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Ayşegül Şakir

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Influences on early childhood educators' adoption of gamified mobile learning tools: a multitheoretical analysis

Ayşegül Şakir

Department of Preschool Education, Kırşehir Ahi Evran University, Kırşehir, Turkey

ABSTRACT

This study explores the determinants influencing preschool teachers' intentions to adopt gamified mobile learning tools, employing a hybrid theoretical framework that integrates the Technology Acceptance Model (TAM), Flow Theory (FT), and the Theory of Planned Behavior (TPB). Analyzing responses from a robust sample of 600 preschool teachers, the study examines the cognitive, emotional, and social factors shaping educators' readiness to embrace these technologies in early childhood educational settings. Through structural equation modeling (SEM), the study tests 11 hypotheses, revealing that perceived usefulness, ease of use, enjoyment, concentration, attitude, subjective norms, and perceived behavioral control significantly influence adoption intentions. The results confirm that the integrated model enhances predictive power over the individual theories, explaining 56% of the variance in adoption intention. These findings highlight the pivotal role of both cognitive and affective factors in technology adoption and underscore the importance of targeted interventions to support teachers in integrating gamified learning tools. This study provides empirical evidence to inform policymakers and educators on fostering technology-enhanced learning environments in preschool education.

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Gamified mobile learning; early childhood education; preschool teachers; technology acceptance model; flow theory; theory of planned behavior

1. Introduction

The integration of gamified mobile learning into preschool education is reshaping the landscape of early childhood education by harmoniously blending traditional teaching methods with the engaging and dynamic elements of digital gaming (Qing, 2022). These tools utilize game mechanics – such as rewards, points, challenges, and levels – to engage and captivate young learners in interactive and enriching educational experiences (Behl et al., 2022). A substantial corpus of research indicates that gamified mobile applications significantly boost motivation, enhance engagement, and support the development of essential cognitive, social, and motor skills in young children (Aznar-Díaz et al., 2022; El hafidy et al., 2021; Mukherjee et al., 2020). By fostering a playful and stimulating environment, these applications provide a foundation for lifelong learning, nurturing not only curiosity and critical thinking but also advancing problem-solving skills among preschool-aged children (Lamrani & Abdelwahed, 2020; Qing, 2022; Zolfaghari et al., 2021).

Despite the evident educational benefits of gamified mobile learning, its adoption within preschool environments remains markedly inconsistent. Many preschool educators exhibit reluctance to integrate these technologies into their teaching practices, a resistance that is supported by empirical evidence (Brooks et al., 2019). This hesitation is attributed to several factors: doubts about the

CONTACT Ayşegül Şakir aselimhocaoglu@ahievran.edu.tr

actual effectiveness of gamification in achieving desired educational outcomes, a widespread lack of familiarity with digital technologies among educators, and significant concerns regarding the ease of integrating these tools into established teaching routines. Moreover, there is a perceived shortfall in institutional support or adequate resources for the effective deployment of these tools within educational settings (Luo et al., 2021). Simultaneously, as young children increasingly adapt to digital environments, they demonstrate a natural receptivity to gamified learning experiences, thus accentuating a pronounced disparity between student readiness and teacher adoption of such technologies (Ofosu-Ampong et al., 2020).

The integration of gamified mobile learning tools in education has been extensively studied, with research highlighting their potential to enhance engagement, motivation, and learning outcomes across various educational levels (e.g. Xezonaki, 2023; Zolfaghari et al., 2021). However, a significant gap exists in the specific investigation of preschool teachers' intentions to adopt such tools, despite the growing emphasis on digital learning environments in early childhood education. While existing studies have extensively examined mobile learning adoption in higher education and K-12 settings, research focusing on preschool educators remains notably underdeveloped (Valverde-Berrocoso et al., 2020). This limited focus creates a critical void in understanding the unique pedagogical, psychological, and infrastructural challenges that preschool teachers face when adopting gamified mobile learning tools.

A primary gap in the literature is the limited focus on early childhood education, where technology adoption behaviors differ significantly from those observed in primary, secondary, or higher education settings. Most prior research centers on students as primary users of gamified mobile learning (Behl et al., 2022; Mukherjee et al., 2020) rather than teachers as facilitators of such technology. Unlike teachers of older students, preschool educators must balance digital engagement with play-based, hands-on learning methodologies, raising concerns about the appropriateness of technology for young learners (Rad et al., 2023). Additionally, teachers' attitudes, perceptions of usefulness, and readiness to integrate gamified tools in preschool classrooms have not been sufficiently explored, making it difficult to identify effective strategies for overcoming potential barriers (Ofosu-Ampong et al., 2020).

Another key gap in existing research is the tendency to rely on singular theoretical frameworks, such as the Technology Acceptance Model (TAM) or the Theory of Planned Behavior (TPB), without integrating a broader perspective that captures cognitive, emotional, and social dimensions of technology adoption. While TAM emphasizes the role of perceived usefulness and ease of use in adoption decisions (Davis, 1989), it does not fully account for motivational or contextual factors that influence early childhood educators' adoption behaviors (Huang et al., 2023). Flow Theory (FT) addresses this gap by highlighting intrinsic motivation, enjoyment, and engagement, which are essential for educators working with young children (Csikszentmihalyi, 1990; Rosas et al., 2023). Meanwhile, TPB expands the model by incorporating social influences and perceived control over technology use, which have been shown to be significant predictors of technology adoption (Ajzen, 1991; Ateş & Garzón, 2023). However, few studies have integrated these frameworks to provide a comprehensive understanding of preschool teachers' intentions to adopt gamified learning tools.

Additionally, while prior research has acknowledged the benefits of gamified mobile learning, empirical studies that systematically examine the barriers preschool teachers face in adopting such technologies remain scarce (Brooks et al., 2019; Luo et al., 2021). These barriers may include lack of institutional support, inadequate training, and concerns over classroom management in technology-enhanced learning environments. Despite evidence that young children are highly receptive to gamified learning (Aznar-Díaz et al., 2022; Qing, 2022), the gap between children's readiness and teachers' hesitancy has not been thoroughly investigated. Addressing these barriers and facilitators is essential to ensure the effective integration of gamified learning tools in early childhood settings.

