

Interactive tax learning for secondary students using SmartTax (CukaiPintar)

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ABSTRACT

Tax literacy remains an essential yet underrepresented component of financial education in secondary schools. However, traditional teaching approaches and the lack of engaging digital tools have made it challenging for students to understand abstract taxation concepts. While mobile learning is increasingly used in education, few applications explicitly combine expert validation and usability evaluation to ensure instructional quality and user acceptance, particularly in tax education. This study developed and evaluated SmartTax (CukaiPintar), a mobile learning application designed to enhance tax literacy among Malaysian secondary students. A dual-method approach was employed: the fuzzy Delphi method (FDM) was used to obtain expert consensus on content and usability, while the technology acceptance model (TAM) guided the evaluation of student acceptance and behavioral intention. Ten mathematics educators participated in the expert validation phase, while 30 students were involved in the usability testing. Findings revealed strong correlations between perceived usefulness and attitude ($r = 0.600$) and between attitude and behavioral intention ($r = 0.653$), with other variables such as mobility, enjoyment, and self-efficacy also showing significant effects. These results underscore the value of integrating expert and user input in educational application development. SmartTax (CukaiPintar) offers evidence-based guidance for creating effective and student-centered mobile learning tools in tax education.

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1. INTRODUCTION

Taxation is a cornerstone of a country's economic and social development. As the primary source of government revenue, taxes play an important role in providing public services such as education, health, and infrastructure. The close relationship between taxation and national development makes it an important tool for sustainable development [1]. Even so, several challenges in tax collection continue to restrict the efficiency of the taxation system in many countries, including Malaysia [2]. In Malaysia, the implementation of the self-assessment system (SAS) in 2001 for business taxpayers, and later extended to individuals in 2004, aims to increase voluntary tax compliance. Tax morale, influenced by political stability and the rule of law, has positively mediated citizens' willingness to comply with taxation [3]. Similarly, trust in government has been identified as a crucial mediator in the link between public service satisfaction and tax compliance, where satisfaction with government services fosters institutional trust, which in turn promotes voluntary tax

compliance [4]. This system requires in-depth knowledge of tax laws such as calculation, relief, and tax privileges. However, the limited tax knowledge in the community shows the urgent need for tax education, especially among school students. Supporting this, earlier studies have shown that Malaysian secondary school students generally exhibit low levels of tax knowledge and awareness [5].

Tax education not only increases awareness but also plays an important role in building tax compliance behavior in the future. Introducing tax literacy in schools not only shapes students into becoming responsible citizens but also fortifies the financial relationship between citizens and the government [6]. Since the implementation of the standard secondary school curriculum (KSSM) in Malaysia, students in Form 5 have been required to take a math course that covers taxes. However, research shows that students struggle to understand the abstract and complex concept of taxes [5]. Limited basic financial literacy, a lack of more interactive teaching materials, and overly abstract methods of learning prevent students from interpreting and applying taxation. This calls for more practical and interactive teaching approaches. In such situations, the use of interactive educational applications is considered a possible answer, offering students more interactive and relevant learning experiences, as stated by Padilla *et al.* [7]. YouTube, as one example of an interactive teaching approach, when used as a supplementary tool, has been shown to significantly improve students' tax awareness and knowledge [8].

This study uses the design and development research (DDR) approach, which consists of three main phases, including requirements analysis, design and development, and usability evaluation. In the first phase, the study used the nominal group technique (NGT) to identify the challenges high school students face in understanding taxation. The results of this stage are published in the International Journal of Research and Innovation in Social Science [9] and become a source for creating the SmartTax (CukaiPintar) application, which aims to present an interactive and relevant platform for learning. This design consideration aligns with prior findings that mobile tax education tools should integrate persuasive elements and clear instructional design [10].

This study began by identifying the various challenges high school students face in understanding taxation. Among the main challenges identified in the needs analysis phase are abstract and complex content, lack of interactive teaching materials such as simulations and applications, and teaching methods that are too theory-oriented, which cause students to lose interest in this topic [9]. This issue is in line with the findings of other researchers who emphasize that the outdated curricula and the absence of strong educational standards in tax literacy have hindered efforts to develop a solid tax awareness among students [11]. As stated in Clercq [6], unorganized and unstructured tax education has caused limited awareness of tax rights and responsibilities. Despite the initiation of awareness programs like Kidzania, these are insufficient, as no formative education in taxation is conducted at the secondary school level in Malaysia [5]. The lack of interactive autonomous learning tools also limits the effectiveness of education, as evidenced by Padilla *et al.* [7], who proposed the integration of features such as meaningful feedback and graded assessment systems to improve learning outcomes.

In this case, the technology acceptance model (TAM) is used to examine how students accept educational applications like SmartTax (CukaiPintar). This model has been widely used in technology adoption examinations to evaluate the reasons for acceptance or rejection of technologies by individuals. Developed by Davis [12], TAM argues that an individual decides to accept a certain technology based on two factors, which are perceived ease of use (PEOU) and perceived usefulness (PU). PU assesses a user's view of the benefits of using an academic system, while PEOU considers the effort needed to employ the system [13]. In the case of mobile learning applications, PU measures how such applications aid in achieving specific educational goals, while PEOU assesses the challenges students face in using the application [14]. These factors have direct effects on users' attitude (AT) and behavioral intention (BI) towards technology adoption.

While TAM provides a strong foundation for understanding technology adoption, recent studies have extended the model by incorporating additional factors that further influence user acceptance. This study integrates three external variables, including perceived mobility value (PMV), perceived enjoyment (PE), and perceived self-efficacy (PSE), to offer a more comprehensive analysis of students' adoption of SmartTax (CukaiPintar).

