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**Research Article**

# Exploring in-service preschool teachers' acceptance of mobile learning in science teaching practice

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## ABSTRACT

In the sphere of preschool and elementary education, new interactive technologies built on intelligent mobile devices and auxiliary applications have drawn increasing attention. Based on the UTAUT2 (The expanding of the unified theory of acceptance and use of technology) theoretical model, the purpose of this study is to understand the situation of pre-school preschool teachers' willingness to use mobile learning. This study conducted a survey on 329 in-service preschool teachers in 9 cities in Fujian Province, China, and conducted data analysis through statistical analysis software SPSS (Statistical Product and Service Solutions) 22.0 and AMOS (Analyze of Moment Structures) 22.0, verifying the UTAUT2 model in Effectiveness in understanding in-service early childhood teachers' intention to move to learn. The results of structural equation modeling show that the proposed model has acceptable fitting data. The results of the study show that in-service preschool teachers have the willingness to actively accept mobile learning. Among many influencing factors, performance expectancy, effort expectancy, social influence, facilitating conditions, learning value, habit have significantly impact on behavioral intention to accept mobile learning. In addition, hedonic motivation did not support to affect behavioral intention and habit to affect use behavior. The study has important implications for researchers, educators, policy makers and mobile learning app designers.

***Keywords:*** in-service preschool teachers; behavioral intention; mobile learning; UTAUT2

## 1. Introduction

Technology has become a popular topic of conversation among educators and decision-makers in the field of education[1,2]. In the sphere of preschool and elementary education, new interactive technologies built on intelligent mobile devices and auxiliary applications have drawn increasing attention[3]. Mobile learning is a consequence of increasing information and communication technology development, which affect the learning environment[4]. It refers to the learning process enabled, empowered, and enhanced by mobile devices with convenient access to suitable supporting materials; learners may enjoy a highly portable and truly personalized experience of learning[5]. Mobile devices are positioned as a significant instrument for learning new ways of educational practice, with technical tools increasingly displacing traditional teaching techniques and strategies[6]. Students now have the option to participate in the continuous learning process using any device, at any time, and from any location thanks to mobile learning, which has established a learning-oriented

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methodology[7].

Nowadays, children were born in the digital age, have interacted with digital technology since childhood, and grew up with the intervention of the Internet, mobile devices and social networks[8,9]. Their daily activities are conducted on computers, mobile phones, and other associated gadgets since technology permeates every aspect of their existence[10], surrounded by technology[11]. It is a reality that technology can be included into children's education, depending on their age, developmental stage, personal interests and aspirations, social context, and culture. Mobile learning, on the other hand, enables teachers to mix different approaches and learning techniques in accordance with the traits and requirements of each student[12]. As a result, current teachers must be aware of these requirements, fully comprehend how to use novel technologies for teaching purposes or have a distinct teaching perspective on the use of these technologies in classroom activities, and be able to use the most recent technology to develop novel teaching methods to meet the specific learning needs of the next generation[13].

Early childhood is a time when kids observe facts and happenings, look for explanations, and build a base of knowledge and skills for grasping fundamental scientific concepts. Some researchers noted that investigating teachers' attitudes and beliefs can influence their practice, how well any technology is used in the classroom, and how well children understand the value of technology[14]. When concerning preschool students, their first interaction will start with the teacher instead of the websites[15]. There is evidence that using technology in the classroom directly improves the delivery of the natural sciences since it exposes teachers and students to novel concepts that they cannot observe directly[11]. It can be seen that in order to give educational administration references, we need investigate teachers' attitudes and acceptance of mobile learning. However, it is not clear whether in-service kindergarten teachers intend to apply mobile learning to their science teaching practice. In most cases, kindergarten teachers have not intended to incorporate different types of technology into their classroom practice[16,17]. Early childhood educators in China are likewise not nearly ready to fully integrate digital technologies into their classrooms[18]. Due to the bias of teachers' concepts, it is difficult to popularize AI educational technology[19], and the relative lack of teachers' use of information technology, which adversely affects young children's experiential learning in science[20]. Additionally, scientific literature on ICT (Information and Communications Technology) in education demonstrates that teachers frequently encounter obstacles while integrating ICT into the classroom[21]. Therefore, it is crucial to comprehend the factors that affect in-service preschool teachers' intention to accept and use mobile technology.

To explain the willingness of in-service early childhood teachers to adopt and use mobile learning in their science teaching practices, variables from the UTAUT2 model were included in this study and their influences were investigated. UTAUT2 is a complete and dynamic theoretical framework that may take into consideration cultural, social, technological, and other relevant behavioural variables, making it more useful for comprehending the phenomena under study. For instance, Nikolopoulou et al.[22] evaluated college students' behaviour intentions to accept and use mobile phones in their studies using the UTAUT2 model In order to investigate the configuration elements that influence instructors' intention to use the mobile Internet in the educational process, Nikolopoulou et al.[22] adopted the UTAUT2 model and expanded it to technical teaching knowledge (perceived self-efficacy) factors[23]. These theories emphasize technology users' psychological and behavioural viewpoints[24]. Therefore, this research seeks to answer the following research questions:

1: What the willingness there are currently in-service kindergarten teachers to adopt and use mobile learning in the teaching practice of science education?

2: What factors influence in-service kindergarten teachers' willingness to adopt and use mobile learning in the practical teaching of science education?

3: What guidance and assistance does the research's conclusion offer kindergarten administrators or teachers?

# 2. Literature review

## 2.1. Overview of previous research

### 2.1.1. Mobile learning

Mobile learning began in the 1970s and spread widely in the early 21st century. Chao defined m-learning as a learning process conducted across various contexts (location, time, and other environmental factors) where learners can benefit from access to learning materials through smart mobile devices such as smartphones and tablet computers[25]. Goksu[26] defined mobile learning as a form of learning that enables individuals to gain experience through personal or collaborative learning through digital interactive activities using portable devices. Goksu[26] pointed out that mobile learning has many advantages such as flexibility in space and time, easy access to information, and convenient use. Mobile learning technology included hardware such as mobile phones, handheld computers, tablets, and other mobile devices that can run mobile applications, including software[27]. Samad et al.[28] believed that mobile learning includes seven basic characteristics: mobility and spontaneity, mobile devices, blended learning, personalization, interaction, collaboration, and immediacy. However, mobile learning has limitations[29]. As Kumar and Chand[30] point out, m-learning can lead to heavy reliance on online platforms and create a sense of isolation between students and teachers.

### 2.1.2. Mobile learning for early childhood science education

Science is a systematic thinking process, which is based on existing theories, laws and facts, and is a process of transferring knowledge to solve existing problems[31]. Ravanis[32] believed that, as a unique research field, early childhood science education research mainly focused on the study of 4–8 years old children's understanding of the nature of materials and objects, as well as the mechanisms of natural science phenomena and concepts. Education and classroom instruction have undergone significant modifications as a result of the growth of e-learning[33], and mobile learning has been introduced in the field of early childhood education. However, researchers primarily concentrate on the development and application of mobile devices in early childhood education. As an actual teaching case, Australian kindergarten STEM (Science, Technology, Engineering and Mathmatics) provided game-based applications for learning related subjects, and developed online seminars, online courses and online games. Idris and Razak[34] designed a suitable mobile learning application prototype for preschoolers aged 5–6 to promote the early development of children.