This study directly addresses these research gaps by focusing on preschool educators, a group that has been largely overlooked in gamified mobile learning research. Unlike studies that emphasize

technology adoption in higher education or general K–12 contexts, this research specifically explores the unique motivations, concerns, and contextual challenges that preschool teachers face when integrating gamified mobile learning tools. Given the distinctive pedagogical demands of early childhood education – where play-based learning and hands-on activities are fundamental – the study aims to uncover the factors influencing teachers' willingness and readiness to adopt these tools within their instructional practices. To provide a comprehensive understanding of these adoption dynamics, this study employs an integrated theoretical model that synthesizes the Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), and Flow Theory (FT). By combining these frameworks, the study presents a multi-dimensional perspective that captures the interplay between cognitive, emotional, and social factors in shaping preschool teachers' adoption intentions. While TAM highlights the significance of perceived ease of use and usefulness, TPB accounts for social influences and perceived behavioral control, and FT emphasizes intrinsic motivation, engagement, and enjoyment. The integration of these three perspectives allows for a more nuanced and holistic analysis of the factors that either encourage or hinder preschool teachers from integrating gamified learning into their classrooms. Furthermore, this study bridges the gap between theoretical models and practical application by conducting an empirical investigation based on preschool teachers. Through structural analysis, the research provides concrete, evidence-based insights into how technology adoption unfolds in real educational settings. The findings offer valuable implications for teacher training programs, institutional policies, and the development of educational technology tools tailored specifically for early childhood education. By anchoring theoretical constructs in empirical data, the study ensures that its contributions are not only academically rigorous but also practically relevant for educators, policymakers, and ed-tech developers. Additionally, this study systematically examines the barriers and facilitators to technology adoption within the context of preschool education, an area that remains insufficiently explored in broader educational technology research. By investigating critical factors such as digital literacy levels, institutional support mechanisms, and the alignment of gamified learning with early childhood pedagogical goals, the study provides a deeper understanding of the obstacles that may prevent teachers from integrating these tools effectively. Addressing these challenges is essential for developing targeted interventions that enhance technology adoption and foster meaningful, sustainable integration of gamified mobile learning tools in preschool classrooms. Through these contributions, this research not only fills a critical void in the existing literature but also offers practical recommendations that can shape future initiatives in preschool education. By illuminating the unique adoption patterns of preschool teachers and the factors that influence their engagement with gamified mobile learning, the study paves the way for more effective and context-sensitive strategies to enhance digital learning in early childhood education.

By synthesizing insights from TAM, TPB, and FT, this study constructs a comprehensive framework that captures cognitive, emotional, and social influences on preschool teachers' adoption of gamified mobile learning. This holistic perspective provides a more nuanced understanding of the complex dynamics shaping technology adoption in early childhood education, offering actionable insights for educators, policymakers, and technology developers (Ateş & Garzón, 2023). Furthermore, the research findings have significant theoretical and practical implications. Theoretically, this study extends existing technology adoption models by demonstrating how a multi-theoretical approach enhances the explanatory power of adoption behavior in early childhood education. Practically, it provides evidence-based recommendations to improve teacher training programs, institutional policies, and the design of gamified learning tools, ensuring successful adoption and meaningful pedagogical integration in preschool settings. By addressing these critical gaps, this study makes a substantial contribution to the fields of educational technology and early childhood education. It advances our understanding of the factors that influence preschool teachers' decisions to adopt gamified learning tools, providing empirical insights that can guide educators, policymakers, and developers in designing effective strategies for technology integration in early childhood settings. The findings have the potential to inform training programs, instructional design, and institutional

policies, ensuring that gamified mobile learning tools are successfully adopted and leveraged to enhance preschool education. The study has established several key objectives, which are detailed below.

1. To construct a comprehensive model that integrates elements from the technology acceptance model, flow theory, and the theory of planned behavior, thereby providing a deeper understanding of the factors influencing preschool teachers' intentions to adopt gamified mobile learning in early childhood education.
2. To assess and compare the predictive efficacy of the combined technology acceptance model, flow theory, and theory of planned behavior model against the application of each theory individually, with the objective of determining whether the integrated model provides enhanced insights into preschool teachers' intentions to adopt gamified mobile learning.
3. To delineate and rank the importance of various constructs within the integrated model in predicting preschool teachers' intentions to adopt gamified mobile learning, thereby identifying the principal facilitators and barriers in this technological adoption process.

The structure of the paper is organized into several sections, beginning with a literature review that lays the theoretical groundwork for the study. This is followed by a comprehensive description of the research methodology and the data collection process. Subsequent sections analyze the results and discuss their implications for the adoption of gamified mobile learning in preschool education. The paper concludes by summarizing the key findings and providing recommendations for future research, with the aim of improving teacher training programs and facilitating the effective integration of new technologies in early childhood education.

2. Literature review and study hypotheses

2.1. Gamified mobile learning in preschool education

Over the past decade, the application of gamified mobile learning within the educational sector has seen a marked increase, particularly within early childhood education (Farooq et al., 2022; Zolfaghari et al., 2021). This sector is uniquely suited to such innovations, as young children show a natural propensity toward play-based and interactive learning approaches. Gamification, defined as the incorporation of game-design elements into non-game contexts, has consistently demonstrated efficacy in capturing learners' attention, enhancing their motivation, and fostering robust engagement (Luo, 2022). Within the realm of preschool education, gamified mobile applications leverage interactive elements such as challenges, rewards, and virtual progress markers to significantly enrich the learning experience (Zolfaghari et al., 2021). These applications are intricately designed to merge educational content with playful interactions, thus supporting the comprehensive development of preschoolers' cognitive, social, and motor skills in a manner that is both engaging and educational (Aznar-Díaz et al., 2022; El hafidy et al., 2021; Mukherjee et al., 2020).

Empirical studies further validate that young children exhibit deeper engagement when learning through gamified environments, aligning well with their developmental needs for tactile and experiential learning (Kouchaksaraei et al., 2021; Ungau et al., 2023). However, the role of educators in the integration of gamified mobile learning tools into early childhood classrooms is crucial (Lamrani & Abdelwahed, 2020). The successful implementation of these technologies hinges significantly on teachers' willingness and their readiness to adopt and effectively deploy these tools. Despite the recognized advantages of gamified learning, the research exploring the specific factors that influence preschool teachers' intentions to adopt these tools remains limited. The majority of research within the field of mobile learning has predominantly focused on general or higher education contexts, which has led to a notable gap in understanding the distinct challenges and enabling factors specific to preschool education.

This gap highlights the critical need for targeted research that delves into the unique dynamics of gamified learning within early childhood educational settings. Such research would not only shed light on the pedagogical and developmental benefits of gamification but also enhance strategies for teacher engagement and technology integration. By addressing these areas, the potential of gamified learning can be fully harnessed to foster the effective nurturing of young minds. Thus, focused studies in this domain are imperative to ensure that the integration of gamified mobile learning tools in preschool education is both successful and sustainable, ultimately contributing to the optimization of educational outcomes in this pivotal developmental stage.