PMV is the degree of ease and user-friendliness provided by mobile-enabled devices. PMV among mobile payment application users, for example, is reported to make a significant contribution, as users of such technologies are more likely to engage when they have the ability to participate anywhere [15]. PE is the degree to which students enjoy using the technology beyond its functional purposes, such as teaching or learning. The acceptance model for technology is further expanded to include enjoyment, which is pertinent to the increased acceptability of technology in education. Studies on students' motivation to learn using metaverse-based learning applications argue that students' willingness to use learning applications is contingent on the degree to which they like them [15]. PSE is an individual's belief in their ability to effectively use a system. Studies have shown that PSE directly influences PEOU, as users who feel more

confident in their technological abilities are more likely to perceive a system as easy to use. TAM analyses on PSE adoption within teleorthodontic technologies revealed that PEOU positively influences BI [16].

In addition to these external aspects, students' AT and BI are significant in the adoption of SmartTax (CukaiPintar). This means that an individual's overall evaluative judgment of a technology will determine whether they adopt it [17]. In this case, students who have positive attitudes toward the application of SmartTax (CukaiPintar) will use it in their learning process. Azizi and Khatony [18] also indicates that student attitudes influence their intention to use mobile learning applications and suggests that positive attitudes towards SmartTax (CukaiPintar) will increase its acceptance. Furthermore, Al-Emran *et al.* [19] notes that attitudes serve as the predictor of continuous usage, emphasizing the need to promote learning that centers on user engagement to achieve sustained adoption.

With these findings in mind, this study incorporates TAM and additional external factors to explore students' adoption of SmartTax (CukaiPintar). The details of these relationships are presented in the methodology part of the paper, which includes the framework of the study. Furthermore, taxation education for non-business and non-accounting students remains insufficient, resulting in a lack of exposure to the taxation system and tax compliance process [20], [21]. To address these issues, increased organized, experiential, and relevant education is needed, not only to develop students' comprehension of taxation but also to motivate them as learners. To meet these requirements, the Smart Tax (CukaiPintar) application was developed, aiming to offer a new, real-life, and participative learning environment.

Based on the aforementioned gaps and objectives, this study aims to address the following research questions (RQ). Accordingly, this study focuses on two main research questions: (i) What design features of the SmartTax (CukaiPintar) application are validated by experts using FDM? and (ii) How do TAM constructs influence students' acceptance and intention to use the application?

2. RESEARCH METHOD

In order to accomplish the goals of the study and obtain trustworthy findings, a well-organized and methodical research approach is necessary. The early phases of development are particularly vulnerable to mistakes. Therefore, it is important to prepare ahead to reduce or eliminate them [22]. The study used the DDR method, which consisted of three main phases, which are needs analysis, design and development, and usability evaluation. Each phase was carefully structured to ensure that the development of the SmartTax (CukaiPintar) application aligned with its goal of enhancing students' understanding of taxation through interactive and practical learning tools. The instructional design of the application is based on the analysis, design, development, implementation, evaluation (ADDIE) model, a renowned framework for creating educational materials. The ADDIE model's organized and iterative approach includes all the necessary steps for developing successful educational programs. Application developers may refer to the five essential steps of the ADDIE model, including analysis, design, development, implementation, and evaluation, to ensure that their work satisfies educational goals and user requirements [23].

This study utilizes the DDR methodology, which has three main phases, including requirements analysis, design and development, and usability assessment. The objectives of this investigation are: i) to identify challenges faced by secondary school learners in the comprehension of taxation concepts, building upon the information previously gathered in a needs analysis; ii) to create and build an interactive educational application, SmartTax (CukaiPintar), that is compliant with the national curriculum and increases students' tax literacy; iii) to assess the effectiveness of the SmartTax (CukaiPintar) application and evaluate the user experience in relation to students' learning activities.

Although the overall research adopts the DDR methodology, this paper specifically focuses on the design, development, and usability evaluation phases. The needs analysis phase, which identified core student challenges in understanding taxation concepts, was reported in a separate publication [9] and serves as the foundational basis for this study. This study was conducted in two phases. First, the fuzzy Delphi method (FDM) was used to validate the instructional content, media, and usability features through expert consensus. The validated features were then integrated into the application before the TAM was applied to evaluate user acceptance and usability among secondary school students. Figure 1 illustrates the research flow and integration of methods used throughout the study.

The research framework for this study was developed based on previous literature on mobile learning adoption and technology acceptance. This study incorporates the TAM alongside external variables, as the model has been widely recognized in the literature for its effectiveness in explaining technology adoption and acceptance. The framework illustrates the relationships between key variables that influence students' BI to use the SmartTax (CukaiPintar) application, as shown in Figure 2. The study examines the impact of PEOU, PMV, and PSE on BI. Additionally, PU and PE influence students' attitude (AT), which in turn affects BI.

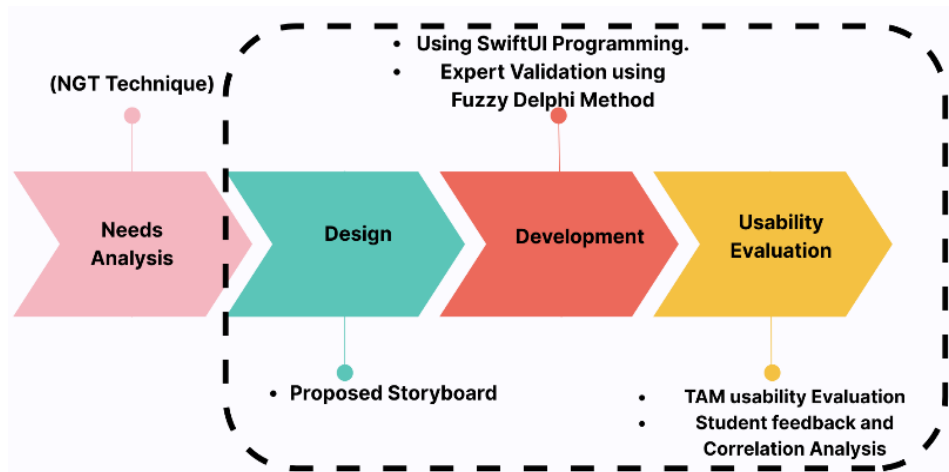


Figure 1. Research flow illustrating the design, development, and usability evaluation phases of the SmartTax (CukaiPintar) study