### 2.1.3. Preschool teachers' acceptance of mobile learning

M-learning adoption is an active field investigated by scholars across different domains. Understanding the intention of early childhood teachers to use mobile learning is necessary because their intention can affect their classroom teaching practice. Haiyan and Ling[35] pointed out that teachers specializing in preschool education have a strong willingness to learn and a more positive attitude. Kara and Cagiltay[36] conducted semi-structured interviews with 18 in-service preschool teachers to understand in-service preschool teachers' thoughts on technology and its use in early education settings. Nikolopoulou[14] affirmed the importance of preschool teachers' skills and beliefs in effectively integrating technology and believed that future preschool teachers should use technology in a responsible and developmentally appropriate manner for children. In addition, several researchers have cited the unified theory of technology acceptance and use in order to explore the factors that influence early childhood teachers' behavior. For example, based on the Integrated Technology Adoption and Use Model (UTAUT), Li et al.[37] investigated and analyzed preschool teachers' acceptance of information-based teaching from four dimensions: performance expectations, effort expectations, social influence and convenience conditions of preschool teachers' information-based teaching activities. With regard to the attitudes and factors influencing the adoption of science and technology by preschool teachers, Doğan and Simsar[38] used a case study approach to reveal early childhood teachers' views on science education, science education methods, science activities, and the problems they face, and the results showed that the majority of early childhood teachers believe they are competent to teach science. Kalogiannakis and Papadakis investigated the willingness of pre-service kindergarten teachers to use mobile devices for activities in the field of natural sciences using the use dimension of the TAM model[16]. Islamoglu et al.[39] explored pre-service teachers' acceptance of mobile technology-supported learning activities based on a combination of TAMA and UTAUT models. These studies have integrated the research into various teaching fields of preschool education, explored the influencing factors of different groups of preschool teachers' acceptance of technology from various angles, and shown the early childhood teachers' preferred position on the use of m-learning in teaching and learning.

### 2.2. Theoretical framework

#### 2.2.1. The unified theory of acceptance and use of technology

Mobile learning technology acceptance and adoption became an active research field[40]. In the area of mobile learning and technology, the unified theory of technology acceptance and use (UTAUT model) has gained credibility[41]. In 2003, Venkatesh and Morris et al. proposed the UTAUT model, which was integrated to provide a further complete view of the technology acceptance process[42,43]. Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions were employed by Venkatesh et al. as the four main factors of technological willingness to validate UTAUT[43]. The developers confirmed UTAUT's significant improvement in interpreting information technology use behavior, and encouraged other researchers to use different technologies, environments, and user verification and testing models[22].

UTAUT-2 (the expanding of the unified theory of acceptance and use of technology) was proposed and tested by Venkatesh et al. in 2012 in order to account for the key variables of the consumer technology usage environment. Hedonic Motivation (HM), Price Value (PV) and Habit (HT) were merged into the original UTAUT. In addition, behavioral intention (BI) is a mediating variable, and use behavior is a dependent variable; in the UTAUT2 model, individual differences (age, gender, and experience) adjust the impact of these structures on BI and technology use[44]. The Extended Unified Theory of Technology Acceptance and Use (UTAUT2) was established less than 10 years ago and has received more than 6000 citations in information systems and other fields[45].

#### 2.2.2. Proposed model and hypotheses

UTAUT-2 is the theoretical framework used in this research. However, without introducing some modifications, UTAUT2 cannot adequately explain the acceptance of the adoption and usage of mobile learning by in-service preschool teachers in scientific education practice. Therefore, this study provides a research hypothesis on the Behavioural Intention (BI) and Use Behavioural (UB) mobile learning of in-service early childhood instructors based on the model architecture of UTAUT2. To support this hypothesis and the study's goals, influencing factors like Performance Expectations (PE), Effort Expectations (EE), Facilitating Conditions (FC), Social Influence (SI), Hedonic Motivation (HM), Learning Values (LV), and Habits (HT) were considered.

Performance expectancy:

Performance expectancy, as an element of UTAUT2, reflects the perceived utility of users using mobile learning[44]. In early childhood science education, mobile learning realizes the function of obtaining information or services anytime and anywhere, liberating learners from the constraints of time and space, which can improve learners' learning efficiency and obtain good teaching effects. As a result, performance expectations will have an impact on user satisfaction. Kindergarten teachers may continue to use mobile learning if they develop positive expectations about its value.

H1. Performance expectation influences the behavioral intention of in-service preschool teachers to adopt and use mobile learning.

Effort expectancy:

UTAUT2 takes effort anticipation as an element, reflecting the perceived difficulty of users using mobile learning[44]. This implies that a relationship exists between the generation of a behavioural intention and the actual difficulty of the thing itself. It is simple for a user to give up at the beginning if the new thing is challenging to master and operate. Teachers may be more inclined to pick the conventional teaching method and abandon the growing teaching technology, especially when there is a conflict between relearning information technology and heavy teaching tasks. Hard expectations will therefore have an impact on user satisfaction.

H2. Effort expectancy influences the behavioral intention of in-service preschool teachers to adopt and use mobile learning.

Social influence:

Social influence refers to how mobile learning users affect the feelings, thoughts, and behaviours of certain individuals or groups in their social environment. It also refers to how much trust individuals or groups expect from the usage of particular technologies, which influences whether or not they are willing to use mobile learning[39,46]. As an element of UTAUT2, social influence reflects the influence of group opinions on individual user behavior[44]. People are naturally influenced by those around them because they live in a social context. This influence includes the views and attitudes of those around you. Therefore, when other people who are important to in-service preschool teachers recommend him or her to use the mobile learning, he or she may follow their suggestions.

H3. Social influence influences the behavioral intention of in-service preschool teachers to adopt and use mobile learning.

Facilitating conditions:

UTAUT2 takes convenience as an element, which means that users have the resources and platforms needed to use mobile learning[44], or the user's perception of the level of support offered by the organization[47]. For in-service preschool teachers, the first thing they need to bear is the cost of using the mobile Internet and downloading resources, such as communication fees and service fees. Secondly, they also need to have the necessary knowledge and skills to operate the mobile Internet, which is an emerging technology.

H4. Facilitating conditions influence the behavioral intention of in-service preschool teachers to adopt and use mobile learning.

H5. Facilitating conditions influence the use of mobile learning by in-service preschool teachers.

Hedonic motivation:

In the context of mobile learning acceptance-usage, hedonic motivation is conceptualized as perceived enjoyment[44]. It represents the enthusiastic, playful and joyful attitude given by the use of mobile devices in an educational context. In-service preschool teachers will accept and continue to use mobile learning if they enjoy using it[48]. Hedonic motivation is a key determinant of behavioral intent[49]. They might stop using mobile learning content if they can't have fun with it due to a bad experience.

H6. Hedonic motivation influences the behavioral intention of in-service preschool teachers to adopt and use mobile learning.

Learning value:

The original purpose of Venkatesh et al.'s usage of the idea of price value in UTAUT2 was to take into account the monetary costs and advantages of consumer technology use[44]. It implies that a consumer's willingness to pay for the cost of a technology depends on how favorably they see its advantages[50]. From the perspective of a teacher, value is determined by the substance of the acquired teaching tools. To close the difference, learning value (LV) was substituted for pricing value[51]. LV represents the output, the achieved goals and the final utility of the learning process obtained through the m-learning system[48].

H7. Learning value influences the behavioral intention of in-service preschool teachers to adopt and use mobile learning.

Habit:

A habit is the tendency to use a technology automatically as a result of learned behavior[44]. In addition, Venkatesh et al. described habits as having a direct effect on usage as well as an indirect effect through behavioral intent[44,49]. For the purpose of this study, habit is defined as the propensity of in-service preschool teachers to actively use mobile learning into their teaching practices in science education.

H8. Habit influences the behavioral intention of in-service preschool teachers to adopt and use mobile learning.