2.2. The research model and hypotheses

The theoretical model for this study integrates key constructs from the technology acceptance model, flow theory, and the theory of planned behavior, aiming to explore the factors influencing preschool teachers' intentions to adopt gamified mobile learning in their teaching practices. The model posits that these intentions are influenced by a variety of cognitive, emotional, and social factors, which are conceptualized within these three well-established theories. This integration allows for a comprehensive examination of how perceived usefulness and ease of use (from technology acceptance model), intrinsic motivation and engagement (from flow theory), and social pressures and perceived behavioral control (from theory of planned behavior) collectively shape the decision-making process of preschool educators regarding the adoption of innovative educational technologies.

2.2.1. Technology acceptance model

The technology acceptance model, formulated by Davis (1989), provides a comprehensive framework for understanding the psychological factors influencing an individual's decision to adopt new technology. Technology acceptance model posits that two primary perceptions – perceived usefulness (PU) and perceived ease of use (PEOU) – significantly influence an individual's attitude towards using a technology, which in turn impacts their behavioral intention to adopt it (Davis et al., 1989; Marangunić & Granić, 2015).

In the context of preschool education, perceived usefulness is defined as the extent to which teachers believe that gamified mobile learning tools will enhance their teaching effectiveness and positively affect student outcomes. Perceived ease of use, conversely, reflects the teachers' perceptions of how effortless it will be to integrate these tools into their daily teaching routines (Rad et al., 2023).

Empirical studies, such as those by Abu Alatta et al. (2023), Koutromanos et al. (2024) and Sungur Gül and Ateş (2023) have consistently validated the applicability of technology acceptance model across various educational settings. These studies demonstrate that both perceived usefulness and perceived ease of use are strong predictors of teachers' intentions to adopt educational technologies. Specifically, the results indicate that when teachers perceive technology as useful and easy to use, their positive attitudes towards adopting such technologies increase, which in turn significantly correlates with their behavioral intentions (Rafique et al., 2023). In preschool environments, the integration of technology is crucial, and as Luo et al. (2021) highlighted, the easier the technology is to use and the more useful it is perceived to be, the more likely teachers are to implement it successfully.

Building on this empirical evidence, this study proposes the following hypotheses to explore the adoption dynamics of gamified mobile learning among preschool educators:

H1: Perceived ease of use of gamified mobile learning tools is positively related to the preschool teachers' perceived usefulness of these tools.

H2: Perceived ease of use of gamified mobile learning tools is positively related to preschool teachers' behavioral attitudes toward these tools.

H3: Perceived usefulness of gamified mobile learning tools is positively related to preschool teachers' behavioral attitudes toward these tools.

H4: Perceived usefulness of gamified mobile learning tools is positively related to preschool teachers' behavioral intentions to use these tools.

These hypotheses aim to elucidate the motivational dynamics underpinning the adoption of gamified mobile learning, emphasizing how intrinsic beliefs about utility and usability collectively shape preschool teachers' adoption decisions. This structured approach provides a basis for examining factors that facilitate or impede the effective integration of innovative teaching tools in early childhood educational settings, offering actionable insights to enhance technology integration strategies tailored to the unique needs of preschool educators.

2.2. Flow theory

Flow theory, as conceptualized by Csikszentmihalyi (1990), delineates an optimal psychological state characterized by profound immersion and elevated concentration, which is inherently enjoyable and engaging. This state, commonly referred to as "flow," is attained when the challenges presented by an activity are aptly aligned with the individual's skill level, thereby fostering deep engagement and a significant sense of achievement (Rosas et al., 2023). In the domain of preschool education, the potential of gamified mobile learning tools to facilitate this flow state among both teachers and students serves as a robust motivator for their adoption.

A pivotal construct of Flow Theory is perceived enjoyment, which relates to the intrinsic pleasure derived from interacting with the technology, irrespective of any direct educational outcomes (Jo & Baek, 2023). Empirical research indicates that when individuals find an activity enjoyable, their likelihood of consistent engagement increases (Fang et al., 2013). Within the context of preschool education, we propose that teachers who perceive gamified learning tools as enjoyable and capable of creating immersive, engaging experiences for students are more inclined to utilize these tools. Additionally, concentration, another critical construct of Flow Theory, is defined as intense focus and absorption in an activity, which is instrumental in achieving the flow state (Atombo et al., 2017). This heightened level of concentration is particularly vital in educational settings, where it significantly contributes to optimal learning experiences (Ateş & Garzón, 2022).

Building upon this theoretical foundation, this study articulates the following hypotheses to explore the adoption dynamics of gamified mobile learning among preschool educators:

H5: Perceived enjoyment is positively related to preschool teachers' behavioral attitudes toward gamified mobile learning tools.

H6: Perceived enjoyment is positively related to preschool teachers' behavioral intentions to adopt gamified mobile learning tools.

H7: Concentration during the use of gamified mobile learning tools is positively related to preschool teachers' behavioral attitudes toward these tools.

H8: Concentration during the use of gamified mobile learning tools is positively related to preschool teachers' behavioral intentions to adopt the technology.

These hypotheses aim to clarify how intrinsic enjoyment and the state of flow, particularly concentration, influence teachers' attitudes and intentions toward technology adoption. This approach emphasizes the psychological and motivational underpinnings that facilitate or hinder the integration of innovative teaching tools in early childhood educational settings. By exploring these dynamics, this study provides a comprehensive basis for examining the factors that promote the effective and fulfilling incorporation of gamified learning into preschool curricula.

2.3. Theory of planned behavior

The theory of planned behavior, developed by Ajzen (1991), posits that an individual's intentions to perform a behavior are influenced by three core factors: attitude toward the behavior, subjective norms, and perceived behavioral control. These elements shape how individuals feel about performing a behavior (attitude), the social pressures they perceive (subjective norms), and their confidence in their ability to perform the behavior (perceived behavioral control) (Ajzen, 2020).

In the context of preschool education, we propose that the attitude of teachers toward gamified mobile learning tools is shaped by their beliefs about the benefits these tools can bring to their teaching practices. Subjective norms encompass the expectations and pressures from colleagues, parents, and school administrators regarding the adoption of new technologies (Teo et al., 2016). If teachers perceive a strong expectation from their professional community to use gamified learning tools, they may be more inclined to adopt them (Cheng et al., 2022). Perceived behavioral control, meanwhile, reflects teachers' confidence in their ability to effectively implement these tools in the classroom (Hou et al., 2022). This can be enhanced by access to resources, training, and technical support, thereby increasing the likelihood of adoption.

Aligning with the structure and flow of the example provided, this study proposes the following adjusted hypotheses to further investigate the dynamics of gamified mobile learning adoption among preschool teachers, based on the constructs of the theory of planned behavior:

H9: Attitude toward gamified mobile learning tools is positively related to preschool teachers' behavioral intentions to adopt the technology.

H10: Subjective norms are positively related to preschool teachers' behavioral intentions to adopt gamified mobile learning tools.