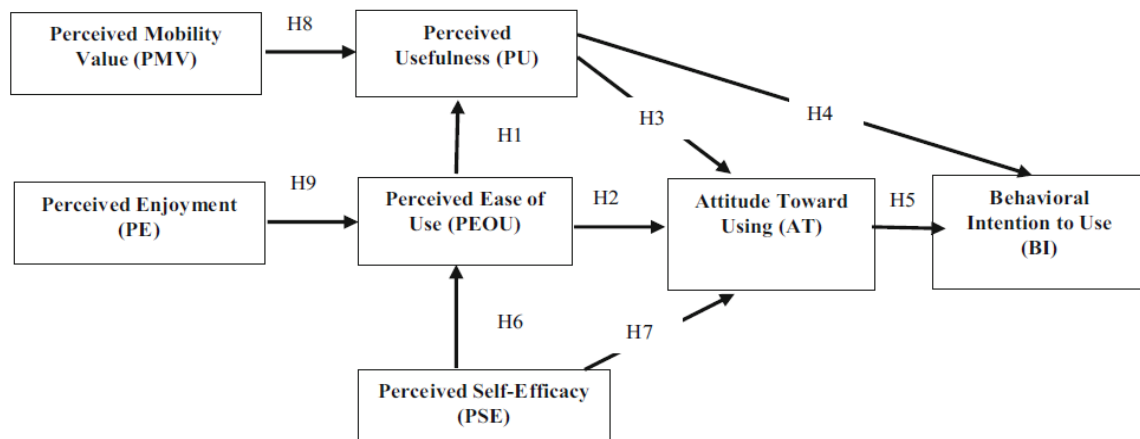


Figure 2. Research framework for SmartTax (CukaiPintar) [24]

Based on the research framework and previous literature, the hypotheses were formulated:

- H1: PEOU has a significant positive impact on PU.
- H2: PEOU has a significant positive impact on AT toward using SmartTax (CukaiPintar).
- H3: PU has a significant positive impact on AT toward using SmartTax (CukaiPintar).
- H4: PU has a significant positive impact on BI to use SmartTax (CukaiPintar).
- H5: AT has a significant positive impact on BI to use SmartTax (CukaiPintar).
- H6: PSE has a significant positive impact on PEOU.
- H7: PSE has a significant positive impact on AT.
- H8: PMV has a significant positive impact on PU.
- H9: PE has a significant positive impact on PEOU.

2.1. Phase 1: need analysis

The needs analysis phase identified the challenges that secondary school students face in understanding taxation. The NGT was employed with expert mathematics teachers to determine, classify, and interpret key difficulties. The findings revealed several challenges, including the abstract and complex nature of taxation concepts, the lack of interactive learning materials, and an overemphasis on theoretical teaching methods. These results, published in the International Journal of Research and Innovation in Social Science [9], served as the foundation for designing the SmartTax (CukaiPintar) application. Therefore, this paper focuses specifically on the design, development, and usability evaluation phases.

2.2. Phase 2: design and development

2.2.1. Instructional design framework

The instructional design of the SmartTax (CukaiPintar) application was guided by the ADDIE model, a commonly used framework in educational technology design. This model comprises five phases, including analysis, design, development, implementation, and evaluation. In this study, the Analysis phase corresponds to the needs analysis conducted earlier, while the Design and Development phases were directly translated into the storyboard and content creation of the application. The focus was on aligning instructional strategies with learners' needs, ensuring clarity, interactivity, and curriculum relevance. Design principles emphasized multimedia learning theory and user-centered design to enhance students' engagement and comprehension of tax-related concepts.

2.2.2. Content and feature development

During the development stage, the researchers focused on developing an effectively organized instruction application derived from the output of the requirements study. For the effective design of the SmartTax (CukaiPintar) application, this phase involved consulting expert teachers and following a systematic process that required creating storyboards and conducting expert interviews. To evaluate and make improvements in important parts of instruction in an application, professionals in subjects of study were interviewed. In an attempt to ensure the application educated students about taxes, such professionals evaluated it for instruction, usability of information, and mastery strategies. Most of the application's function and its contents stemmed from feedback gained during these interviews.

A significant contribution during this stage involved adopting validated learning design standards from Ramadani *et al.* [25], specifically concerning the use of clear and simple language to enhance students' comprehension. To make instruction easier and more engaging, interactive and engaging educational materials such as animations and organized instructions were incorporated. Emphasis was also placed on the practicality and relevance of video-based instructional content, which was designed to be as immersive as possible to aid understanding. Upon validation, a storyboard was drawn up that provided a comprehensive outline for the application's structure, user interface, and interactive features, as shown in Figure 3. The storyboard served as the development's thesis statement structure, to which every component of the application was crafted with regard to educational and usability factors.