H9. Habit influences the use behavior of mobile learning by in-service preschool teachers.

Behavioral intention:

According to several intention models, behavioural intention has a significant role in predicting actual technology use. Venkatesh et al.[43] suggest that behavioral intention to use a given technology has significant influence on usage behavior. Individual's intention to use a particular technology for different tasks is explained as behavioral intention[50]. In order to assess how well in-service preschool teachers have incorporated mobile learning into their practice, this study uses behavioural intention as the dependent variable.

Use behavior:

It is the result of the influence of various factors. Use behavior may not be the result of deliberated cognitions and are simply routinized or automatic responses[44]. Venkatesh et al.[44] have measured the use by the different types of uses of mobile internet.

H10. Behavioral intention to use mobile learning influences the use behavior of mobile learning by in-service preschool teachers.

In view of the above-mentioned, **Figure 1** illustrates the proposed conceptual model.

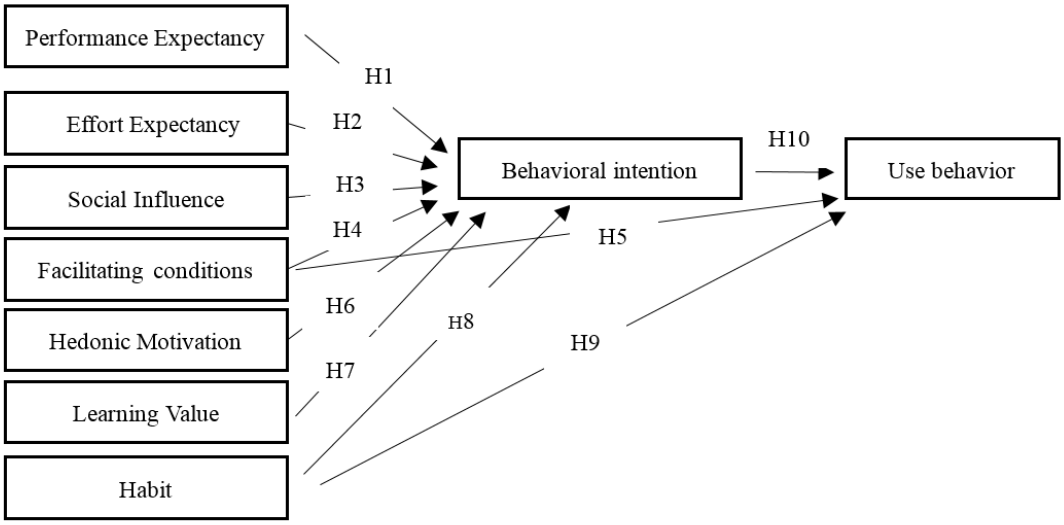


**Figure 1.** Proposed model.

# 3. Research methodology

## 3.1. Instrument development

The overall content of the questionnaire was divided into two parts. The first part was the demographic information of the respondents, including age, gender, and teaching experience. The second part was the test items of the questionnaire. The original items from UTAUT2 theoretical model of Venkatesh et al.[44] were modified and adapted to the mobile application framework to develop scales for behavioral intention (BI) and use behavior (UB)[10], performance expectancy (PE)[45], effort expectancy (EE), social impact (SI), facilitation conditions (FC), hedonic motivation (HM), learning value[7], habit (HA). At the same time, the compilation content of the questionnaire items is also referenced and expanded according to the scale prepared by Saud S. Alghazi et al.[52] and Ain[50], so as to increase the reliability and validity of the survey questions. To guarantee translation equivalence, we translated the English questionnaire into Chinese and then back into English. Professional translators check the correctness of the content and edit it as necessary.

We collected a total of 158 sample data for pilot test. The Cronbach's α of each construct should be ≥ 0.7[53]. The results of the pilot study showed that Cronbach's α ranged from 0.840 to 0.938, and the coefficients were all above 0.7, which reached the reliability test standard, indicating that the questionnaire items used in this study had good measurement reliability. In addition, the result of KMO and Bartlett's Test is 0.865 (greater than 0.7), the degree of freedom[40] is 435, $p < 0.05$ indicates that the hypothesis of independent variables is not valid, and the concentration of data measured by the questionnaire is good, which is suitable for factor analysis.

## 3.2. Sampling and data collections

In-service preschool teachers from nine administrative regions in Fujian Province were selected to participate in the survey, covering Fuzhou, Xiamen, Zhangzhou, Quanzhou, Putian, Longyan, Sanming, Nanping, and Ningde. The inclusion criteria for participants in this study (i.e., early childhood teachers) were that they were active early childhood teachers in their careers and that their kindergartens provided mobile devices, wireless communication technologies, and mobile learning platforms in science education to support teaching and learning. In addition, since the sample is composed of preschool teachers from different regions in Fujian Province, this study represents the overall situation of preschool teachers' willingness to accept mobile learning in Fujian Province. Data collection was mainly conducted through the distribution of online questionnaires. In-service early childhood teachers who participated in the survey participated in answering questions according to the links on the survey website. Subsequently, the study used SPSS 22.0 and Amos 22.0 to evaluate the collected data, and analyzed the results to detect whether the factors used would affect early childhood teachers' acceptance intention to use mobile learning.

The survey ultimately collected 346 online questionnaires. In order to ensure the quality of the recovered questionnaires, after careful analysis and checking, some invalid questionnaires were eliminated, such as questions. In order to ensure the quality of the collected questionnaires, we carefully analyzed and checked the questionnaires to eliminate some invalid questionnaires, such as those with the same answers for all options, those with multiple answers from the same IP, and those with too short or too long answers. Finally, 329 valid questionnaires were identified, with an efficiency rate of 95.09%. Hair et al.[54] noted that the sample size was 10–15 sample/item for applying structural equation modeling. The current sample size of 329 with ten constructs of 30 items was also considered to be fit and above (329 > 30 × 10 = 300) the desired level. Therefore, the sample size was considered to be appropriate.

# 4. Data analysis and results

In this study, SPSS 22.0 and AMOS 22.0 software were used for analysis. In the data analysis, the demographic information of the participants was first given. Second, confirmatory factor analysis (CFA) was used to assess the reliability, convergent validity, and discriminant validity of the measurement model, and third, a structural model was used to test the proposed hypotheses.

## 4.1. Participants' demographic profile

The background information of the participants was based on their gender, age, and teaching experience. The descriptive statistics are expressed in **Table 1**. Of the participants, 97.3% were female, and 2.7% were male. The age distribution was 2.7% for under 20 years old, 57.8% for 20–30 years old, 28.9% for 31–40 years old, 9.4% for 41–50 years old, and 1.2% were over 51 years of age. Among the participants, 22.8% of the participants had 1–2 years of teaching experience, 25.5% of the participants had 4 years of teaching experience, 25.5% of the participants had 5–7 years of teaching experience, and 21.6% had 8 years of experience.

**Table 1.** Demographic characteristics.

| Characteristic | Demographic | Frequency | Percent |
|---|---|---|---|
| Age | Under 20 | 9 | 2.7 |
| | 20–30 | 190 | 57.8 |
| | 31–40 | 95 | 28.9 |
| | 41–50 | 31 | 9.4 |
| | 51–60 | 4 | 1.2 |
| Gender | Female | 317 | 96.4 |
| | Male | 12 | 3.6 |
| Teaching experience | 1–2 | 75 | 22.8 |
| | 3 | 84 | 25.5 |
| | 4 | 84 | 25.5 |
| | 5–7 | 15 | 4.6 |
| | Over 8 | 71 | 21.6 |

## 4.2. Measurement model: Reliability and validity

According to the results, the mean values of all constructs were above the midpoint of 3.00 and ranged from 2.76 to 3.29, indicating that most participants responded more positively to the factors in the proposed study model. Tabachnick and Fidell[55] suggested that univariate skewness values should be < |2| and univariate kurtosis values should be < |4| to provide a normal distribution. The skewness and kurtosis results in this study were −0.302 to 0.163 and −0.538 to −1.794, respectively, suggesting that the construct exhibits a sufficiently normal distribution.