H11: Perceived behavioral control is positively related to preschool teachers' behavioral intentions to adopt gamified mobile learning tools.

These hypotheses seek to elucidate how attitudes, social pressures, and self-efficacy influence teachers' intentions to adopt innovative technologies, emphasizing the psychological and motivational underpinnings that facilitate or hinder the integration of gamified learning tools in early childhood educational settings. This theoretical approach provides a comprehensive basis for exploring factors that promote or impede the effective adoption of gamified learning technologies in preschool education. The composite model that outlines the relationships between the analyzed constructs is shown in Figure 1.

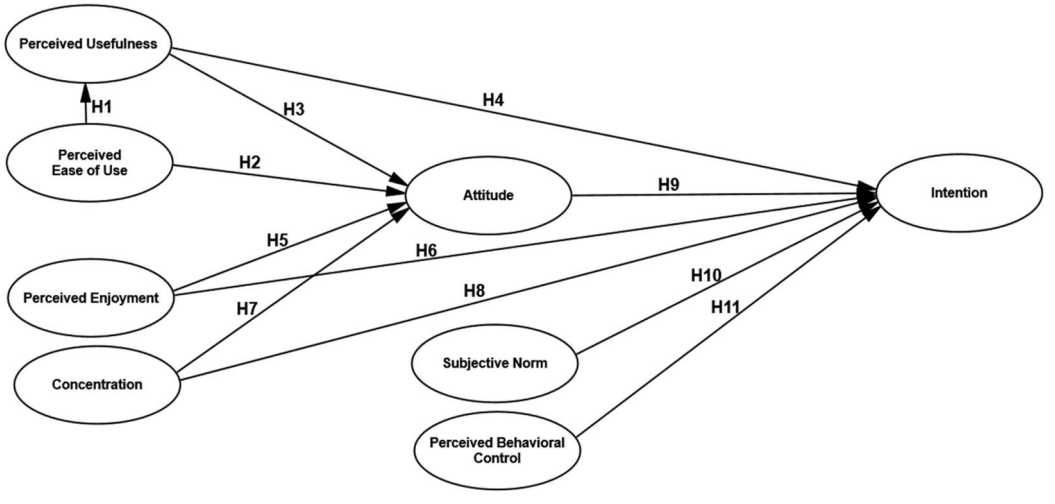

Figure 1. Integrated model diagram.

3. Method

3.1. Data collection process

In this study, we initially introduced preschool teachers to the concept of gamified mobile learning, detailing its purpose, capabilities, and its potential to enhance early childhood development. This preliminary orientation was crucial to contextualize the research and align the capabilities of gamified mobile learning tools with the educational goals of preschool environments. We provided an extensive explanation of how these tools can be seamlessly integrated into classroom settings, including details on system requirements, technical specifications, and a variety of educational content options.

To ensure teachers were well-prepared to utilize the technology effectively, we organized a series of hands-on workshops. These sessions were designed to cover the essential operations of the gamified mobile learning tools, encompassing setup procedures, usage functionalities, and troubleshooting methods. Complementary to the workshops, we provided user manuals and video tutorials to further facilitate ease of use and enhance comprehension. Acknowledging the need for ongoing support, we established a dedicated help desk and an online community forum where teachers could seek assistance and exchange best practices.

Feedback was integral to the data collection process. We implemented a structured feedback mechanism that enabled teachers to offer their insights during and after the workshops through surveys. This input was instrumental in refining the instructional materials and enhancing the training sessions. Regular updates on the gamified mobile learning tools were disseminated to participants, ensuring they remained informed about the latest advancements in the technology.

3.2. Participants

The data for this study were collected using a self-administered questionnaire, distributed to preschool teachers across various regions of Turkey between February and July 2024. A convenience sampling method was employed to select participants from both urban and rural preschool institutions, ensuring a diverse representation of teaching environments. Prior to data collection, all participants received informed consent forms that clearly explained the purpose of the study, emphasized the voluntary nature of their participation, and assured confidentiality in line with established ethical standards.

A total of 700 questionnaires were distributed, and 643 were returned, yielding an impressive response rate of approximately 92%. Following a rigorous data screening process, 600 responses were deemed valid for analysis. The final sample comprised 495 female and 105 male preschool teachers, representing a broad age range from 25 to 55 years. The majority of participants had at least five years of teaching experience, with 80% holding a bachelor's degree and 20% possessing postgraduate qualifications in early childhood education.

The sample size exceeded the minimum threshold recommended by Kline (2023), who suggests a minimum of 10 cases per item to ensure statistical reliability. Given that the study utilized a 25-item questionnaire, the sample of 600 participants provided robust statistical power, enhancing the reliability and validity of the findings. This sample offers a comprehensive representation of preschool educators, capturing a wide range of professional experiences and educational backgrounds, which is essential for generating meaningful insights into the adoption of gamified mobile learning in early childhood education.

3.3. Measures

The measurement instruments used in this study were meticulously developed through a multistage process, grounded in an extensive review of the literature on the technology acceptance

model, flow theory, and the theory of planned behavior. These theoretical models provided the foundation for designing the scale items, which were intended to capture the factors influencing preschool teachers' adoption of gamified mobile learning tools, including their attitudes, perceived ease of use, perceived usefulness, and behavioral intentions. The process of developing these scales was guided by existing research (e.g. Ajzen, 1991; Ateş & Garzón, 2022; Csikszentmihalyi, 1990; Davis, 1989), ensuring that the constructs measured were relevant and aligned with the study's objectives.

3.3.1. Initial item development

The first stage of item development was based on an extensive review of the literature on technology acceptance model, flow theory, and theory of planned behavior, drawing on well-established scales from previous research. Items were drafted to measure constructs such as perceived ease of use (e.g. "It is easy for me to learn how to use gamified mobile learning tools") and perceived usefulness (e.g. "Using gamified mobile tools will enhance my teaching effectiveness"). These items were tailored to reflect the specific context of preschool education, where technology adoption is often influenced by practical and pedagogical considerations.

3.3.2. Preliminary testing

Once the items were developed, they were pre-tested with a sample of 150 pre-service and in-service preschool teachers to evaluate their clarity, relevance, and applicability to the research context. The primary objective of this phase was to gather qualitative and quantitative feedback on how well the items captured the teachers' experiences, perceptions, and expectations regarding the use of gamified mobile learning tools in preschool education. Participants were asked to assess the comprehensibility, wording, and relevance of each item and identify any ambiguities, redundancies, or missing constructs that might influence the validity of the questionnaire. Based on their feedback, several key revisions were implemented to enhance the precision and usability of the instrument. First, some items were reworded to improve clarity and ensure that teachers with varying levels of technological familiarity could interpret them without difficulty. Second, redundant items were removed or merged to reduce cognitive load and ensure that the questionnaire remained concise and focused. Additionally, new items were added in response to participant suggestions, particularly in areas where teachers felt that the original items did not fully capture their concerns about ease of use, institutional support, or classroom integration. Furthermore, a Likert-scale adjustment was made after feedback indicated that certain response options were too vague or restrictive, limiting participants' ability to express nuanced perspectives. To enhance readability, simplified language and more concrete examples were incorporated where necessary, ensuring that the items were contextually appropriate for the target population. This iterative refinement process helped validate the questionnaire's content and align it more closely with the realities of preschool education, ultimately ensuring that the final instrument was both statistically robust and practically meaningful for investigating preschool teachers' adoption of gamified mobile learning tools (Thabane et al., 2010).