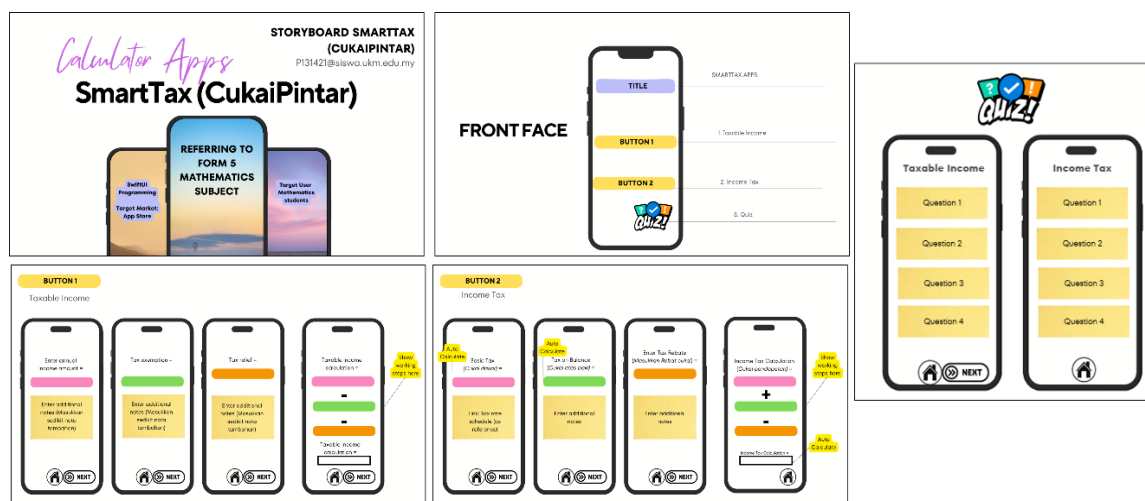


Figure 3. Storyboard of SmartTax (CukaiPintar) application

The design and development phase aimed to create an interactive and engaging educational tool suitable for secondary school students. Features such as a calculator for taxes, real-life-related “Sijil Pelajaran Malaysia” (SPM) practice questions, and step-by-step analysis for incorrect options were incorporated. The SwiftUI programming language was used to develop the application because it is a simple, user-friendly, and real-time platform. During development, the primary objective was to ensure the application was easy to use and navigate so that students could learn anytime and anywhere. In addition, the application was in line with the national curriculum, enhancing classroom lessons while offering real-world examples of taxation-related mathematical concepts.

SmartTax (CukaiPintar) is an educational application for iOS that aims at assisting Form 5 students in better understanding income tax calculations in mathematics. SmartTax (CukaiPintar) is different from traditional materials, as it utilizes interactive and gamified features to increase engagement and comprehension. The application is personalized, allowing students to practice with real exam questions, including SPM trial papers and even textbook exercises. One of the real strengths of SmartTax (CukaiPintar) is its expert content development using the FDM, which makes it accurate and educationally effective. The application is designed so that corrections and feedback are given instantly, which allows students to improve their understanding as soon as they realize their mistakes. In addition, SmartTax (CukaiPintar) is flexible in terms of input formatting, allowing students the freedom to express their responses in their own unique style. SmartTax (CukaiPintar) also incorporates interactive gamification features, including Quizizz, which fosters motivation and engagement for students as learning becomes fun and competitive. SmartTax (CukaiPintar) offers a user-friendly interface, which makes it an innovative and practical solution to aid tax education in Malaysia's secondary school curriculum.

2.2.3. Expert validation procedure

The expert panel for this study was selected based on three criteria: (i) a minimum of 10 years of teaching experience, (ii) active involvement in curriculum implementation at the secondary level, and (iii) familiarity with taxation topics in the national syllabus. A 7-point Likert scale questionnaire was employed to evaluate the application's content, design, and instructional relevance. The instrument was administered via Google Forms, and a two-round Delphi process was conducted. Threshold values ($d \leq 0.2$) and expert consensus level ($\geq 75\%$) were used to determine item agreement.

The FDM facilitated the process of reaching expert consensus regarding important parts of the application. In general, FDM is a useful tool for attaining expert consensus on particular issues [26]. Compared to the traditional Delphi Method, FDM offers a more structured and cost-efficient method of managing expert input through questionnaires. It allows for continuous improvement of expert views throughout the evaluation process [27]. As a decision tool, FDM employs expert group consensus to affirm research outputs and the accuracy of selected parts [28], [29]. What sets FDM apart is its integration of Fuzzy Numbering Sets into the Delphi Method, making it a distinctive approach for refining expert evaluations while accommodating uncertainty and variability in responses [28]. For expert respondents' selection for use in this stage, Adler and Ziglio [30] recommended that an expert group should consist of 10 to 15 specialists in order to have a balanced and dependable group agreement. For this study, 10 expert respondents have been specifically recruited to take part in the evaluation process. All experts had extensive teaching experience, with at least 10 years of service in education, qualifying them to assess the educational and instructional use of the SmartTax (CukaiPintar) application. The FDM process adopted in this study is illustrated in Figure 4.

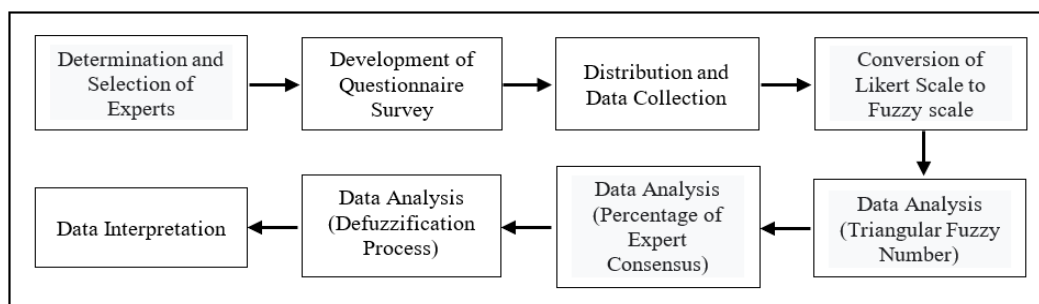


Figure 4. Research procedure for the FDM [31]

To evaluate the prototype effectiveness of SmartTax (CukaiPintar), a 7-point Likert expert evaluation form was used, including an instruction evaluation, usability, and clarity of contents [25]. This structured review ensured that the application met the necessary educational and instructional standards. The FDM was used for the expert evaluation process. This allows the experts to reach a consensus on the most important requirements for the application. Two key dimensions were examined, which are media evaluation and expertise evaluation. These included assessment items such as instruction and sentence clarity, communicative use of language, instruction, and stimulation through educational materials. The demographic and professional profiles of the FDM experts are presented in Table 1. The developed SmartTax (CukaiPintar) application is shown in Figure 5.

