relevant to be utilised in the classroom and can encourage students to create and share learning content (Chee & Tan, 2021; Yusof et al., 2012), engage students with different learning needs (Ali et al., 2017), and facilitate learning inside and outside the classroom (Abdul Rabu et al., 2019; Anggraeni et al., 2022; Tan & Chee, 2021) due to its fast readability and capacity. When loaded on mobile devices, the QR code reader application enables users to scan the information contained in the code from any place and deliver it in the form of a video, link, text, or other forms. By connecting them to dynamic, editable websites, it is also utilized to transform a handout into an interactive, dynamic resource.

Teachers should incorporate appealing technology use because university instruction needs to be more attractive and student focused. Internet access and the value of QR codes for users are factors to consider before employing them in teaching (Ali et al., 2017). According to Mehendale et al. (2017), adding QR codes to study materials may improve interactions between students and teachers. Students can quickly access the assessment sheet and contact their teachers by including a QR code in their study materials. To replace the requirement for paper handouts, this technology can also be utilized to offer access to announcements, assignments, and directions. Multiple handouts can be replaced with a single page of QR codes, and on-screen codes can completely replace paper. Additionally, the use of QR codes can support learner-centered education since it allows students to choose their own learning paths and gain access to resources made available by teachers. This method fosters a dynamic and engaging relationship between the teacher and the learner by allowing students to be creative and actively involved in their own learning.

Despite all the benefits, the current focus for educators is on finding innovative ways to use this QR code tool to foster collaboration and a more active learning environment. There is an obvious need for greater research on the usage of QR code in higher education because studies show that students' opinions of the usefulness of QR codes have a big impact on how they feel about using them in the classroom. Furthermore, it is vital to incorporate QR codes as a technology tool into the classroom given the significance of mobile learning and heutagogical approaches in education. Educators may encourage learner-centered teaching and improve communication with their students by doing this.

According to published research (Wang, 2022; Wanget al., 2022; Tamilmani et al., 2021; Arain et al., 2019) the TAM and UTAUT2 models are frequently employed in studies of the adoption of mobile learning. However, the research of QR code acceptability, especially in learning, is still limited by the combination of these two models. Therefore, to better understand and advance these technological integration practices, research is required that combines elements

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of the TAM and UTAUT2 models to evaluate the adoption of QR code integration for learning.

PURPOSES OF THE STUDY

The TAM and UTAUT2 models were used to study the factors impacting the behavioral intention to adopt QR codes as a learning aid, guided by the literature. This study investigated the factors that influence whether students will accept using QR codes for learning, including perceived playfulness (PP), social influence (SI), facilitating conditions (FC), hedonic motivation (HM), perceived usefulness (PU), perceived ease of use (PEU), and attitude towards scanning (ATS), as well as how these factors relate to students' behavioral intentions (BI) to use QR codes for learning. The following research question was investigated: What connections exist between students' individual drivers of motivation (PP, SI, FC, HM, PU, PEU, ATS) and their behavioral intentions (BI) that influence their willingness to embrace (A) the use of QR codes for learning?

In specific, the following sub-research questions were investigated:

- Will PP and SI have a positive relationship on students' PU in using QR code for learning?
- Will FC and HM have a positive relationship on students' PEU in using QR code for learning?
- Will PEU has a positive relationship on the PU in using QR code for learning?
- Will PEU has a positive relationship on the ATS QR code for learning?
- Will PU has a positive relationship on the ATS QR code for learning?
- Will ATS has a positive relationship on the BI to adopt QR code for learning?
- Will BI has a positive relationship on the A of QR code for learning?

The factors that could have influenced students' intention to use and actual usage towards accepting QR codes as a learning tool in classroom activities were analyzed based on the following proposed research model as displayed in Figure 1.

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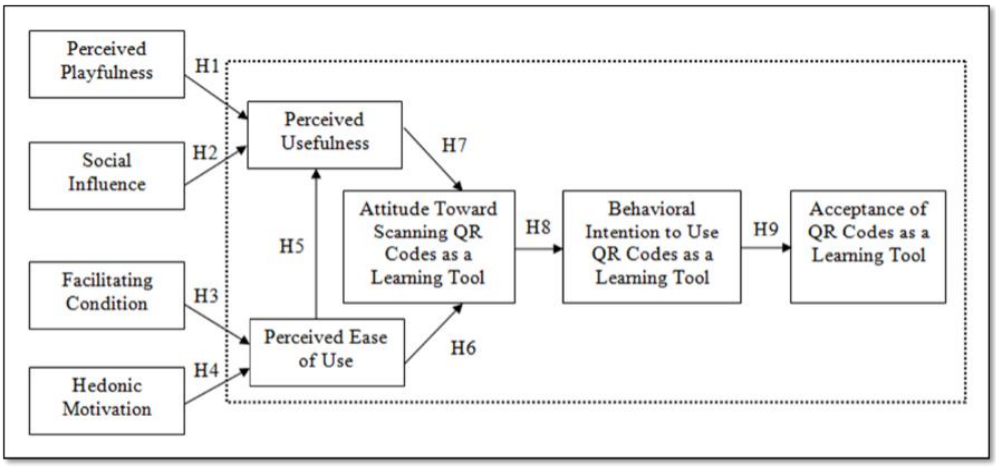

H1: Perceived Playfulness (PP) has a positive relationship on students' Perceived Usefulness (PU) in using QR code as a learning tool.