In the current study, the factor loadings (FL) were higher than 0.30, Cronbach α values were ranged from 0.765 to 0.877, CR values were ranged from 0.770 to 0.877 and finally, the values of Average Validity Extracted (AVE) of variables were ranged from 0.529 to 0.657 as seen in **Table 2**. According to Hair et al.[53], a variance greater than 0.5 is acceptable. Therefore, the convergent validity values for the research constructs are acceptable. In the literature, the minimum acceptable value for CA was suggested as 0.60[54].

The square root of AVE for each construct was greater than the correlation between the studied constructs, indicating that the instrument was considered acceptable in terms of discriminative validity. As shown in **Table 3**, for each construct, the square root of the AVE (shown on the bold value diagonal) exceeds the inter-construct correlation to provide sufficient discriminant validity to indicate an appropriate level.

**Table 2.** Descriptive statistics and measurement model: Reliability and validity.

| Construct | Items | Mean | SD | CA | Convergent validity | | | | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Std. | SMC | CR | AVE | | |
| PE | PE1 | 3.210 | 1.300 | 0.845 | 0.706 | 0.498 | 0.846 | 0.580 | −0.163 | −1.140 |
| | PE2 | 3.150 | 1.441 | - | 0.824 | - | - | - | 0.019 | −1.436 |
| | PE3 | 3.090 | 1.517 | - | 0.788 | - | - | - | −0.266 | −1.457 |
| | PE4 | 3.130 | 1.381 | - | 0.721 | - | - | - | −0.257 | −1.184 |
| EE | EE1 | 2.910 | 1.492 | 0.832 | 0.830 | 0.690 | 0.837 | 0.568 | −0.010 | −1.550 |
| | EE2 | 2.920 | 1.668 | - | 0.851 | - | - | - | 0.151 | −1.688 |
| | EE3 | 2.930 | 1.517 | - | 0.749 | - | - | - | −0.118 | −1.533 |
| | EE4 | 3.160 | 1.123 | - | 0.547 | - | - | - | −0.302 | −0.538 |
| SI | SI1 | 3.020 | 1.654 | 0.816 | 0.854 | 0.729 | 0.818 | 0.602 | 0.015 | −1.670 |
| | SI2 | 2.930 | 1.624 | - | 0.707 | - | - | - | 0.048 | −1.635 |
| | SI3 | 3.290 | 1.545 | - | 0.759 | - | - | - | −0.227 | −1.450 |
| FC | FC1 | 3.000 | 1.476 | 0.877 | 0.840 | 0.705 | 0.877 | 0.641 | 0.046 | −1.502 |
| | FC2 | 3.000 | 1.395 | - | 0.786 | - | - | - | −0.258 | −1.283 |
| | FC3 | 2.960 | 1.414 | - | 0.781 | - | - | - | −0.035 | −1.361 |
| | FC4 | 2.960 | 1.414 | - | 0.795 | - | - | - | −0.150 | −1.334 |
| HM | HM1 | 2.990 | 1.386 | 0.798 | 0.716 | 0.513 | 0.799 | 0.571 | 0.070 | −1.253 |
| | HM2 | 3.040 | 1.538 | - | 0.765 | - | - | - | −0.072 | −1.447 |
| | HM3 | 2.960 | 1.536 | - | 0.784 | - | - | - | 0.138 | −1.534 |
| LV | LV1 | 2.930 | 1.552 | 0.765 | 0.812 | 0.659 | 0.770 | 0.529 | −0.099 | −1.603 |
| | LV2 | 3.020 | 1.270 | - | 0.681 | - | - | - | 0.052 | −1.095 |
| | LV3 | 3.160 | 1.379 | - | 0.681 | - | - | - | 0.085 | −1.297 |

**Table 2.** (*Continued*).

| Construct | Items | Mean | SD | CA | Convergent validity | | | | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Std. | SMC | CR | AVE | | |
| HT | HT1 | 3.020 | 1.756 | 0.794 | 0.838 | 0.702 | 0.798 | 0.570 | −0.064 | −1.794 |
| | HT2 | 3.160 | 1.545 | - | 0.688 | - | - | - | −0.262 | −1.426 |
| | HT3 | 3.140 | 1.483 | - | 0.731 | - | - | - | −0.174 | −1.424 |
| BI | BI1 | 2.760 | 1.429 | 0.848 | 0.802 | 0.643 | 0.851 | 0.657 | 0.083 | −1.448 |
| | BI2 | 2.930 | 1.466 | - | 0.887 | - | - | - | −0.001 | −1.479 |
| | BI3 | 3.020 | 1.284 | - | 0.736 | - | - | - | 0.163 | −1.076 |
| UB | UB1 | 3.140 | 1.692 | 0.847 | 0.815 | 0.664 | 0.847 | 0.649 | −0.099 | −1.661 |
| | UB2 | 2.980 | 1.699 | - | 0.808 | - | - | - | 0.037 | −1.704 |
| | UB3 | 3.090 | 1.594 | - | 0.793 | - | - | - | −0.027 | −1.536 |

**Table 3.** Correlation matrix and square root of the AVE.

| Construct | UB | BI | HT | LV | HM | FC | SI | EE | PE |
|---|---|---|---|---|---|---|---|---|---|
| UB | **0.806** | - | - | - | - | - | - | - | - |
| BI | 0.478 | **0.811** | - | - | - | - | - | - | - |
| HT | 0.207 | 0.298 | **0.755** | - | - | - | - | - | - |
| LV | 0.252 | 0.282 | 0.146 | **0.727** | - | - | - | - | - |
| HM | 0.197 | 0.150 | 0.218 | 0.239 | **0.756** | - | - | - | - |
| FC | 0.467 | 0.451 | 0.188 | 0.137 | 0.182 | **0.801** | - | - | - |
| SI | 0.142 | 0.435 | 0.130 | 0.027 | 0.115 | 0.179 | **0.776** | - | - |
| EE | 0.153 | 0.294 | 0.225 | 0.098 | 0.092 | 0.125 | −0.070 | **0.754** | - |
| PE | 0.263 | 0.332 | 0.221 | 0.139 | 0.111 | 0.253 | 0.034 | 0.184 | **0.762** |

## 4.3. Structural model: Goodness of fit statistics, hypotheses test

Goodness of fit indices was examined with the following assessment criteria: the ratio of $\chi2$ to the degree of freedom ($\chi2$/df)[54], the Goodness of Fit Index (GFI)[56], the Incremental Fit Index[57,58] the Comparative Fit Index (CFI)[59], the Root Mean Square Error Approximation (RMSEA)[56], and the Adjusted Goodness of Fit Index (AGFI)[60]. SEM analysis revealed that goodness of fit statistics of theoretical framework represented a good fit ($\chi2$/df = 1.184, GFI = 0.911, AGFI = 0.895, IFI = 0.982, CFI = 0.982, RMSEA = 0.024). As presented in **Table 4**, all fit indices had estimated values within the recommended range, indicating a good fit from the measurement model.