3.3.3. Translation and cultural adaptation

Given that the study was conducted in Turkey, where participants were primarily Turkish-speaking, the scales were translated from English to Turkish using a double-blind translation-back-translation process (Bracken & Barona, 1991). This method ensured both linguistic accuracy and cultural relevance. The translation process was carried out by bilingual experts who were proficient in both languages and familiar with the field of educational technology. After translation, the scales were reviewed by a team of professionals who further refined the items to ensure that they were culturally and contextually appropriate for Turkish preschool teachers.

3.3.4. Expert review

Following the translation and initial adjustments, the scales were subjected to an expert review process. Six experts in early childhood education, educational technology, and psychology were

consulted to evaluate the alignment of the items with the constructs of technology acceptance model, flow theory, and theory of planned behavior. The experts provided feedback on the face and content validity of the items, ensuring that the scales were theoretically sound and relevant to the preschool education context (Gravetter et al., 2009). This review process led to further refinements, particularly in adjusting the wording of items to better reflect the practical realities of preschool teaching.

3.3.5. Pilot study

To further assess the reliability and validity of the scales, a pilot study was conducted with 120 preschool teachers from various regions of Turkey. This phase allowed for a thorough evaluation of the instrument's robustness. The pilot study confirmed that the scale items were clear and easy to interpret, and the data collected demonstrated strong reliability (Cronbach's alpha > 0.80 across all constructs). The feedback from this phase informed final revisions to the items, enhancing both clarity and precision (Kline, 2023).

3.3.6. Final instrument

The final version of the instrument consisted of 30 items, divided into several sections corresponding to the theoretical models. Each item was rated on a 7-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (7), which allowed for a detailed analysis of the participants' attitudes and behavioral intentions.

- **Technology Acceptance Model**: This section included perceived usefulness (e.g. "Using gamified mobile learning tools improves my teaching effectiveness") and perceived ease of use (e.g. "I find it easy to integrate gamified mobile learning tools into my daily teaching activities") (Davis, 1989).
- **Flow Theory**: Items measuring perceived enjoyment (e.g. "I find using gamified mobile learning tools enjoyable") and concentration (e.g. "While using gamified mobile learning tools, I am completely absorbed in the activity") were adapted from previous research (Csikszentmihalyi, 1990; Moon & Kim, 2001).
- **Theory of Planned Behavior**: This section measured attitude (e.g. "Using gamified mobile learning tools is a good idea"), subjective norms (e.g. "People important to me think I should use gamified mobile learning tools"), and perceived behavioral control (e.g. "I am confident in my ability to use gamified mobile learning tools effectively") (Ajzen, 1991).
- **Behavioral Intentions**: Items assessing teachers' intentions to adopt the technology included statements such as "I plan to use gamified mobile learning tools in the future" (Ajzen, 1991; Davis, 1989).

The final instrument provided a comprehensive measure of the factors influencing preschool teachers' adoption of gamified mobile learning tools. By integrating constructs from multiple theoretical models and rigorously testing the instrument across multiple phases, the study ensured that the measures were both reliable and valid, offering a solid foundation for the analysis of technology adoption in early childhood education. Table 1 provides a detailed breakdown of the items and constructs used in the study, along with their corresponding statistical values. This table serves as a foundation for understanding how each theoretical component was operationalized within the research framework, offering insight into the measurement properties of key variables such as perceived usefulness, ease of use, enjoyment, concentration, attitude, subjective norms, and perceived behavioral control.

3.4. Data analysis

Data analysis for this study was performed using SPSS version 26 to calculate descriptive statistics and assess reliability, while AMOS version 24 was employed for structural equation modeling

Table 1. Constructs, items, factor loadings, and sources.

Constructs	Statements	Factor Loading
Perceived ease of use	I find the gamified mobile learning tools easy to use in my teaching	0.79
	It is easy for me to become skillful at using gamified mobile learning tools in my teaching	0.81
	My interaction with gamified mobile learning tools is clear and understandable	0.74
Perceived usefulness	Using gamified mobile learning tools improves my teaching effectiveness	0.82
	Using gamified mobile learning tools increases my productivity in teaching	0.75
	Using gamified mobile learning tools enhances my overall teaching outcomes	0.80
Perceived enjoyment	Using gamified mobile learning tools in the classroom is enjoyable	0.73
	Using gamified mobile learning tools makes my teaching more fun	0.77
	I feel happy using gamified mobile learning tools in my classroom	0.87
Concentration	While using gamified mobile learning tools, I lose track of time	0.85
	While using gamified mobile learning tools, I am unaware of things happening around me	0.79
	I am completely absorbed in using gamified mobile learning tools in my classroom	0.76
Intention	I predict I will use gamified mobile learning tools in the future	0.83
	I plan to integrate gamified mobile learning tools in my teaching practices in the future	0.72
	I will make an effort to incorporate gamified mobile learning tools into my teaching	0.84
Attitude	Using gamified mobile learning tools is a good idea	0.76
	I enjoy using gamified mobile learning tools in my teaching practices	0.85
	Using gamified mobile learning tools in my teaching would be a pleasant experience	0.84
Subjective Norm	People important to me think that I should use gamified mobile learning tools in my classroom	0.77
	People who influence my decisions think I should use gamified mobile learning tools	0.78
Perceived Behavioral Control	I have the knowledge and skills to effectively use gamified mobile learning tools	0.80
	I am confident that I can successfully use gamified mobile learning tools in my classroom	0.75
	Using gamified mobile learning tools in my teaching is completely within my control	0.79

(SEM) to test the proposed theoretical model. Descriptive statistics, including means, standard deviations, skewness, and kurtosis, were calculated to provide an initial understanding of the data distribution and the general tendencies in participants' responses to the items. These statistics were essential for identifying any potential outliers or irregularities in the data, ensuring the accuracy of subsequent analyses.