H2: Social Influence (SI) has a positive relationship on students' Perceived Usefulness (PU) in using QR code as a learning tool.

H3: Facilitating Conditions (FC) has a positive relationship on Perceived Ease of Use (PEU) in using QR code as a learning tool.

H4: Hedonic Motivation (HM) has a positive relationship on Perceived Ease of Use (PEU) in using QR code as a learning tool.

H5: Perceived Ease of Use (PEU) has a positive relationship on Perceived Usefulness (PU) in using QR code as a learning tool.

H6: Perceived Ease of Use (PEU) has a positive relationship on Attitude Towards Scanning (ATS) QR code as a learning tool.

H7: Perceived Usefulness (PU) has a positive relationship on Attitude Towards Scanning (ATS) QR code as a learning tool.

H8: Attitude Toward Scanning (ATS) QR code has a positive relationship on Behavioural Intention (BI) to use QR code as a learning tool.

H9: Behavioural Intention (BI) has a positive relationship on the acceptance of QR code as a learning tool.

Figure 1. The proposed research model

THEORETICAL BACKGROUND

This research adopted the TAM and the UTAUT2 to investigate students' acceptance of QR for learning. These models measured the factors that influenced students to adopt QR codes for learning.

Technology Acceptance Model (TAM)

To better understand how users react to new technology, the TAM was put forth (Scherer et al., 2019). The PU and PEU are its two main cognitive behavioral assumptions. Perceived Ease of Use (PEU) is the degree to which a person perceives that utilizing a specific system would make it

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easier for them to do their jobs, according to Davis (1989). Perceived Usefulness (PU) is the degree to which a person believes that using a particular system would improve their job performance. According to TAM, "Actual System Use" is determined by the Behavioral Intention (BI), which is influenced by "Attitude Towards Using", as shown in Figure 2. Both PEU and PU will have an impact on the "Attitude Towards Using," which in turn will have an impact on a user's behavior. PEU will impact a user's PU with relation to the technology as well. The "External Variables" mentioned in TAM are the user's internal attitudes, beliefs, and intentions in relation to the user's differences from other people, circumstances, and controllable behaviors. This is an underlying factor that subtly affects a user's behavior. For instance, different system attributes will influence the user's PU of that specific technology, whereas the user's PEU will be influenced by the system's design, training, and operating instructions. According to Kashada et al. (2020), TAM has successfully directed numerous research that describe acceptance of information systems and technology utilization. To look at the driving forces behind students' acceptance of QR codes for learning, the current study used the TAM.

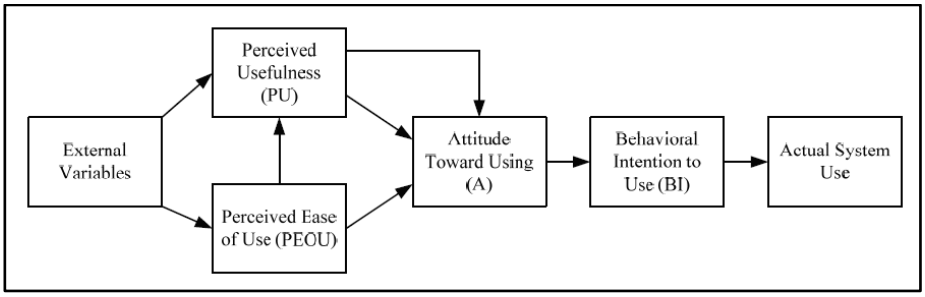

Figure 2. Technology acceptance model

Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)

The factors impacting the behavioral intention to utilize QR codes as a learning tool were investigated using the UTAUT2 model. UTAUT2 is an expanded version of UTAUT that was created to study how new technology is received by consumers (Venkatesh et al., 2012). The seven key constructs in the UTAUT2 model—performance expectancy, effort expectancy, social influence, enabling conditions, hedonic motivation, price value, and habit—are what motivate people to use information systems in their behaviors. Four of these constructs are from the UTAUT model, which was created by combining 32 variables from 8 other models that had been previously utilized in research to explain why users accepted new information systems (Venkatesh et al., 2003). The UTAUT2 model has been used in a variety of research fields, including air transport management (Escobar-Rodrguez & Carvajal-Trujillo, 2013), which examined online drivers' airline ticket purchasing behaviors, and computer and information technology (Touray et al., 2013), which investigated moderating factors on behavioral intention to use the Internet. The model has also been suggested in the fields of accounting and auditing to investigate the adoption of Computer-Assisted-Auditing Techniques and Tools (CAATTs) in audit firms (Rosli et al., 2012). The UTAUT2 model (see Figure 3) was used for this work because, according to Venkatesh et al. (2012), it provided extensions that improved the variance explained in the behavioral intention of UTAUT. Additionally, according to Jamaludin and Mahmud (2011), UTAUT is the most effective theory for analyzing information systems' utilization intentions.