Table 1. FDM participation profile

Expert	Position	Experience	Field of Expertise
E1	Head of Mathematics Panel	17 years	Mathematics teacher for Form 5 students (Active Speaker for Mathematics Workshops)
E2	Head of Mathematics Panel	24 years	Mathematics teacher for Form 5 students
E3	Secondary School's Teacher	19 years	Mathematics teacher for Form 5 students
E4	Secondary School's Teacher	18 years	Mathematics teacher for Form 5 students (Active Speaker for Mathematics Workshops)
E5	Secondary School's Teacher	10 years	Mathematics teacher for Form 5 students
E6	Secondary School's Teacher	12 years	Mathematics teacher for Form 5 students
E7	Secondary School's Teacher	16 years	Mathematics teacher for Form 5 students
E8	Head of Science and Mathematics Department	21 years	(Active Speaker for Mathematics Workshops)
E9	Secondary School's Teacher	27 years	Mathematics teacher for Form 5 students
E10	Secondary School's Teacher	15 years	Mathematics teacher for Form 5 students

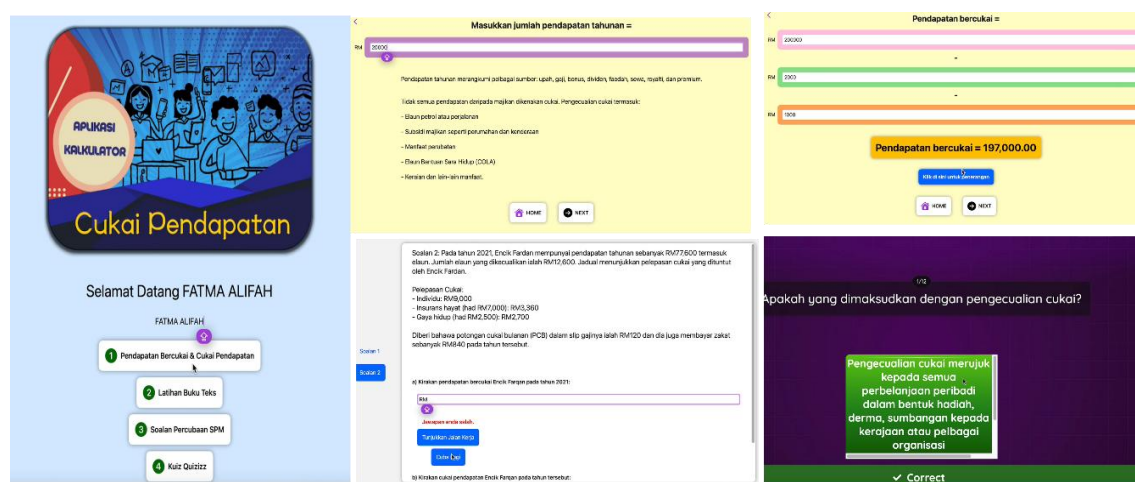


Figure 5. SmartTax (CukaiPintar) application

2.3. Phase 3: usability evaluation

This phase aimed to evaluate the usability of the SmartTax (CukaiPintar) application from the students' perspective and to identify areas for potential improvement. The usability test was conducted during a one-day enrichment session where students were introduced to taxation concepts using the SmartTax (CukaiPintar) application. Students interacted directly with the application and answered items related to their experience.

2.3.1. Sampling and participants

Purposive sampling was employed to select participants based on accessibility and relevance to the study's objectives. As defined by Andrade [32], purposive sampling involves selecting individuals who possess specific characteristics aligned with the research aims. A total of 30 form four students, who were transitioning to form five, participated in the study during a school holiday enrichment program. Although taxation is part of the form five syllabus, form four students were selected to avoid disrupting the academic preparation of form five students for the SPM, the national public-school examination taken by form five students in Malaysia. The topic was introduced earlier as a preparatory initiative, and instruction was delivered using the SmartTax (CukaiPintar) application as the core teaching tool.

2.3.2. Instrument

The TAM was employed as the underlying framework for evaluating user acceptance. A structured questionnaire was adapted from Qashou [24], originally developed for measuring M-learning adoption in higher education. To ensure contextual relevance, the term "M-learning" was replaced with "SmartTax (CukaiPintar)" throughout the instrument.

The questionnaire measured six key constructs, including PEOU, PU, PE, self-efficacy (SE), attitude toward use (ATU), and BI. It used a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument consisted of two sections, including the first, which captured demographic

data such as gender, age, and prior mobile usage; the second focused on statements related to students' perceptions and acceptance of the application.

2.3.3. Data analysis

The quantitative data obtained in this phase were analyzed using SPSS version 27.0. The analysis began with a normality test using the Shapiro-Wilk method, which indicated that the data were not normally distributed. Consequently, Spearman's rho correlation was employed to examine the relationships among the constructs of the TAM and to assess the level of user acceptance of the SmartTax (CukaiPintar) application.

3. RESULTS AND DISCUSSION

3.1. Expert validation (findings for RQ 1)

Although previous studies have highlighted the importance of instructional clarity and usability in educational applications, there is limited research focusing specifically on expert validation for mobile applications that teach taxation within the Malaysian secondary school context. This study addresses that gap by employing the FDM to gather expert consensus in the design and development of the SmartTax (CukaiPintar) application. This method was selected with the aim of ensuring that the features aligned with effective education practices for students. The design principles, which addressed secondary school students' needs, were intended to make the application pedagogically useful and effective in the learning process.

This section presents the findings addressing the first research question (RQ1): What design features of the SmartTax (CukaiPintar) application are validated by experts using FDM? The expert validation process was conducted using the FDM, involving ten experienced mathematics educators who assessed both media and instructional content features of the application.

A total of ten expert mathematics educators, including heads of mathematics panels and experienced workshop facilitators (with teaching experience ranging from 10 to 27 years), participated in this validation. These experts evaluated two main dimensions of the application, which are media validation and material validation, focusing on aspects such as instructional clarity, relevance, usability, and alignment with learning goals.

For media validation, the use of clear sentences emerged as the highest-rated element (fuzzy score = 0.947, $d = 0.049$, 100% agreement), followed by the use of communicative language and easily understandable sentences, both scoring 0.937 ($d = 0.064$). Clarity of instruction and practicality of instructional videos also received a fuzzy score of 0.937, indicating strong expert consensus on the importance of simple, structured, and engaging content. Elements such as appealing media illustrations (0.893) and animations (0.867) were accepted but ranked lower in importance, suggesting that while visual appeal adds value, clarity and usability are prioritized.