To assess the reliability and validity of the measurement scales, Confirmatory Factor Analysis (CFA) was conducted. The measurement model was evaluated through CFA to determine whether the hypothesized factor structure fit the collected data. Reliability was first assessed using Cronbach's alpha for each construct. All constructs exceeded the 0.70 threshold for Cronbach's alpha, indicating a high level of internal consistency. In particular, the constructs measuring Perceived Usefulness and Perceived Behavioral Control had the highest reliability values at 0.88 and 0.86, respectively, while other constructs such as Perceived Enjoyment and Subjective Norms also demonstrated strong reliability, with values ranging between 0.77 and 0.85.

Convergent validity was further evaluated by examining Composite Reliability (CR) and Average Variance Extracted (AVE) for each construct. The results indicated that all CR values surpassed the recommended minimum of 0.70, with most constructs achieving CR values between 0.75 and 0.86. AVE values for all constructs exceeded the 0.50 benchmark, with Perceived Ease of Use and Flow Concentration recording AVE values of 0.60 and 0.67, respectively, further confirming convergent validity.

Discriminant validity was assessed by comparing the square roots of the AVE values for each construct against the inter-construct correlations. For all constructs, the square roots of the AVE values were greater than the corresponding correlations, confirming that each construct was sufficiently

distinct from the others. This step was particularly important for ensuring that overlapping constructs such as Perceived Behavioral Control and Self-Efficacy were properly distinguished in the analysis.

Following the assessment of the measurement model, the structural model was tested using SEM to explore the relationships between the constructs as proposed by the theoretical framework. Several fit indices were employed to evaluate the overall goodness-of-fit of the structural model, including the Chi-square to degrees of freedom ratio (χ^2/df), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). The χ^2/df ratio was found to be 2.34, falling within the acceptable range of below 3.0, indicating a reasonable model fit. The GFI and CFI values were 0.94 and 0.96, respectively, both exceeding the minimum threshold of 0.91, while the TLI recorded a value of 0.93, further supporting the adequacy of the model. Additionally, the RMSEA value of 0.047 was below the recommended cutoff of 0.06, indicating a good fit to the data. The CFA and SEM results are comprehensively presented in Table 2, which details factor loadings, reliability estimates, and model fit indices. This table provides a quantitative validation of the theoretical constructs, ensuring that the measurement model demonstrates strong reliability, validity, and fit with the data.

4. Findings

4.1. Fit evaluation and predictive efficacy of the proposed model

In this study, we formulated an integrated model that amalgamates the technology acceptance model, flow theory, and the theory of planned behavior to enhance our understanding of preschool teachers' intentions to adopt gamified mobile learning tools within early childhood education contexts. We undertook a comparative analysis against the standalone models (technology acceptance model, flow theory, and theory of planned behavior) to assess their individual and collective efficacy in explaining the data and forecasting behavioral intentions.

The goodness-of-fit metrics indicated that our integrated model provided an excellent alignment with the collected data. Specifically, the integrated model exhibited a superior fit with a Chi-square to degrees of freedom ratio (χ^2/df) of 2.25, compared to the theory of planned behavior model at 2.41, the technology acceptance model model at 2.59, and the flow theory model at 2.75. This suggests that the synthesized theoretical framework, by integrating multiple perspectives, offers a more nuanced and comprehensive understanding of the dynamics influencing preschool teachers' adoption decisions than each model could on its own.

Furthermore, the integrated model demonstrated enhanced predictive power ($R^2 = 0.56$) in elucidating teachers' intentions, surpassing the individual performances of the theory of planned behavior model ($R^2 = 0.48$), technology acceptance model model ($R^2 = 0.44$), and flow theory model ($R^2 = 0.41$). This higher R^2 value for the integrated model underscores its capability to

Table 2. Results toward the measurement model.

Constructs	1	2	3	4	5	6	7	8	α	AVE	CR
1. PEOU	**0.78**								0.85	0.61	0.82
2. PU	0.53	**0.79**							0.88	0.62	0.83
3. ATT	0.49	0.61	**0.82**						0.82	0.67	0.86
4. SN	0.33	0.41	0.40	**0.77**					0.77	0.60	0.75
5. PBC	0.54	0.31	0.47	0.50	**0.78**				0.86	0.61	0.82
6. PE	0.42	0.46	0.67	0.48	0.30	**0.79**			0.80	0.63	0.83
7. CON	0.22	0.22	0.30	0.26	0.19	0.32	**0.80**		0.77	0.64	0.84
8. INT	0.56	0.62	0.57	0.35	0.60	0.54	0.37	**0.80**	0.87	0.64	0.84
Mean	5.18	5.02	4.90	4.28	4.53	4.48	3.88	4.75	–	–	–
SD	1.10	1.07	0.94	1.12	1.13	1.11	1.43	1.06	–	–	–

Note. Diagonal and bold values show the square root of AVE. Perceived Ease of Use: PEOU, Perceived Usefulness: PU, Perceived Enjoyment: PE, Concentration: CON, Intention: INT, Attitude: ATT, Subjective Norm: SN, Perceived Behavioral Control: PBC.

encapsulate the multifaceted influences – cognitive, emotional, and social – that shape teachers' behavioral intentions.

Table 3 presents a comparative analysis of model fit indices and predictive strengths across different theoretical models. This table highlights the superior analytical leverage of the integrated model over singular theoretical approaches such as TAM, TPB, or FT in isolation. These findings robustly support the proposition that a multidimensional analytical framework, which interweaves constructs from technology acceptance model, flow theory, and theory of planned behavior, significantly enhances our comprehension of the factors driving the adoption of educational technologies in preschool environments.

4.2. Path analysis and hypothesis testing in gamified mobile learning adoption

4.2.1. Results of the technology acceptance model

The path analysis within the technology acceptance model framework revealed robust and statistically significant relationships among the constructs, confirming the significant roles of Perceived Usefulness and Perceived Ease of Use as determinants of preschool teachers' intentions to adopt gamified mobile learning tools. Specifically, Perceived Ease of Use demonstrated a direct and notable positive influence on Perceived Usefulness ($\beta = 0.38$, $p < 0.01$), affirming the hypothesized link between the ease of using technology and its perceived benefits. Additionally, Perceived Usefulness exerted a profound impact on teachers' attitudes towards adoption ($\beta = 0.42$, $p < 0.01$), underscoring the critical role of perceived utility in fostering favorable attitudes towards gamified tools.

Furthermore, Perceived Ease of Use also significantly enhanced teachers' attitudes towards gamified mobile learning ($\beta = 0.36$, $p < 0.01$), highlighting how usability contributes to positive perceptions. This positive perception, in turn, significantly influenced their behavioral intentions ($\beta = 0.44$, $p < 0.01$), illustrating the strong connection between attitude and the intention to adopt technology. Moreover, Perceived Usefulness directly and significantly affected behavioral intention ($\beta = 0.31$, $p < 0.01$), reinforcing its pivotal role in influencing the decision to adopt gamified learning tools.