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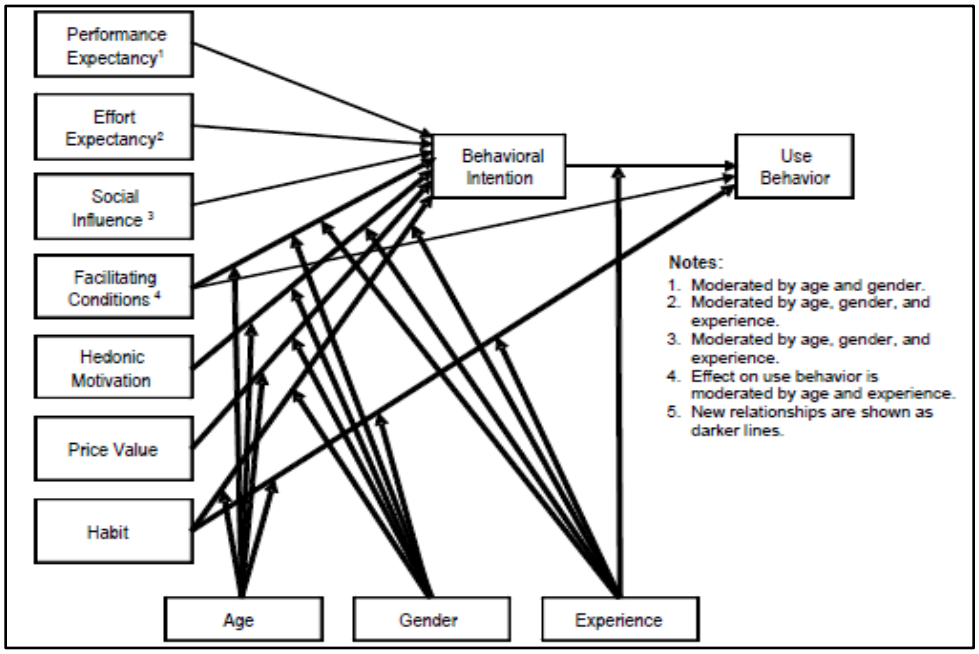

Figure 3. UTAUT2 model

Incorporated Model of TAM and UTAUT2

Motivated by the insufficient research on learners' intention to continue using QR code-based integration in classroom, this study utilized the TAM model as the foundational framework. To enhance the explanatory capacity of this research on intention to continue using, additional variables were integrated from UTAUT2 model developed by Venkatesh et al. in 2012. Combining the TAM and the UTAUT2 models can provide a more comprehensive understanding of the factors influencing the acceptance of QR code for promoting active learning. As a result, nine hypotheses (as shown in Figure 1) were formulated to explore and provide a more comprehensive understanding of the factors influencing the intention to continue using QR code-based integration.

The TAM, proposed by Davis in 1986, focuses on the constructs of PU and PEU to explain and predict BI information systems. PU refers to the belief that using a particular system enhances job performance, while PEU refers to the belief that using the system is free of effort. TAM suggests that BI determines technology acceptance. In the context of QR code integration in a large classroom, TAM can help assess students' perceptions of the usefulness and ease of use of QR codes for active learning. It can provide insights into whether students believe that using QR codes will enhance their learning experience and whether they perceive it as an effortless tool for accessing learning resources or participating in classroom activities.

The UTAUT2 expands upon TAM by incorporating additional constructs that influence technology acceptance. UTAUT2, proposed by Venkatesh et al. (2003) introduced2011 constructs such as PP, SI, FC, and HM. PP construct relates to the degree to which individuals perceive the use of technology as enjoyable and entertaining. It provides insights into the extent to which students find QR codes fun, entertaining, and engaging, which can influence their acceptance and adoption of QR code usage. Understanding students' perceived playfulness can provide insights into their attitudes and engagement levels when using QR codes for active learning. SI construct

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captures the influence of social factors on technology acceptance. It includes subjective norms, social relationships, and the impact of others' opinions. When studying student acceptance of QR codes, considering social influence can help identify how peer opinions, teacher recommendations, or classroom norms influence their willingness to adopt and use QR codes. FC construct refers to the external factors that facilitate or inhibit technology use.

It encompasses aspects such as access to necessary resources, technical support, and infrastructure. For QR code integration in a large classroom, examining facilitating conditions can help identify potential barriers (e.g., lack of devices, poor internet connectivity) and support mechanisms required for successful implementation. Finally, HM construct pertains to the intrinsic pleasure and enjoyment derived from using technology. It reflects individuals' motivation to engage with technology due to the positive emotional experiences it provides. Understanding students' hedonic motivation towards QR code usage can shed light on their willingness to participate actively and enjoy the learning activities facilitated through QR codes. By combining TAM and UTAUT2, researchers can assess a broader range of factors that influence student acceptance of QR code integration. This integration allows for a more comprehensive understanding of the various factors shaping technology acceptance in the specific context of QR code usage for active learning.