For material validation, logical organization of content was ranked the most critical factor (fuzzy score = 0.957, $d = 0.027$, 100% agreement), followed by alignment with learning objectives, clarity of examples, and ease of understanding (all scoring 0.947). Other aspects, such as spelling and grammatical accuracy, scored 0.937, while coverage of material (0.870) and correspondence to competencies (0.900) were rated slightly lower, indicating areas for potential content expansion.

These results align with validated instructional design principles for mobile learning outlined by Bamberg and Möser [21], which emphasize clarity, communicative simplicity, and structured design over visual aesthetics. While earlier frameworks often highlighted gamification or multimedia appeal, this study confirms that expert educators in mathematics prioritize pedagogical effectiveness and direct curriculum alignment over purely aesthetic features.

A potential limitation of this phase is the exclusive involvement of mathematics educators, which may restrict the generalizability of the findings to other subjects or educational levels. Additionally, while the FDM is effective for reaching expert consensus, it does not capture real-time student interaction or long-term learning outcomes.

The findings offer valuable guidance for future instructional design, particularly in STEM-focused educational applications. It is recommended that future validation efforts include curriculum designers and education technologists to provide a broader perspective. Additionally, real-time classroom-based evaluations could help measure the actual impact of validated instructional features on student performance and engagement.

To ensure that the results met the FDM validity criteria, the threshold value (d) obtained had to be equal to or less than 0.2 [33]. Additionally, for expert consensus to be considered valid, the agreement percentage needed to exceed 75% [34], [35]. In this study, all evaluated elements met these conditions, with expert agreement percentages consistently reaching or exceeding 90%, confirming strong consensus among the panel.

In summary, the FDM results confirmed strong expert consensus on the instructional quality, organization, and usability of the SmartTax (CukaiPintar) application. All evaluated elements surpassed the required validity thresholds ($d \leq 0.2$, agreement $\geq 75\%$) and fuzzy alpha-cut values (≥ 0.5), affirming their inclusion in the application. The validated features were subsequently integrated into the final version of the application, ensuring that it meets pedagogical standards while remaining accessible and engaging for secondary school learners studying taxation.

Tables 2 and 3 present the results of the FDM for both media and material validation, summarizing expert agreement on key instructional elements. As previously mentioned, the media validation and material validation criteria were adapted from Ramadani *et al.* [25], which outlined validated instructional design elements for mobile learning applications. These elements, initially developed for teaching informatics, were reviewed and refined by experts to suit the context of secondary school mathematics education in this study.

Table 2. FDM results for media validation

Element	Threshold value, d	Percentage of expert agreement	Fuzzy score (A)	Expert consensus	Ranking
Use of clear sentences	0.049	100%	0.947	ACCEPT	1
Use of communicative language	0.064	100%	0.937	ACCEPT	2
Use of easily understandable sentences	0.064	100%	0.937	ACCEPT	3
Clarity of instruction	0.064	100%	0.937	ACCEPT	3
Practicality of instructional video	0.064	100%	0.937	ACCEPT	3
Relevance of materials used for learning media	0.073	100%	0.927	ACCEPT	6
Ease of understanding media	0.073	100%	0.927	ACCEPT	6
Clarity of materials	0.073	100%	0.927	ACCEPT	6
Clarity of examples	0.073	100%	0.927	ACCEPT	6
Engaging presentation of materials	0.103	90%	0.910	ACCEPT	10
Appealing media illustrations	0.132	100%	0.893	ACCEPT	11
Appealing animations	0.155	100%	0.867	ACCEPT	12

Table 3. FDM results for material validation

Item/element	Threshold Value, d	Percentage of expert agreement	Fuzzy score (A)	Expert consensus
Material is logically organized	0.027	100%	0.957	ACCEPT
Material aligns with learning objectives	0.049	100%	0.947	ACCEPT
Material is easily understood	0.049	100%	0.947	ACCEPT
Examples included in media are appropriate to the content	0.049	100%	0.947	ACCEPT
Spelling accuracy	0.064	100%	0.937	ACCEPT
Grammatical accuracy	0.064	100%	0.937	ACCEPT
Intellectual appropriateness of students	0.073	100%	0.927	ACCEPT
The explanation of material on media is appropriate and clear	0.076	100%	0.917	ACCEPT
Material corresponds to competencies	0.101	100%	0.900	ACCEPT
Extent of material coverage presented	0.065	100%	0.870	ACCEPT

The FDM results were instrumental in refining the SmartTax (CukaiPintar) application by identifying key instructional components based on expert consensus. The ranked defuzzification process was essential to confirm the level of agreement on each component's importance, with all elements meeting the required alpha-cut value (≥ 0.5), thus confirming their acceptance [36]. These validated components were subsequently integrated into the final design to enhance pedagogical effectiveness and user engagement.

3.2. Usability evaluation (findings for RQ2)

This section addresses the second research question (RQ2): How do TAM constructs influence students' acceptance and intention to use the SmartTax (CukaiPintar) application? The analysis focuses on students' perceptions based on key TAM variables, gathered through a structured usability questionnaire.

The usability evaluation phase aimed to assess students' acceptance and user experience when interacting with the SmartTax (CukaiPintar) application. This phase focused on evaluating key factors such as PEOU, PU, PE, perceived mobility (PM), PSE, AT, and BI towards using the application as a mobile learning tool.

A structured questionnaire was distributed to 30 Form 4 students transitioning to Form 5, who participated in a tax education session using the SmartTax (CukaiPintar) application. The research instrument, adapted from existing M-learning adoption studies [24], employed a 5-point Likert scale to measure user perceptions of the application's usability and engagement.

3.2.1. Respondent demographics

This subsection presents the demographic characteristics of the respondents involved in the usability evaluation of the SmartTax (CukaiPintar) application. The analysis includes gender distribution, levels of mobile device capability, and mobile usage experience. Table 4 presents the demographic profile of the respondents, including gender, mobile device capability, and usage levels. The data show that 60% of participants were female, and none rated themselves at a low capability level. Most rated their skills as good (53.3%) or high (46.7%), while 70% reported medium usage levels and 30% reported advanced use. All respondents had prior mobile experience, suggesting high digital literacy and minimal technological barriers in interacting with SmartTax (CukaiPintar). These demographic characteristics are crucial as they ensure that the usability evaluation reflects the experiences of students who are already accustomed to mobile learning environments. This strengthens the validity of the findings, as the participants' existing digital fluency allowed them to focus on the application's instructional quality rather than struggling with basic technical navigation.