**Table 4.** Fit structural model indices analysis.

| Fit indices | Recommended value | Estimated value |
|---|---|---|
| $\chi2$/df | 1~3 | 1.184 |
| GFI | > 0.80 | 0.911 |
| AGFI | > 0.80 | 0.895 |
| IFI | > 0.90 | 0.982 |
| CFI | > 0.90 | 0.982 |
| RMSEA | < 0.08 | 0.024 |

Assessment of the direct effects between the research constructs was performed, and the results were as follows: PE ($\beta$ = 0.197, $t$ = 3.516, $p$ < 0.001), EE ($\beta$ = 0.237, $t$ = 4.224, $p$ < 0.001), SI ($\beta$ = 0.407, $t$ =6.628, $p$ < 0.001), FC ($\beta$ = 0.314, $t$ =5.513, $p$ < 0.001) ($\beta$ = 0.316, $t$ =4.922, $p$ < 0.001), LV ($\beta$ = 0.208, $t$ =3.514, $p$ < 0.001), HT ($\beta$ = 0.120, $t$ =2.215, $p$ < 0.001), and BI ($\beta$ = 0.322, $t$ = 4.929, $p$ <0.001) had a significant positive influence on BI to adopt mobile learning. In addition, HM ($\beta$ = -0.021, $t$ = −0.381, $p$ = 0.703), had not significant positive influence on BI. In addition, HT ($\beta$ = 0.075, $t$ = 904, $P$ = 0.366) had not significant positive influence on UB. Thus, all hypotheses were supported and shown in **Table 5** and **Figure 2**.

**Table 5.** Regression coefficients.

| Hypotheses | Path from/to | | | Standardized estimate | S.E. | C.R. | *p*-Value | Test results |
|---|---|---|---|---|---|---|---|---|
| H1 | BI | ← | PE | 0.197 | 0.067 | 3.516 | *** | Supported |
| H2 | BI | ← | EE | 0.237 | 0.054 | 4.224 | *** | Supported |
| H3 | BI | ← | SI | 0.407 | 0.057 | 6.628 | *** | Supported |
| H4 | BI | ← | FC | 0.314 | 0.056 | 5.513 | *** | Supported |
| H5 | UB | ← | FC | 0.316 | 0.078 | 4.922 | *** | Supported |
| H6 | BI | ← | HM | −0.021 | 0.051 | −0.381 | 0.703 | Non-supported |
| H7 | BI | ← | LV | 0.208 | 0.069 | 3.514 | *** | Supported |
| H8 | BI | ← | HT | 0.120 | 0.057 | 2.125 | 0.034 | Supported |
| H9 | UB | ← | HT | 0.055 | 0.075 | 0.904 | 0.366 | Non-supported |
| H10 | UB | ← | BI | 0.322 | 0.081 | 4.929 | *** | Supported |

Note: ***, ** and * express $P$ < 0.001, $P$ < 0.01 and $P$ < 0.05.

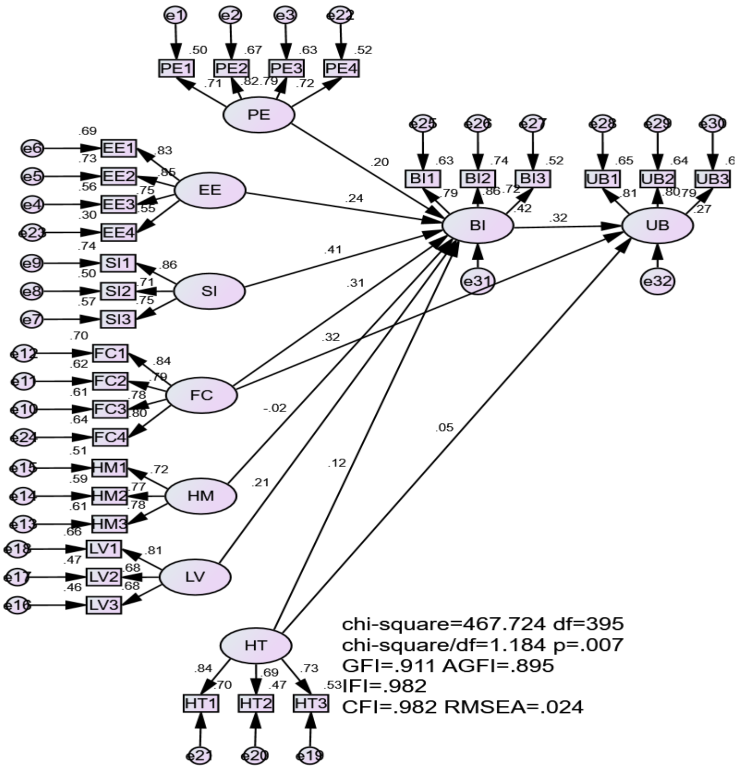


**Figure 2.** Structural model analysis.

## 5. Discussion and implications

Teachers' acceptance of technology is an important factor in adopting and integrating various types of

ICT into teaching. The purpose of this study was to assess the willingness of in-service preschool teachers to it as well as identify factors that affect the acceptance and use of mobile learning. A sample of in-service kindergarten teachers from different parts of China's Fujian Province were put to the test. The findings showed that the variables in the research hypothesis were significantly and favourably associated to the acceptance of mobile learning by in-service preschool teachers. This study also constructed a model based on UTAUT2 theory and carried out structural equation modelling analysis to test these assumptions. The outcomes revealed that the structural model has significant practical consequences.

According to the study, a variety of factors, such as performance expectations, effort expectations, social influence, facilitating conditions, learning values, and habits, have an impact on how well mobile learning is accepted and used. Following is a discussion of the study's results.

The study analyzes the hypothetical relationship between performance expectations and behavioral intentions, and the significant result is $\beta = 0.197$, $t = 3.516$, $p < 0.001$, which confirms that H1 is supported. This explains the identification among early childhood teachers that if they find mobile learning useful in implementing educational activities, they will be inclined to use mobile learning as part of their instruction. The results of this study are in line with previous findings, supporting the relationship between performance expectations and behavioral intentions to use the Moodle[61].

Effort expectancy has a positive effect on kindergarten teachers' intention to use mobile learning, which confirms the hypothesis of H2. Efforts and expectations are mainly manifested in two aspects of perceived ease of use and complexity, especially when teachers think they can operate mobile learning, they will tend to use it in teaching activities, so teachers perceive the difficulty of using information-based teaching degree will have a significant impact on its usage behavior. This finding is consistent with previous research[52,62], which has shown that perceived ease of use is a crucial factor in mobile learning acceptation.

The significant result H3 for the relationship between social influence and behavioral intention was $\beta = 0.407$, $t = 6.628$, $p < 0.001$. The recognition and support of education authorities, school leaders, parents and children will continuously improve the perception level of preschool teachers in terms of social influence factors, thereby increasing teachers' intention to use mobile learning in science education teaching practice. Preschool teachers are most influenced by peer teachers in the process of teaching practice, and peer teachers' development of mobile learning will prompt teachers to increase their intention to use it. Similarly, Fidani and Idrizi[63] reported that social influence significantly affects behavioral intention to accept LMS.

The fourth hypothesized relationship, H4, between facilitating conditions and behavioral intention towards Mobile learning was supported ($\beta = 0.314$, $p < 0.001$). Similarly, hypothesis H5, linking facilitating conditions and the use of mobile learning, was supported at $\beta = 0.316$, $p < 0.001$. Organizational support and basic technical facilities are the prerequisites to ensure the smooth development of information-based teaching. At the same time, teachers need to have relevant knowledge to facilitate access to teaching resources, so teachers will use them frequently. If you fail to get timely help or guidance when you encounter problems with mobile technology in the daily teaching process, it will also cause teachers to reduce information-based teaching behaviors. Alghazi et al.[52] also reported similar findings and explained that the influence of facilitating conditions (like the influence of network) on the intention to utilize m-learning was high since the relationship was very significant. According to the results of the study, it was shown that the influence of device performance, device compatibility, network speed, and price value on the intention to utilize m-learning was exceptionally effective.