RESEARCH METHODOLOGY

Research Context and Participants

A total of 140 Year 2 undergraduate students from the School of Educational Studies (SoE) were involved in this study. A 5-week in-class QR code activity was customized based on the content of the Instructional Technology Practices course syllabus. Females accounting for 83.6% of the respondents, while males constituted 16.4% of the sample size. Most of the participants were aged between 21 and 23 years old (96.4%), with 135 respondents falling into this age category. The next largest age group consisted of 3 respondents aged from 18 to 20 years old (2.1%), followed by 2 respondents above 23 years old (1.4%). The respondents mainly used smartphones with internet access, while only 3 participants reported using an iPad or iPad Mini.

Questionnaire Design

This study used a quantitative survey research design, collecting data through a questionnaire. The questionnaire was created after reviewing the body of research on the TAM and UTAUT2 models. To increase the explanatory power of behavioral intentions, these models were integrated. Only theories pertinent to the use of QR codes as a learning tool were chosen, though. The survey questions were modified from those used by earlier researchers to reflect whether students would be willing to use QR codes for learning. The survey was divided into two sections: a demographic segment and a major section with nine constructs and a total of 39 items (see Table 1). On a five-point Likert scale, from strongly disagree (1) to strongly agree (5), students' acceptance replies were recorded. Three university professors assessed the questionnaire to confirm its dependability, and a pilot test was carried out to gauge its correctness. Some alterations were made in response to suggestions given by students and subject matter experts. Since they exceeded the cutoff point of 0.7, the Cronbach's Alpha values for all constructs varied from 0.871 to 0.901, indicating appropriate and reliable measures. The finalised survey form was transformed into Google Forms following editing. See Table 1 and Appendix 1 for a breakdown of the survey items.

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Table 1
Constructs definition

Contructs/ Factors	Definition	Number of items	Adapted (Reference)
Perceived Playfulness (PP)	Refers to students' attention that focused on the interaction with the QR Code, they are curious during the interaction and finds the interaction intrinsically enjoyable or interesting.	3	Donaldson (2011)
Hedonic Motivation (HM)	Refers to the motivation to do something due to the internal satisfaction when using QR code in classroom activity such as enjoyable and entertaining.	4	Aziz (2015)
Social Influence (SI)	Refers to the degree to which students perceive that important others (peers and instructor) believe he or she should use QR code.	4	Donaldson (2011)
Facilitating Condition (FC)	Refers to the degree to which students believes that institution and technical infrastructure exists to support use of QR Code.	4	Donaldson (2011)
Perceived Usefulness (PU)	Refers to the degree to which the students believe that QR Code provide access to useful information.	7	Donaldson (2011)
Perceived Ease of Use (PEU)	Refers to ease-of-use refers to student's perception that using a QR Code is effortless or simply easy to do.	5	Tajudeen et al. (2013)
Attitude Toward Scanning (ATS)	Refers to student's positive or negative behavior toward scanning QR code for learning.	5	Lo (2014)
Behavioral Intention (BI)	Refers to student's intention to use QR code for learning.	5	Lo (2014)
Acceptance/Actual Use (A)	Refers to the manner in which the students actually scan QR code, including frequency of use, daily usage, and diversity of use the QR code for learning.	2	Lo (2014)

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Research Procedures

To integrate the usage of QR codes as connections to learning resources, this study created five QR code activities (see Appendix 2). Students received the QR code exercises in physical copy form, and they were also posted to the course's Facebook group page. To participate in the QR code activities, students were instructed to download a QR code reader on their mobile devices and bring them to class. Each group of five to six students had one hour and fifteen minutes to finish the in-class QR code project that had been assigned to them.

The instructor handed printed copies of the allocated QR code sheet to each group representative as well as projected them onto the projector screen for each QR code activity, as shown in Figure 4. The assessment questions and links to central learning materials were located on the QR code sheets. To encourage group discussion, these resources were linked to YouTube videos, websites, and the Padlet platform. To complete each task, students had to work in groups to complete Google Docs shared with the instructor by their group or post their responses to a Padlet.

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Figure 4. QR code activities

Data Analysis

A Google Forms survey was posted in the course Facebook group at the end of the semester to gauge how well the integration of QR codes was received by the students. Using SPSS, the data that was gathered was examined. The associations between the predictor variable and the criterion variable that would influence students' acceptance of QR codes for learning were investigated using simple linear regression analyses. The statistical significance of the coefficient and the strength of the association were examined throughout the analysis of linear regressions. The predictor variable significantly predicts the criterion variable if it is significant (Sig. < .05 in the SPSS table).

FINDINGS

The means (M) and standard deviations (SD) are shown in Table 2. According to survey results, respondents generally provided consistent responses for each construct. PEU with a mean score of 4.39, was the least important factor that contributed to the acceptance of QR code integration as a learning tool, according to the respondents, who indicated that HM and ATS factors are the most important factors in accepting the integration of QR code for learning in large classrooms. Indicating that the data points are close to the mean, all the questions' standard deviations are less than 1 (Al-Saleh & Yousif, 2009), which demonstrates the consistency of respondents' responses.