Table 4. Demographic profile of respondents

No	Statement	Demographic	Percentage (N)
1	Gender	Male	40.0% (12)
		Female	60.0% (18)
		Low level	0%
2	Mobile device capability levels	Good level	53.3% (16)
		High level	46.7% (14)
		Beginner	0%
3	Mobile device usage levels	Medium	70.0% (21)
		Advanced	30.0% (9)

3.2.2. Normality test and justification for non-parametric analysis

In this study, the normality test indicated that the data did not follow a normal distribution. This aligns with the findings of Matore and Khairani [37], who emphasized that expectations of normality do not always correspond to real-world population data. With smaller samples, the distribution often differs from normality, unlike larger groups or samples where bell-shaped distributions are more common to see. In most statistical analyses, normality is often assumed without any evidence, and this assumption underpins the validity of the results. If these assumptions are invalid, the resulting analyses may not be reliable or meaningful. Similarly, Fah and Hoon [38] pointed out that checking data distribution is crucial at the stage of selecting statistical tests, as failing to do so may lead to incorrect conclusions. Given these considerations, the Shapiro-Wilk and Kolmogorov-Smirnov tests were conducted to assess normality, with the results presented in Table 5. The findings further established that some key variables, such as AT and BI, were far away from a normal distribution.

Table 5. Tests of normality

	Shapiro-Wilk		Skewness		Kurtosis	
	df	Sig.	Statistic	Std. error	Statistic	Std. error
PEOU	30	0.000	-1.205	0.427	0.570	.833
PU	30	0.001	-.631	0.427	-0.699	.833
PSE	30	0.002	-.239	0.427	-1.268	.833
PM	30	0.001	-.979	0.427	0.404	.833
PE	30	0.000	-.988	0.427	0.075	.833
AT	30	0.000	-1.869	0.427	3.723	.833
BI	30	0.000	-2.906	0.427	10.017	.833

The Shapiro-Wilk test yielded significant values ($p < 0.05$) across all constructs, confirming deviation from normality. There are some sets of skewness and kurtosis values that are considered normal by researchers, such as ± 1.0 [39] and a value of ± 2.0 [40], [41]. According to Kline [42], values above three for skewness are considered extreme by some researchers. For kurtosis values, values greater than 10 are problematic and become more serious when they exceed 20. In this study, BI recorded a skewness of -2.906 and a kurtosis of 10.017, exceeding these thresholds, indicating a significant deviation from normality. Considering the combined evidence from statistical tests and distribution characteristics, the use of non-parametric methods like Spearman's correlation is deemed appropriate for further analysis.

3.2.3. Correlational research framework

To explore relationships among the usability constructs, this study employed Spearman's rho correlation due to the non-normal distribution of several variables. The analysis focused on key constructs, including how PEOU, PE, and PMV influence students' AT, and how attitude correlates with BI to continue using SmartTax (CukaiPintar). Correlational research, also known as associational research, examines the strength and direction of relationships between variables without manipulation [43]. It is a widely used method in educational research for hypothesis generation, theory development, and guiding interventions [44]. In this context, the study aimed to determine significant relationships between constructs such as PU, PE, PEOU, PMV, PSE, AT, and BI, consistent with the research framework and proposed hypotheses.

In this analysis, the interpretation of correlation coefficients served as a reference for evaluating the strength of relationships between the study's key variables [45]. These include PEOU, PM, PSE, and PE with AT, and PU with intention to act BI.

To interpret the results, the correlation coefficients were analyzed using the classification scale adapted from Salkind [46], as shown in Table 6. This scale helps determine the strength of association, ranging from weak (0.0 to 0.2) to very strong (0.8 to 1.0), thus guiding interpretation of students' acceptance and interaction with the application.

Table 6. Correlation table, adopted from Salkind [46]

Size of the correlation	Coefficient interpretation
0.8 to 1.0	Very strong relationship
0.6 to 0.8	Strong relationship
0.4 to 0.6	Moderate relationship
0.2 to 0.4	Weak relationship
0.0 to 0.2	Weak or no relationship

3.2.4. Spearman's Rho correlation results

The summary of Spearman's rho correlation results is presented in Table 7, showing the strength and direction of the relationships between the TAM variables.

Table 7. Spearman's rho correlation analysis

Hypothesis	Variables	Correlation coefficient (ρ)	p-value	N	Interpretation
H1	PEOU $\rightarrow$ PU	0.594**	< 0.001	30	Moderate positive
H2	PEOU $\rightarrow$ AT	0.496**	0.005	30	Moderate positive
H3	PU $\rightarrow$ AT	0.600**	< 0.001	30	Strong positive
H4	PU $\rightarrow$ BI	0.379*	0.039	30	Weak positive
H5	AT $\rightarrow$ BI	0.653**	< 0.001	30	Strong positive
H6	PSE $\rightarrow$ PEOU	0.465**	0.010	30	Moderate positive
H7	PSE $\rightarrow$ AT	0.546**	0.002	30	Moderate positive
H8	PMV $\rightarrow$ PU	0.634**	< 0.001	30	Strong positive
H9	PE $\rightarrow$ PEOU	0.494**	0.005	30	Moderate positive

Notes:

- ρ (Spearman's correlation coefficient) indicates the strength and direction of the relationship.
- p-value shows the statistical significance (* $p < 0.05$, ** $p < 0.01$).
- N represents the number of respondents.

Interpretation follows [46] guidelines.