The results for the sixth hypothesis H6 did not support hedonic motivation and behavioral intention link ($\beta = -0.021$). This shows that early childhood teachers are not feeling joy and enjoyment when using mobile learning. The reason may be that when early childhood teachers use mobile learning in science teaching classrooms, there is a greater focus on task orientation. They do not seek novelties in the system and only use it for curriculum-related activities such as finding teaching resources, submitting activity videos, organizing discussions with young children, downloading/uploading teaching-related files, etc. This result is consistent with previous research. In the study of bank customers using mobile banking by Owusu Kwateng et al.[64], it was found that hedonic motivation had no significant impact on bank customers' BI.

The path analysis for hypothesis H7 revealed a significant relationship between learning value and behavioral intention towards mobile learning at $\beta = 0.208$, $p < 0.001$. This shows that child teachers feel the value of learning through mobile learning is greater than investing time and energy in using it to do different activities. Therefore, the value of learning affects the willingness to use mobile learning. A similar link was reported by Ain et al.[50] where it was asserted that perception of leaning value has a direct influence on student' willingness to use learning management system.

The hypothesized relationship between habit and behavioral intention towards mobile learning, H8, was insignificant at $\beta = 0.120$, $p < 0.05$. However, the hypothesized relationship between habit and behavior, H9, was not supported. The explanation for this phenomenon may be that due to the pressure of teaching effect, preschool teachers will have the willingness to use mobile learning to perform teaching tasks, but they may not be habitual in action. Raman and Don[65] also found habit an insignificant determinant of pre-service teachers' intention to use Moodle and its actual use.

Finally, hypothesis H10 on the relationship between behavioral intention towards mobile learning and its use was supported at $\beta = 0.322$, $t = 4.929$, $p < 0.001$. Apart from the fact that early childhood teachers considered mobile learning to be a useful and beneficial tool for their teaching, social influence also encouraged positive perceptions of mobile learning, thereby influencing the use of mobile learning. This result is consistent with previous studies that have reported significant relationships between behavioral intentions and actual Moodle use[66].

In addition to the above analysis of the research hypotheses, this study has made some progress. The study offers some theoretical and practical implications. First, based on the development of the UTAUT2 model, the most important factors influencing the adoption and use of mobile learning by in-service preschool teachers were explored, theoretically complementing the body of knowledge on the subject. Second, this study identifies the influential factors that affect the adoption and use of mobile learning by in-service early childhood teachers, which are critical for early childhood teachers themselves as well as for administrators. These factors can be used to further promote the popularity and adoption of mobile learning in early childhood education. Finally, this study demonstrates the appropriateness of using the UTATU2 model to analyze the variables that influence the acceptance of mobile learning among in-service early childhood teachers.

In terms of the practical implications of this study, the findings can provide recommendations for researchers, educators, policy makers, and mobile learning application designers. This study can help researchers further investigate other factors that can influence early childhood teachers' intention to accept mobile learning. The study also increases education stakeholders and policymakers' understanding of the determinants of early childhood teachers' intention to accept mobile learning in the Chinese education context. Research shows that teachers demonstrate positive performance expectations when using mobile devices in science education teaching practices, indicating that they recognize the benefits of mobile learning in enhancing teaching practices and student engagement. However, the effort is expected to have a greater impact by increasing ease of use through training and mobile device design. Therefore, educators should provide adequate educational, technical, and management support in classroom teaching and training programs, combined with practical exploration of mobile learning tools. Especially for teachers without extensive experience, it can overcome the psychological barriers of novice teachers and enhance their confidence and willingness to accept and use mobile learning in future science classes. Social influence was found to be the most significant influencing factor. Educators can build professional communities and share successful teaching experiences, which can greatly increase the possibility of teachers accepting mobile learning and form a positive and important hint. At the same time, peer communication will help early childhood teachers form a more accurate and objective understanding of mobile learning. Additionally, access to equipment and infrastructure is an essential convenience to enable practical use. As a developer of mobile technology, we create friendly interfaces and functions for early childhood teachers that meet the needs and preferences of mobile learning system platforms. This can technically reduce the potential cognitive load of early childhood teachers and enhance the interactivity and functionality of mobile learning software. Perceived learning value also has a significant impact on acceptance intention, so linking adoption to learning goals and highlighting relevant high-quality apps can shed light on the educational value of mobile technologies. For example, early childhood teachers are encouraged to incorporate mobile learning into their classrooms and create original lessons or lesson plans, thereby creating a positive feedback loop that increases teacher performance expectations. Habits are important for willingness to continue using, and educators and policy specifiers can make regular mobile learning a goal through training programs and learning communities.

## 6. Limitations and future studies

The researchers encountered a number of important limitations in this study. First, the view of people's acceptance of mobile learning may alter at any time due to advancements in science and technology as well as educational reforms. Second, the sample size for this study was constrained to in-service preschool teachers from one Chinese province, which reduced its representativeness. Meanwhile, there are very serious imbalances in the demographic distribution, such as gender, and this situation constitutes one of the most important limitations of this study. Therefore, statistical analysis and comparison of study results based on this limitation is currently not possible. Furthermore, the study was restricted to examining the effects of in-service early childhood teachers' mobile learning intentions and usage behaviours based on the UTAUT2 theoretical model, and it solely applied to the study's intended topic.

Future studies may need to examine a larger group of educators working in the same field and perhaps evaluate educators in various educational systems. In order for future research to fully reflect preschool teachers' intention to accept mobile learning, comparative research between different provinces can be conducted. In addition, further studies based on the UTAUT2 extension could also be conducted to explore other influences on mobile learning and to assess their potential for application in educational settings. Further understanding of the contextual attitudes of early childhood teachers towards mobile learning can help us better understand the changes and prospects of mobile learning in early childhood education. Finally, longitudinal tracking of kindergarten teachers' acceptance attitudes toward mobile learning can reveal changes in attitudes over time and better assess the enablers and barriers to acceptance intention. As for the gender imbalance, China's tolerance and encouragement of men as preschool teachers in recent years, as well as the introduction of a series of publicly funded normal school student recruitment policies, have attracted more and more male college students to devote themselves to preschool education teaching. This trend of narrowing the gap will help researchers to conduct further research on gender differences in the near future, and consider extending the analysis and comparison of differences in teachers' age, teaching experience, academic level, etc.

## 7. Conclusion

In this study, we built a theoretical framework based on UTAUT2 to gauge in-service preschool teachers' acceptability intention of mobile learning. The major key objectives set at the initial stage of the study were accomplished. The UTAUT2 framework was extended by introducing the learning value concept. The suggested model was empirically assessed using the SEM method. The results of this investigation supported 10 of the original hypotheses; 8 of them were accepted, while 2 were rejected. This finding clarifies the relationship between behavioral intention to embrace and use mobile learning, and also highlights the influence of performance expectations, effort expectations, social influence, facilitation, learning value, and habits. Additionally, the proposed relationships between key constructs were examined and the eight hypothesized structural paths were supported.

With the intimate integration of science and technology into education, mobile learning is using its benefits in the early childhood sector, where early childhood teachers' acceptance is crucial. This study explores the factors that influence the adoption and use of mobile learning by in-service early childhood teachers through the development of the UTAUT2 theoretical model and can hope that early childhood teachers will adopt mobile learning to achieve their educational goals. They need to recognize that the education of young children in science will be significantly impacted by mobile learning. The literature on mobile learning in science education is the theoretical basis for this study, and a practical investigation of teachers' acceptance of mobile learning in early childhood science education complements this area of research and can provide some reference suggestions for kindergarten administrators.