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Table 2
Mean and standard deviation for each construct

Contructs/ Factors	Mean (M)	Standard Deviation (SD)
Perceived Playfulness (PP)	4.53	0.673
Perceived Usefulness (PU)	4.54	0.733
Social Influence (SI)	4.54	0.692
Facilitating Condition (FC)	4.47	0.747
Perceived Ease of Use (PEU)	4.39	0.814
Hedonic Motivation (HM)	4.60	0.645
Attitude Toward Scanning QR Codes as Learning Tool (ATS)	4.60	0.701
Behavioral Intention to Use QR Codes as Learning Tool (BI)	4.31	0.794
Acceptance/Actual Use of QR Code as Learning Tool (A)	4.48	0.704

Simple Linear Regression between PP and PU in Using QR code for learning
H1: PP has a positive relationship on Students PU in using QR code for learning.

A significant regression equation was discovered (F(1,138)= 164.691, p< .000), with an R2 of .544. Based on Table 3, the adjusted R2 value was .541. This indicates that 54% of the variance in PU was explained by the PP. Pearson's coefficient of linear correlation R = 0.738 shows that H1 is accepted.

Table 3
Summary linear regressions test between PP and PU

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
PP		.738	.544	.541		.39739
Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.179	.264		4.464	.000
	PP	.742	.058	.738	12.833	.000

Simple Linear Regression between SI and PU in Using QR code for learning
H2: SI has a positive relationship on Students' PU in using QR code for learning.

A significant regression equation was discovered (F(1,138)= 194.719, p < .000), with a R2 of .585. From Table 4, SI has R = 0.765 and 0.000 significant value which indicates that SI has a positive relationship on PU in using QR code for learning.

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Table 4
Summary linear regressions test between SI and PU

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
SI		.765	.585	.582		.37904
Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.982	.257		3.821	.000
	SI	.781	.056	.765	13.954	.000

Simple Linear Regression between FC and PEU in using QR code for learning
H3: FC has positive relationship on PEU in using QR code for learning.

A significant regression equation was discovered ($F(1,138)= 140.472$, $p < .000$), with an $R2$ of .504. As the significant value is 0.000, hypothesis 3 is supported with $R = 0.710$ (see Table 5).

Table 5
Summary linear regressions test between FC and PEU

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
FC		0.710	.504	.501		.43984
Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.998	.289		3.456	.001
	FC	.757	.064	.710	11.852	.000

Simple Linear Regression between HM and PEU in using QR code for learning
H4: HM has a positive relationship on PEU in using QR code for learning.

A significant regression equation was discovered ($F(1,138)= 109.708$, $p < .000$), with an $R2$ of .443. From Table 6, the $R = 0.666$ which indicates that there is positive relationship between HM and PEU. As its significant value is 0.000, hypothesis 4 is supported.

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Table 6
Summary linear regressions test between HM and PEU

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
HM		.666	.443	.439		.46635
			Coefficients			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.061	.321		3.311	.001
	HM	.724	.069	.666	10.474	.000

Simple Linear Regression between PEU and PU in using QR code for learning
H5: PEU has a positive relationship on PU in using QR code for learning.

A significant regression equation was discovered ($F(1,138)= 157.027$, $p < .000$), with an R2 of .532. Table 7 shows that PEU has R = 0.730 which indicates that PEU is positively associated with PU. As the significant value 0.000 less than 0.05, hypothesis 5 is also supported.

Table 7
Summary linear regressions test between PEU and PU

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
PEU		.730	.532	.529		.40252
			Coefficients			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.523	.243		6.261	.000
	PEU	.687	.055	.730	12.531	.000

Simple Linear Regression between PEU and ATS QR code for learning
H6: PEU has a positive relationship on ATS QR code for learning.

A significant regression equation was discovered ($F(1,138)= 194.916$, $p < .000$), with an R2 of .585. Based on Table 8, the R value of PEU is 0.765. The results indicate that PEU has a positive significant effect on ATS in using QR code for learning. As the significant value 0.000 less than 0.05, hypothesis 6 is also supported.

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Table 8
Summary linear regressions test between PEU and ATS

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
PEU		.765	.585	.582		.39597
			Coefficients			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.187	.239		4.960	.000
	PEU	.753	.054	.765	13.961	.000

Simple Linear Regression between PU and ATS QR code for learning
H7: PU has a positive relationship on ATS QR code for learning.

A significant regression equation was discovered ($F(1,138)= 266.138$, $p < .000$), with an R2 of .659. From Table 9, the R value of PU is 0.812 which indicates that PU is positively related with ATS. Since its significant value 0.000 is below 0.05, hypothesis 7 is supported.

Table 9
Summary linear regressions test between PU and ATS

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
PU		0.812	.659	.656		.35938
			Coefficients			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.644	.238		2.705	.008
	PU	.848	.052	.812	16.314	.000

Simple Linear Regression between ATS and BI in using QR code for learning
H8: ATS QR code has a positive relationship on BI in using QR code for learning.

A significant regression equation was discovered ($F(1,138)= 175.528$, $p < .000$), with an R2 of .560. The results in Table 10 indicates that ATS QR code has a positive relationship on BI in using QR code for learning with R value 0.748. Hence, hypothesis 8 is supported.