The Spearman's rho correlation analysis revealed significant relationships among key constructs in the research framework, including PEOU, PU, PE, PM, PSE, AT, and BI toward using SmartTax (CukaiPintar). A moderate positive correlation was found between PEOU and PU ($\rho = 0.594$, $p < 0.001$), indicating that students who found the application easy to use also found it useful. Similarly, PEOU was moderately correlated with AT ($\rho = 0.496$, $p = 0.005$), suggesting that usability positively influenced students' attitudes, supporting findings from prior studies on mobile learning acceptance.

PU also showed a strong correlation with AT ($\rho = 0.600$, $p < 0.001$), reinforcing that perceived benefits influence positive attitudes. However, PU and BI had a weaker yet significant correlation ($\rho = 0.379$, $p = 0.039$), indicating that usefulness alone may not fully drive intention to use, and other constructs may play a role.

AT demonstrated a strong positive correlation with BI ($\rho = 0.653$, $p < 0.001$), underscoring the role of attitude as a key mediator in technology adoption. In terms of external factors, PSE was moderately correlated with both PEOU ($\rho = 0.465$, $p = 0.010$) and AT ($\rho = 0.546$, $p = 0.002$), suggesting that confidence

in using mobile tools supports positive perceptions and attitudes. PMV also had a strong correlation with PU ($\rho = 0.634$, $p < 0.001$), while PE moderately influenced PEOU ($\rho = 0.494$, $p = 0.005$), highlighting that enjoyment enhances perceived usability.

Overall, the findings support most of the study's hypotheses, demonstrating that PEOU, PU, PE, PSE, and PMV significantly influence student attitudes and BI. Notably, AT emerged as a stronger predictor of BI than PU, consistent with previous TAM-based studies. These results emphasize the importance of developing educational applications that are intuitive, motivating, and accessible to sustain long-term usage. Future research should explore additional factors, such as system interactivity, instructional design, and external motivators, to further enhance student engagement and intention.

4. CONCLUSION

The objective of the study was to identify the factors that affect the intention of students to use SmartTax (CukaiPintar), an interactive application for taxation learning. The methodology was based on the TAM, where PEOU, PU, PE, PM, and PSE were considered in relation to AT and BI. Moreover, the FDM phase 2 was used to improve the core instructional design elements of SmartTax (CukaiPintar). FDM analysis involved experts to coordinate interactivity, content relevance, and pedagogic usability to ensure the application's integration with students' learning. These results showed that simple language, interactive videos, and structured content can significantly promote students' tax literacy. These components, validated by experts, were adopted in the final version of SmartTax (CukaiPintar), enhancing its effectiveness and teaching efficiency.

The results demonstrate that factors such as PEOU, PU, PE, PMV, and PSE play major roles in influencing students' attitudes towards SmartTax (CukaiPintar), which affects their BI. AT and BI are highly correlated, suggesting that students had good experiences, engagement, and perceived value, which are central to the adoption of educational technologies. The inclusion of FDM in phase 2 adds expert validation to the development of the digital learning, ensuring that the tools created are pedagogically appropriate and user-friendly. This study addresses key concerns in mobile learning, educational technology, and tax education by combining quantitative user perceptions (TAM-based analysis) and expert-driven validation of the DDBE model (FDM-based analysis). This approach enhances the validity of the results and creates a model that enables the development of interactive educational applications.

Despite its contributions, the study has several limitations. The sample size was relatively small, limiting generalizability. Expanding the study to include a larger and more diverse student population across different educational institutions would enhance the robustness of the findings. Also, external factors such as social influence, gamification, and instructional design were not included in the model, which could provide deeper insights into students' motivation and engagement in mobile learning. Future studies could explore the integration of AI-driven personalized learning, adaptive feedback mechanisms, or gamified tax learning experiences to further enhance student engagement. The results have important implications for educators, policymakers, and developers of educational applications. The positive impact of PEOU and PU on students' attitudes suggests that intuitive design and practical application of tax-related knowledge are essential in fostering effective digital learning. Developers should prioritize interactive content, real-world problem-solving exercises, and step-by-step guidance to enhance students' comprehension. Additionally, incorporating self-efficacy-enhancing features, such as guided tutorials and interactive assessments, may further improve students' confidence in using taxation applications.

Moreover, the integration of FDM as a validation method demonstrates the importance of expert-driven feedback in educational technology development. Policymakers and curriculum designers should leverage expert consensus techniques like FDM when developing interactive learning tools, ensuring alignment with educational objectives and student needs. In summary, the SmartTax (CukaiPintar) application represents a positive step towards addressing challenges in learning taxation by providing an engaging learning experience through the use of modern technology. The integration of the analysis of user attitudes TAM and expert evaluation FDM has generated a solid strategy for creating and assessing digital learning tools. To maintain the effectiveness and impact of the application over time, it will be essential to continue refining and expanding the application based on feedback from learners, experts, and ongoing advancements in educational technologies.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : Conceptualization	I : Investigation	Vi : Visualization
M : Methodology	R : Resources	Su : Supervision
So : Software	D : Data Curation	P : Project administration
Va : Validation	O : Writing - Original Draft	Fu : Funding acquisition
Fo : Formal analysis	E : Writing - Review & Editing	

CONFLICT OF INTEREST STATEMENT

The authors declare that there are no financial, professional, or personal conflicts of interest that could have influenced the outcomes or interpretation of this research.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

This research was conducted in alignment with core ethical standards, encompassing informed consent, voluntary participation, and strict confidentiality of participant data [47], [48]. Prior to data collection, all student participants were clearly briefed on the study’s objectives, and verbal consent was obtained with their understanding and agreement. During their interaction with the SmartTax (CukaiPintar) application, guidance from researchers or teachers was provided only when requested to ensure student responses remained unbiased.

As the participants were 16-year-old secondary school students, particular attention was paid to the clarity and suitability of instructions and questionnaire items. No personal identifiers were collected at any stage of the study. All data were kept anonymous and stored securely in password-protected digital files, with access restricted to the research team. This study complied with research ethics practices applicable to postgraduate academic research at the National University of Malaysia.

DATA AVAILABILITY

The datasets generated and analyzed during this study are not publicly available due to privacy considerations but are available from the corresponding author upon reasonable request.

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