## Author contributions

Conceptualization, LC and SRSA; methodology, LC; validation, SRSA, and MKR; analysis, LC; resources, LC; data curation, LC; writing—original draft preparation, LC; writing—review and editing, SRSA; supervision, SRSA and MKR; project administration, LC; funding acquisition, LC. All authors have read and agreed to the published version of the manuscript.

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## Conflict of interest

The authors declare no conflict of interest.

## References

1. Kalogiannakis M, Papadakis S. Hybrid learning for women and socially sensitive groups for the promotion of digital literacy. In: Proceedings of the 5th WSEAS/IASME International Conference on Engineering Education; 22–24 July 2008; Heraklion, Greece. pp. 305–311.
2. Kalogiannakis M, Papadakis S. Combining mobile technologies in environmental education: A Greek case study. International Journal of Mobile Learning and Organisation 2017; 11(2): 108. doi: 10.1504/ijmlo.2017.084272
3. Dorouka P, Papadakis S, Kalogiannakis M. Tablets and apps for promoting robotics, mathematics, STEM education and literacy in early childhood education. International Journal of Mobile Learning and Organisation 2020; 14(2): 255. doi: 10.1504/ijmlo.2020.106179
4. Al-Rahmi AM, Al-Rahmi WM, Alturki U, et al. Exploring the factors affecting mobile learning for sustainability in higher education. Sustainability 2021; 13(14): 7893. doi: 10.3390/su13147893
5. Quan Z, Grant L, Hocking D, Connor A. Distinctive mobile learning: Where it is different and how it can make a difference. Interactive Learning Environments 2022; 1–16. doi: 10.1080/10494820.2022.2086267
6. García-Martínez I, Fernández-Batanero JM, Cobos Sanchiz D, Luque de la Rosa A. Using mobile devices for

improving learning outcomes and teachers' professionalization. Sustainability 2019; 11(24): 6917. doi: 10.3390/su11246917

7. Vallejo-Correa P, Monsalve-Pulido J, Tabares-Betancur M. A systematic mapping review of context-aware analysis and its approach to mobile learning and ubiquitous learning processes. Computer Science Review 2021; 39: 100335. doi: 10.1016/j.cosrev.2020.100335
8. Criollo-C S, Guerrero-Arias A, Jaramillo-Alcázar Á, Luján-Mora S. Mobile learning technologies for education: Benefits and pending issues. Applied Sciences 2021; 11(9): 4111. doi: 10.3390/app11094111
9. Dimock M. Defining generations: Where Millennials end and Generation Z begins. Pew Research Center; 2019.
10. Amadu L, Syed Muhammad S, Mohammed AS, et al. Using technology acceptance model to measure the ese of social media for collaborative learning in Ghana. Journal of Technology and Science Education 2018; 8(4): 321. doi: 10.3926/jotse.383
11. Papadakis S, Kalogiannakis M, Zaranis N. Educational apps from the Android Google Play for Greek preschoolers: A systematic review. Computers & Education 2018; 116: 139–160. doi: 10.1016/j.compedu.2017.09.007
12. Betancourt-Odio MA, Sartor-Harada A, Ulloa-Guerra O, Azevedo-Gomes J. Self-perceptions on digital competences for m-learning and education sustainability: A study with teachers from different countries. Sustainability 2021; 13(1): 343. doi: 10.3390/su13010343
13. Iqbal S, Bhatti ZA. A qualitative exploration of teachers' perspective on smartphones usage in higher education in developing countries. International Journal of Educational Technology in Higher Education 2020; 17(1): 29. doi: 10.1186/s41239-020-00203-4
14. Nikolopoulou K. Preschool teachers' practices of ICT-supported early language and mathematics. Creative Education 2020; 11(10): 2038–2052. doi: 10.4236/ce.2020.1110149
15. Zhou X. Mechanism and structural parameter optimization method of linear energy-gathering cutting device for towering steel structures based on computational intelligence. Wireless Communications and Mobile Computing 2022; 2022: 9092062. doi: 10.1155/2022/9092062
16. Kalogiannakis M, Papadakis S. Evaluating pre-service kindergarten teachers' intention to adopt and use tablets into teaching practice for natural sciences. International Journal of Mobile Learning and Organisation 2019; 13(1): 113–127. doi: 10.1504/ijmlo.2019.096479
17. Papadakis S, Kalogiannakis M. eTwinning in the early childhood as starting line of innovative practices for the didactic of natural sciences. In: Proceedings of the HSci2010 7th International Conference Hands-on Science Bridging the Science and Society gap; 25–31 July 2010; Rethymno, Greece. pp. 235–240.
18. Luo W, Berson IR, Berson MJ, Li H. Are early childhood teachers ready for digital transformation of instruction in Mainland China? A systematic literature review. Children and Youth Services Review 2021; 120: 105718. doi: 10.1016/j.childyouth.2020.105718
19. Nan J. Research of application of artificial intelligence in preschool education. Journal of Physics: Conference Series 2020; 1607(1): 012119. doi: 10.1088/1742-6596/1607/1/012119
20. Chai SZ. Research on the cultivation of children's core literacy in kindergarten science education [Master's thesis]. Shandong Normal University; 2018. p. 71.
21. Stockless A. Acceptance of learning management system: The case of secondary school teachers. Education and Information Technologies 2017; 23(3): 1101–1121. doi: 10.1007/s10639-017-9654-6
22. Nikolopoulou K, Gialamas V, Lavidas K. Acceptance of mobile phone by university students for their studies: An investigation applying UTAUT2 model. Education and Information Technologies 2020; 25(5): 4139–4155. doi: 10.1007/s10639-020-10157-9
23. Nikolopoulou K, Gialamas V, Lavidas K. Habit, hedonic motivation, performance expectancy and technological pedagogical knowledge affect teachers' intention to use mobile internet. Computers and Education Open 2021; 2: 100041. doi: 10.1016/j.caeo.2021.100041
24. Momani AM, Jamous MM, Hilles SMS. Technology acceptance theories. International Journal of Cyber Behavior, Psychology and Learning 2017; 7(2): 1–14. doi: 10.4018/ijcbpl.2017040101
25. Chao CM. Factors determining the behavioral intention to use mobile learning: An application and extension of the UTAUT model. Frontiers in psychology 2019; 10: 1652. doi: 10.3389/fpsyg.2019.01652
26. Goksu I. Bibliometric mapping of mobile learning. Telematics and Informatics 2021; 56: 101491. doi: 10.1016/j.tele.2020.101491
27. Al-Hunaiyyan A, Al-Sharhan S, Alhajri R. A new mobile learning model in the context of the smart classrooms environment: A holistic approach. International Journal of Interactive Mobile Technologies (iJIM) 2017; 11(3): 39–56. doi: 10.3991/ijim.v11i3.6186
28. Samad MRA, Ihsan ZH, Khalid F. The use of mobile learning in teaching and learning session during the Covid-19 pandemic in Malaysia. Journal of Contemporary Social Science and Educational Studies 2021; 1(2): 46–65.
29. Alsswey A, Al-Samarraie H. M-learning adoption in the Arab gulf countries: A systematic review of factors and challenges. Education and Information Technologies 2019; 24(5): 3163–3176. doi: 10.1007/s10639-019-09923-1