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Table 10
Summary linear regressions test between ATS and BI

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
ATS		.748	.560	.557		.44557
Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.642	.280		2.296	.023
	ATS	.817	.062	.748	13.249	.000

Simple Linear Regression between BI and A of QR code for learning
H9: BI has a positive relationship on the A of QR code for learning.

A significant regression equation was discovered ($F(1,138)= 138.887$, $p < .000$), with an R2 of .502. Table 11 shows that BI has a R value of 0.708 which indicates that BI has a positive relationship on the acceptance of QR code for learning. As the significant value is 0.000, the hypothesis 9 is accepted.

Table 11
Summary linear regressions *test between BI and A*

Model		R	R Square	Adjusted R Square		Std. Error of the Estimate
BI		.748	.560	.557		.44557
Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.542	.252		6.119	.000
	BI	.680	.058	.708	11.785	.000

Summary of Findings
A total of 9 proposed hypotheses were tested through the formulation of a simple linear regression analysis in SPSS. The results from the simple linear regression analysis for the proposed hypotheses is shown in Figure 5 and Table 12. Based on the findings, all hypotheses were supported.

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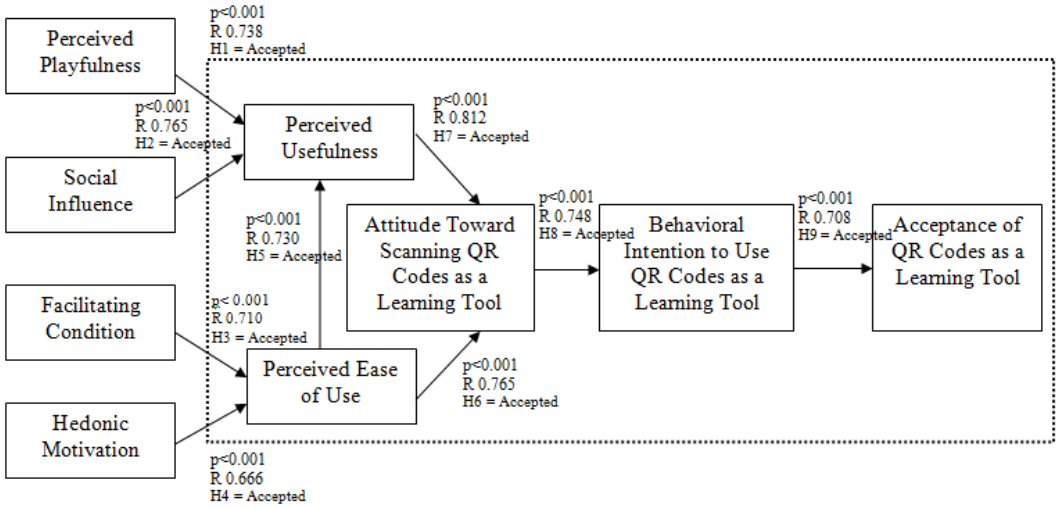

Figure 5. Results of the examined hypotheses

Table 12
Summary of hypotheses tested

Hypothesis	R	R Square	Adjusted R Square	Std. Error of the estimate	Support
H1: PP □ PU	.738	.544	.541	.39739	YES
H2: SI □ PU	.765	.585	.582	.37904	YES
H3: FC □ PEU	.710	.504	.501	.43984	YES
H4: HM □ PEU	.666	.443	.439	.46635	YES
H5: PEU □ PU	.730	.532	.529	.40252	YES
H6: PEU □ ATS	.765	.585	.582	.39597	YES
H7: PU □ ATS	.812	.659	.656	.35938	YES
H8: ATS □ BI	.748	.560	.557	.44557	YES
H9: BI □ A	.708	.502	.498	.45545	YES

DISCUSSION

Relationship between PP and SI on Students' PU in using QR Codes as a Learning Tool

PP was found to have a positive relationship with PU in accepting QR codes as a learning tool. The results suggest that the more students enjoy using QR codes, the more positive their attitude towards adopting QR codes will be, and perhaps may engage in QR code activities in the classroom. Hence by integrating QR codes in playful activities or games in the classroom, students can see the practical applications of this technology which can lead to an increased likelihood of them using QR codes for other purposes in the future (Chiu & Churchill, 2015). The authors also concluded that using QR codes can be an effective way to enhance classroom learning and promote positive attitudes towards technology adoption.

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SI was also found to have a positive relationship with PU in accepting QR codes as a learning tool. Furthermore, this relationship was the second strongest. Based on social learning theory, the external interaction i.e., through interaction with others can influence other people's behaviors (Slade et al., 2015; Tu et al., 2022). In the context of QR code for this study, it is suggested that the SI am2022ShinShinong peers strongly influences students to use QR codes as a learning tool. This finding also highlights the importance of ensuring positive experiences with QR codes, as users may be influenced by their peers' positive opinions. However, Jiin et al. (2012) suggest that the relationship between SI and PU will be more significant during the initial and early stages of using QR codes in class activities and will decrease over time as users gain greater experience. Therefore, it is now up to the instructor to learn to design their learning activities in unique and meaningful ways to keep their student's interest in always using QR code at high level. It is important for QR code to entail more activities that related to socialization rather than just activities to assess information per se.