These findings indicate that when preschool teachers perceive gamified mobile learning tools as easy to use, they are more likely to regard these tools as beneficial, which positively impacts their attitudes towards adoption. Subsequently, these positive attitudes greatly enhance their intention to integrate these technologies into classroom environments. The detailed path coefficients elucidate the robust links between usability, perceived utility, attitude, and behavioral intention, emphasizing the integral role of technology acceptance model constructs in elucidating preschool teachers' technology adoption decisions. Figure 2 illustrates the technology acceptance model's role in influencing preschool teachers' decisions to adopt gamified mobile learning tools.

4.2.2. Results of flow theory

The analysis of Flow Theory constructs demonstrated significant associations between Perceived Enjoyment and Concentration and the attitudes of preschool teachers toward the adoption of

Table 3. Comparative analysis of model fit and predictive accuracy.

Metric	Proposed Model	TPB	TAM	FT
χ^2	1023.75	686.85	699.30	495.00
df	455	285	270	180
χ^2/df	2.25	2.41	2.59	2.75
GFI	0.93	0.91	0.90	0.90
IFI	0.95	0.93	0.91	0.90
TLI	0.92	0.91	0.90	0.90
CFI	0.95	0.92	0.91	0.90
RMSEA	0.048	0.052	0.053	0.055
SRMR	0.039	0.040	0.045	0.049
R^2	0.56	0.48	0.44	0.41

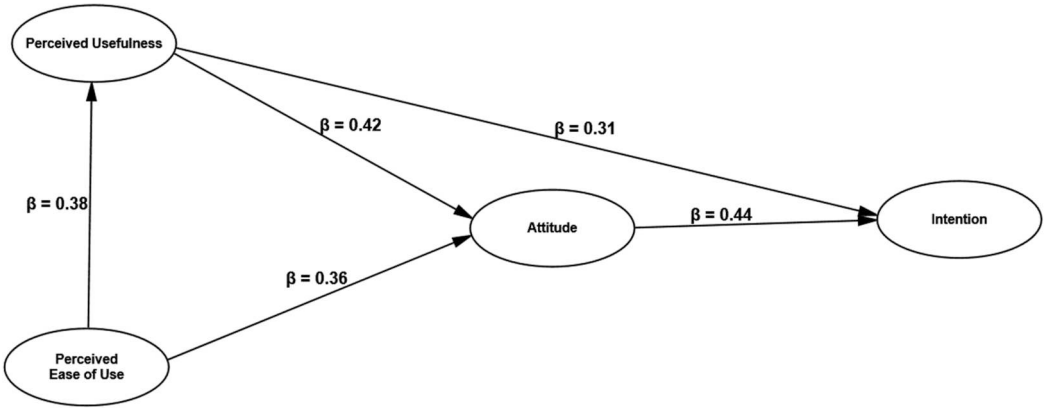

Figure 2. Path diagram of the technology acceptance model for gamified mobile learning adoption.

gamified mobile learning tools. Perceived Enjoyment exerted a pronounced positive impact on teachers' attitudes ($\beta = 0.47$, $p < 0.01$), indicating that teachers who find the use of gamified tools enjoyable are more likely to develop favorable attitudes towards their adoption. Similarly, Concentration, which reflects the teachers' capacity to remain fully immersed in the use of these tools, also showed a strong positive correlation with attitude ($\beta = 0.36$, $p < 0.01$).

Additionally, both Perceived Enjoyment ($\beta = 0.40$, $p < 0.01$) and Concentration ($\beta = 0.33$, $p < 0.01$) significantly influenced the intention to adopt gamified mobile learning tools. These findings underscore that intrinsic enjoyment and deep engagement, as fostered by the gamified learning environment, play crucial roles in motivating teachers to integrate these tools into their teaching practices. Figure 3 displays the flow theory's effects, showing how perceived enjoyment and concentration contribute to shaping attitudes and subsequently, the intention to adopt gamified learning tools in preschool education.

4.2.3. Results of the theory of planned behavior

The path analysis of the Theory of Planned Behavior model revealed significant results, underscoring the critical role of attitude, subjective norms, and perceived behavioral control in predicting preschool teachers' intentions to adopt gamified mobile learning tools. The attitude towards the

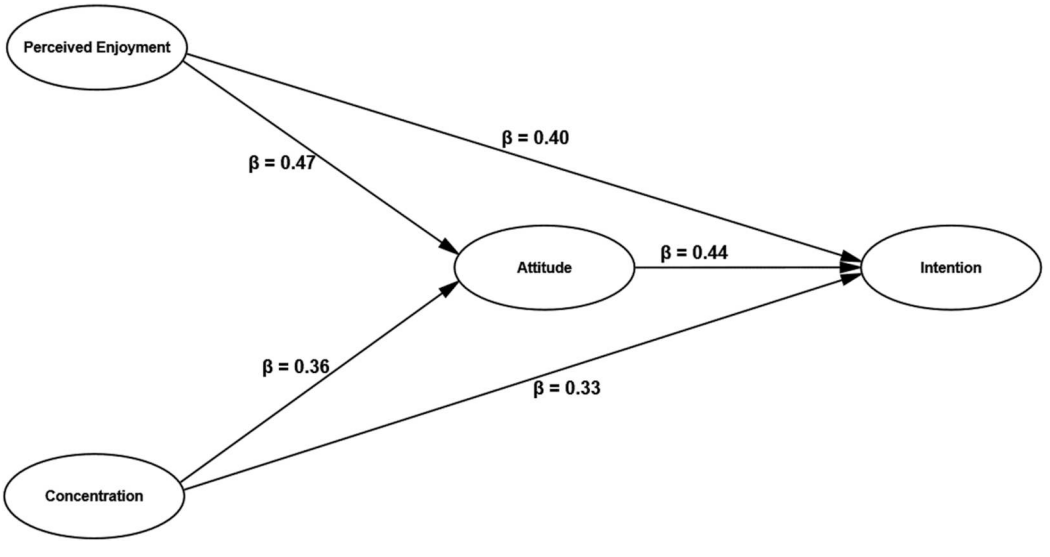

Figure 3. Influence of flow theory constructs on gamified learning adoption.

technology had the most profound impact on behavioral intention ($\beta = 0.50$, $p < 0.01$), indicating a robust positive influence of teachers' overall perceptions of the tools. Subjective norms, reflecting the social pressures exerted by peers and administrators, also significantly shaped adoption decisions ($\beta = 0.29$, $p < 0.01$). This suggests that support from the professional community enhances teachers' likelihood of embracing the technology.