30. Kumar BA, Chand SS. Mobile learning adoption: A systematic review. Education and Information Technologies 2018; 24(1): 471–487. doi: 10.1007/s10639-018-9783-6
31. Tabiin A. Implementation of STEAM method (science, technology, engineering, arts and mathematics) for early childhood developing in Kindergarten Mutiara Paradise Pekalongan. Early Childhood Research Journal (ECRJ) 2020; 2(2): 36–49. doi: 10.23917/ecrj.v2i2.9903
32. Ravanis K. Early childhood science education: State of the art and perspectives. Journal of Baltic Science Education 2017; 16(3): 284–288. doi: 10.33225/jbse/17.16.284
33. Chatti H, Hadoussa S. Factors affecting the adoption of e-learning technology by students during the COVID-19 quarantine period: The application of the UTAUT model. Engineering, Technology & Applied Science Research 2021; 11(2): 6993–7000. doi: 10.48084/etasr.3985
34. Idris WIS, Razak RA, Rahman SSBA. The design and development of mobile learning for preschool education. JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik 2021; 9(1): 37–48.
35. Haiyan L, Lin Z. An empirical study on the current situation and effect of mobile learning for kindergarten teachers in the internet plus context. Journal of Guizhou Education University 2021; 37(1): 70–77.
36. Kara N, Cagiltay K. In-service preschool teachers' thoughts about technology and technology use in early educational settings. Contemporary Educational Technology 2017; 8(2): 119–141. doi: 10.30935/cedtech/6191
37. Li HX, Zhao CL, Jiang ZH, Liang YZ. A study on the influencing factors about preschool teachers' acceptance of informational teaching based on the UTAUT model. Studies in Early Childhood Education 2017; 14: 25.
38. Doğan Y, Simsar A. Preschool teachers' views on science education, the methods they use, science activities, and the problems they face. International Journal of Progressive Education 2018; 14(5): 57–76. doi: 10.29329/ijpe.2018.157.6
39. Islamoglu H, Kabakci Yurdakul I, Ursavas OF. Pre-service teachers' acceptance of mobile-technology-supported learning activities. Educational Technology Research and Development 2021; 69(2): 1025–1054. doi: 10.1007/s11423-021-09973-8
40. Kumar JA, Bervell B. Google classroom for mobile learning in higher education: Modelling the initial perceptions of students. Education and Information Technologies 2019; 24(2): 1793–1817. doi: 10.1007/s10639-018-09858-z
41. Venkataraman JB, Ramasamy S. Factors influencing mobile learning: A literature review of selected journal papers. International Journal of Mobile Learning and Organisation 2018; 12(2): 99–112. doi: 10.1504/ijmlo.2018.090836
42. Alkhwaldi A, Kamala M. Why do users accept innovative technologies? A critical review of models and theories of technology acceptance in the information system literature. Journal of Multidisciplinary Engineering Science and Technology (JMEST) 2017; 4(8): 7962–7971.
43. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: Toward a unified view. MIS Quarterly 2003; 27(3): 425–478. doi: 10.2307/30036540
44. Venkatesh V, Thong JYL, Xu X. Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. MIS Quarterly 2012; 36(1): 157–178. doi: 10.2307/41410412
45. Tamilmani K, Rana NP, Wamba SF, Dwivedi R. The extended unified theory of acceptance and use of technology (UTAUT2): A systematic literature review and theory evaluation. International Journal of Information Management 2021; 57: 102269. doi: 10.1016/j.ijinfomgt.2020.102269
46. Xie A. Research on influence factors of university student's willingness of mobile phonelearning base on UTAUT [Master's thesis]. Zhejiang Normol University; 2012.
47. Yakubu MN, Dasuki SI. Factors affecting the adoption of e-learning technologies among higher education students in Nigeria. Information Development 2018; 35(3): 492–502. doi: 10.1177/0266666918765907
48. Sitar-Taut DA, Mican D. Mobile learning acceptance and use in higher education during social distancing circumstances: An expansion and customization of UTAUT2. Online Information Review 2021; 45(5): 1000–1019. doi: 10.1108/oir-01-2021-0017
49. Mtebe JS, Mbwilo B, Kissaka MM. Factors influencing teachers' use of multimedia enhanced content in secondary schools in Tanzania. The International Review of Research in Open and Distributed Learning 2016; 17(2). doi: 10.19173/irrodl.v17i2.2280
50. Ain N, Kaur K, Waheed M. The influence of learning value on learning management system use. Information Development 2016; 32(5): 1306–1321. doi: 10.1177/0266666915597546
51. Zwain AAA. Technological innovativeness and information quality as neoteric predictors of users' acceptance of learning management system. Interactive Technology and Smart Education 2019; 16(3): 239–254. doi: 10.1108/itse-09-2018-0065
52. Alghazi SS, Kamsin A, Almaiah MA, et al. For sustainable application of mobile learning: An extended UTAUT model to examine the effect of technical factors on the usage of mobile devices as a learning tool. Sustainability 2021; 13(4): 1856. doi: 10.3390/su13041856
53. Hair JF Jr, Black WC, Babin BJ, Anderson RE. Multivariate Data Analysis: A Global Perspective. Pearson; 2010.
54. Hair JF Jr, Babin BJ, Anderson RE, Black WC. Multivariate Data Analysis, 8th ed. Cengage India; 2018.

55. Tabachnick BG, Fidell LS. Using Multivariate Statistics, 7th ed. Pearson; 2018.
56. Hu L, Bentler PM. Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. Psychological Methods 1998; 3(4): 424–453. doi: 10.1037/1082-989x.3.4.424
57. Alghatrifi I, Khalid H. A systematic review of UTAUT and UTAUT2 as a baseline framework of information system research in adopting new technology: A case study of IPV6 adoption. In: Proceedings of 2019 6th International Conference on Research and Innovation in Information Systems (ICRIIS); 2–3 December 2019; Johor Bahru, Malaysia.
58. Schumacker RE, Lomax RG. A Beginner's Guide to Structural Equation Modeling, 3rd ed. Routledge; 2010.
59. Kline RB. Principles and Practice of Structural Equation Modeling, 2nd ed. Guilford Press; 2005.
60. Hooper D, Coughlan J, Mullen M. Structural equation modelling: Guidelines for determining model fit. Electronic Journal of Business Research Methods 2008; 6(1): 53–60.
61. Abbad MMM. Using the UTAUT model to understand students' usage of e-learning systems in developing countries. Education and Information Technologies 2021; 26(6): 7205–7224. doi: 10.1007/s10639-021-10573-5
62. Dahri NA, Al-Rahmi WM, Almogren AS, et al. Acceptance of mobile learning technology by teachers: Influencing mobile self-efficacy and 21st-century skills-based training. Sustainability 2023; 15(11): 8514. doi: 10.3390/su15118514
63. Fidani A, Idrizi F. Investigating students' acceptance of a learning management system in university education: A structural equation modeling approach. ICT Innovations 2012 Web Proceedings 2012; 2(23): 311–320.
64. Owusu Kwateng K, Osei Atiemo KA, Appiah C. Acceptance and use of mobile banking: An application of UTAUT2. Journal of Enterprise Information Management 2019; 32(1): 118–151. doi: 10.1108/jeim-03-2018-0055
65. Raman A, Don Y. Preservice teachers' acceptance of learning management software: An application of the UTAUT2 model. International Education Studies 2013; 6(7): 157–164. doi: 10.5539/ies.v6n7p157
66. Šumak B, Polancic G, Hericko M. An empirical study of virtual learning environment adoption using UTAUT. In: Proceedings of 2010 Second International Conference on Mobile, Hybrid, and On-Line Learning; 10–16 February 2010; Saint Maarten, Netherlands Antilles. doi: 10.1109/elml.2010.11