Relationship between FC and HM on Students' PEU in using QR code for learning

This study found that FC and HM had a positive relationship with the PEU in using QR code for learning. This indicates that the role of the instructor influenced the ease of use of the QR code application by creating QR codes activities that are dependable and secure. This is supported by study done by Huang and Liang (2011) where the authors investigated the use of QR codes for English vocabulary learning and found that facilitating conditions and hedonic motivation were significant predictors of perceived ease of use. They also emphasized the importance of instructors in providing support and creating enjoyable QR code activities to enhance the perceived ease of use of QR codes for learning. When comparing FC and HM, it was found that FC had a stronger relationship with students' intention to use QR code for learning.

This suggests that a more user-friendly system design can make users feel more comfortable and find the system easier to use. Therefore, it is crucial to provide resources, training, and information to users as that can have a significant effect on the ease of use of QR code during the learning process. The popularity of QR code during the pandemic which can be seen as an external stimulus facilitating condition may have also accelerated its ease of use (Yan et al., 2021) but it is not clear how that helps in learning context as it is not properly measured during this study. Despite being a positive significant factor, HM was the lowest scoring determinant factor that affected the PEU of using QR code during the class activity. This result may be due to their group activity, as some students are depending on other members to complete the task and felt forced to use the QR code. In the learning context, this makes sense as QR codes might be difficult to use when it comes to learning activities what involves writing and collaboration compared to reading or listening (Bakla, 2018). Nevertheless, most of them still agreed that the QR code was an interesting and entertaining tool that motivated them to support class activities.

Relationship of PEU on Students' PU in using QR code for learning

The PEU has a positive relationship with students' PU of QR codes as a learning tool. The results show that direct access to digital learning materials, such as website links, videos, and other applications used during class activities, was convenient using QR codes. In this study, a larger number of participants strongly agreed that it was easy to learn how to scan QR codes and use them to access learning materials. They found that by scanning the QR codes, they were directed to the appropriate web addresses with relevant learning content. Consistent with the findings of

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previous studies, Fathema et al. (2015) indicated that PU was significantly determined by the PEU in the context of teachers' technology usage.

Relationship of PEU on Students' ATS QR code for learning

PEU is positively related to ATS QR codes as a learning tool. In this study, most students agreed that using QR codes in classroom activities was very easy and that they could learn to use them quickly. Note that these respondents live in digital environment where technology is a vital part of their lives. Hence, they are very competent in using QR code where they know how to adjust their camera to scan the square QR etc. Furthermore, QR code scanners are easy to download from free websites or mobile applications. This indicates that QR code applications must have easy functions, high navigation speed, and interaction capabilities to influence students' attitudes towards scanning QR codes in class activities. When users find QR codes easy to use, they feel more comfortable, and therefore, have stronger intentions to scan them in the future. QR codes is indeed can fulfil these 3 elements if it is used wisely in learning context: location independence, time independence, and meaningful content (AlNajdi, 2022). The study by Wu et al. (2017) also provides evidence for the importance of PEU in the adoption and use of QR codes as a learning tool where there is a need for technology to be perceived as easy to use for it to be accepted and used effectively in educational settings.

Relationship of PU on ATS QR code for learning

PU is positively related and has the strongest relationship to ATS QR codes as a learning tool. According to TAM, PU is a fundamental concern that determines the attitude towards using technology which can enhance user performance in a desired context. Based on this study findings, majority of the students found that QR codes were very useful, and goal directed which can link them to videos, websites, and other platforms because they helped them understand what is required to complete class activities (Downer et al., 2016). Besides that, QR codes activities which created for this study does not involve with any privacy concern and financial security issues, therefore they are not hesitated to scan the QR codes during their learning process, compared to any other QR code applications especially in mobile payment and health care situations (Tu et al., 2022). Promoting the PU of QR codes for learning and emphasizing their benefits and usefulness for learning through less cumbersome process could be a positive strategy for increasing QR codes' usage as a learning tool.

Relationship of ATS QR code on BI to use QR code for learning

The regression analysis revealed that the ATS QR codes is the single factor that significantly impacts students' BI to use this application as a learning tool. This finding can explain differences in people's preferences for QR code services. The study's results in the education context confirm the positive effect of attitude towards scanning QR codes on users' BI to accept QR codes as learning tools, which is consistent with previous research on users' intentions to accept technology (see Ali et al., 2017; Shin et al. 2012). Overall, the results suggest that not only did the students demonstrate positive attitudes towards the integration of QR codes in learning activities, but they also had clear intentions to use the system in the future. Hence, educators must respond to this situation through curriculum change (AlNajdi, 2022) especially on learning activities and pedagogies.

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Relationship of BI on the A of QR code for learning

The study found a positive correlation between students' BI and their A of QR codes as a learning tool. The results indicate that the usefulness of QR codes for learning purposes which build on its utilitarian benefits has met students' expectations, thereby affecting their intention to use them. A study by Wu et al. (2017) provides evidence for the positive correlation between students' behavioral intention and their acceptance of QR codes as a learning tool. The study highlights the importance of the utilitarian benefits of QR codes for learning purposes, specifically in assisting students in completing tasks, accessing online materials, and seeking help at any time. This discovery has proven to be beneficial, saving time and enhancing learning outcomes. As a result, students are more inclined to continue using QR codes as a learning tool.

CONCLUSION

For most participants, their PP and PEU influenced their PU, which in turn affected their attitudes towards QR codes as a learning tool. Within this study, students viewed their experiences with QR codes as very interesting and enjoyable, which promoted fun and engagement in their learning activities. They associated the fun aspect of using QR codes with their usefulness for learning, thus reducing cognitive load. This enjoyable flow experience resulted in active and meaningful learning, supporting their PU. As a result, students' positive perceptions of the ease of use and usefulness of QR codes led to a positive attitude towards the technology's use in learning.

The results of this study have significant implications for all teachers, software developers and instructional technology specialists regarding how to enhance teaching and learning by utilizing QR codes as a tool. This study offered real-world examples of how QR codes might be used in a big classroom setting in higher education to enhance learning. The use of QR codes in education is a step towards fully integrating modern technologies into the teaching and learning process. By enhancing conventional teaching techniques, the usage of QR codes in the classroom is an innovative and fruitful way to successfully integrate technology.

This study provides practical examples of how educators could creatively utilize QR codes in teaching and learning, creating a more active, meaningful, interesting, and student-centered learning environment that promotes peer interaction and collaboration, especially in a large classroom. QR code activities also allow quick access to a variety of useful information, thus saving students a lot of time. This study offers real-world examples of how teachers might imaginatively use QR codes in teaching and learning, fostering peer engagement and collaboration and resulting in a more active, exciting, and student-centered learning environment, particularly in a big classroom. Students can save a tone of time by engaging in QR code activities that provide quick access to a variety of essential information.

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Appendix 1

Constructs	Items
Perceived Playfulness (PP)	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 (HM)	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 (SI)	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 (FC)	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.

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Perceived Usefulness (PU)	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.
Perceived Ease of Use (PEU)	Using QR code as a learning tool increased my learning productivity. 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 Toward Scanning (ATS)	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 (BI)	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.
Acceptance/ Actual Use (A)	Using QR code for learning purposes has improved my knowledge. Using QR code for learning purposes has improved my skills.

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Appendix 2

Activity 1	Topic: Behaviorism, Cognitivism, Constructivism QR code provided to students will navigate them to questions: 1. What are the different viewpoints between Behaviorism, Cognitivism and Constructivism learning theories? 2. What are the role of teachers in Behaviorism, Cognitivism, Constructivism? 3. What are the role of learners in Behaviorism, Cognitivism, Constructivism? 4. What are the benefits of Constructivist student-centered learning approach compared to teacher-centered learning approach? 5. What are the strategies that can be used to support Constructivist learning? QR code link to : Youtube, Google Doc and Websites
Activity 2	Topic : Learning Theory QR code provided to students will navigate them to questions: 1. Create a minimum of FIVE (5) questions for each video using Edpuzzle platform. 2. Share/Paste the link to your group Google Doc QR code link to : Edpuzzle, Google docs and Websites
Activity 3	Topic: Gagne's Nine Events of Instruction QR code provided to students will navigate them to questions: 1. List events in this model. 2. Explain these 9 events. 3. Explain how these events are used in the instructional design process with appropriate examples. QR code link to : Padlet wall and Youtube

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Activity 4	Topic: Flipped classroom QR code provided to students will navigate them to questions: 1. What are the advantages of flipped classroom? 2. What are the challenges in implementing flipped classroom? 3. Explain student-led and instructor-led flipped classroom models. 4. Explain collaborative learning activities that can be conducted for flipped classroom in-class time QR code link to : Padlet wall and Websites
Activity 5	Topic : 21st Century Teaching and Learning QR code provided to students will navigate them to questions: 1. What are the essential skills that are in demand in the 21st century? 2. What is cooperative and collaborative learning? QR code link to : Padlet wall, LMS and Websites

Conflict of Interest

The authors declare that they have no conflict of interests.

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Authors' Contributions

Dr Siti Nazleen Abdul Rabu conceptualized the study, conducted the research, wrote and edited the article. Mdm Haniza Hussin analysed the data and wrote the initial draft. Dr Siti Khadijah Mohamad wrote the article and helped with the manuscript formatting.

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About the Authors

	Dr Siti Nazleen Abdul Rabu is a senior lecturer at the Centre for Instructional Technology and Multimedia (CITM), Universiti Sains Malaysia (USM), Penang. Her research interests include instructional strategies in online learning, specifically looking into online learning discourse analysis, computer-supported collaborative learning (CSCL), including game-based learning and gamification.
	Mdm Haniza Hussin is a Computer Science and ICT teacher at Straits International School, Penang.
	Dr Siti Khadijah Mohamad is a senior lecturer at School of Distance Education, Universiti Sains Malaysia. Her research interests include educational technology, learning analytics, and educational data mining.

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