Moreover, perceived behavioral control – the teachers' confidence in their ability to effectively utilize the tools – exerted a significant influence on their intentions ($\beta = 0.40$, $p < 0.01$). This finding highlights that providing adequate resources, training, and support can markedly increase teachers' propensity to implement gamified mobile learning tools in their instructional practices. Figure 4 delineates the impact of the theory of planned behavior constructs on the intention to use gamified learning tools among preschool teachers.

4.2.4. Results of the proposed comprehensive model

SEM was utilized to analyze the relationships within the proposed model. The results of the hypothesis testing indicated that Perceived Ease of Use exerted a positive and significant impact on Perceived Usefulness ($\beta = 0.39$, $p < 0.001$) and Attitude ($\beta = 0.31$, $p < 0.001$), thus affirming Hypotheses 1 and 2. Additionally, the pathways from Perceived Usefulness to Attitude ($\beta = 0.35$, $p < 0.001$) and to Intention ($\beta = 0.33$, $p < 0.001$) were statistically significant, supporting Hypotheses 3 and 4. Perceived Enjoyment also significantly influenced Attitude ($\beta = 0.42$, $p < 0.001$) and Intention ($\beta = 0.36$, $p < 0.01$), corroborating Hypotheses 5 and 6. Furthermore, the links from Concentration to Attitude ($\beta = 0.37$, $p < 0.01$) and to Intention ($\beta = 0.34$, $p < 0.01$) were statistically robust, endorsing Hypotheses 7 and 8. Within the framework of the Theory of Planned Behavior, Attitude ($\beta = 0.44$, $p < 0.001$), Subjective Norm ($\beta = 0.29$, $p < 0.01$), and Perceived Behavioral Control ($\beta = 0.41$, $p < 0.01$) all positively influenced the Intention to adopt gamified mobile learning tools, thus confirming Hypotheses 9, 10, and 11.

In aggregate, the model accounted for substantial variances within the primary constructs. Specifically, Perceived Ease of Use explained approximately 29% of the variance in Perceived Usefulness, while the combined influences of Perceived Ease of Use, Perceived Usefulness, Perceived Enjoyment, and Concentration explained 51% of the variance in Attitude. Moreover, 56% of the variance in Intention was elucidated by its antecedents. These hypothesis testing outcomes are detailed in Table 4, and the corresponding structural model is illustrated in Figure 5.

4.2.5. Mediating effects of constructs on preschool teachers' adoption of gamified mobile learning tools

Regarding indirect relationships, significant effects were noted. Perceived Ease of Use exerted a positive indirect influence on Attitude ($\beta = 0.18$, $p < 0.05$), illustrating that the simplicity of using

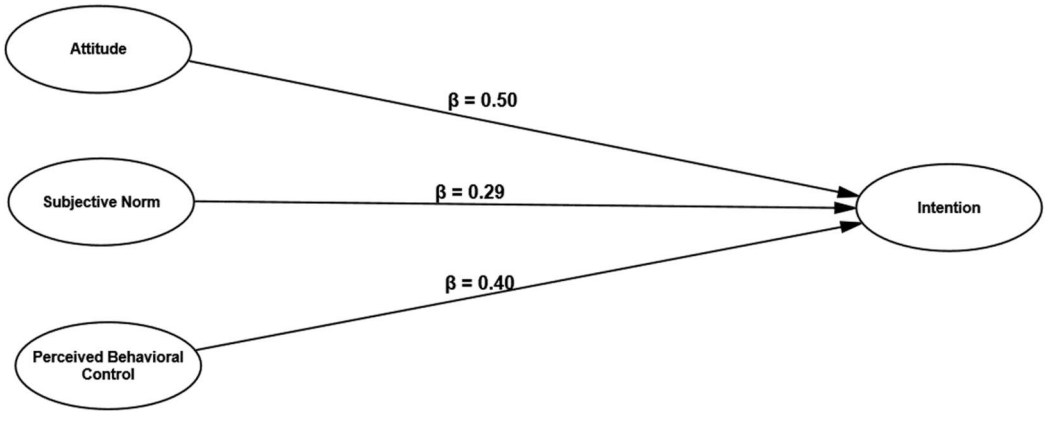

Figure 4. Structural model depicting theory of planned behavior for adopting gamified learning tools.

Table 4. Results of hypothesis testing based on the provided fabricated values for the study.

Hypothesis	Pathway	Path Coefficient (β)	t-value	State
H1	PEOU → PU	0.39	7.25	Supported
H2	PEOU → ATT	0.31	6.72	Supported
H3	PU → ATT	0.35	6.85	Supported
H4	PU → INT	0.33	7.01	Supported
H5	PE → ATT	0.4	7.92	Supported
H6	PE → INT	0.36	5.44	Supported
H7	CO → ATT	0.37	5.23	Supported
H8	CO → INT	0.34	5.14	Supported
H9	ATT → INT	0.44	6.97	Supported
H10	SN → INT	0.29	5.87	Supported
H11	PBC → INT	0.41	6.33	Supported

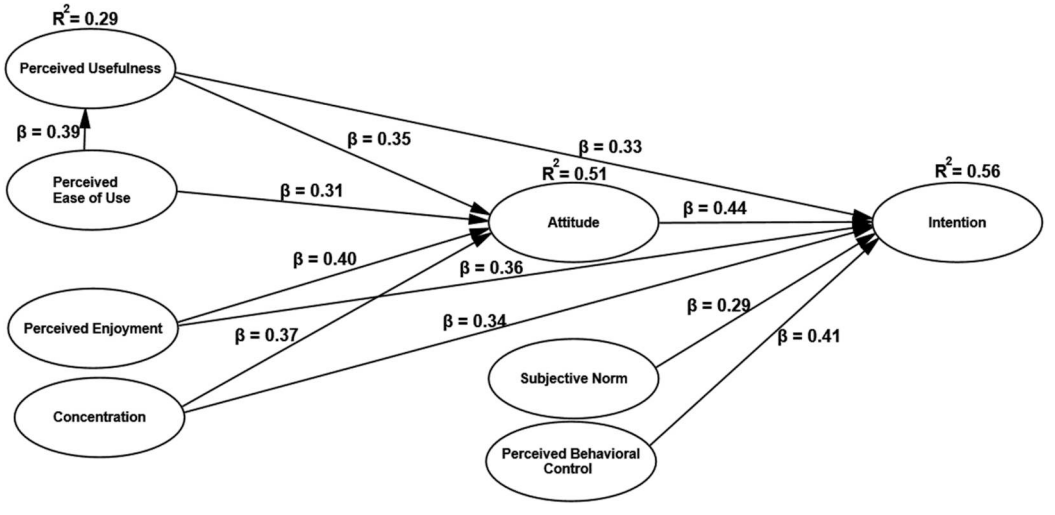

Figure 5. Path diagram results for gamified mobile learning adoption model.

gamified mobile learning tools enhances teachers' attitudes via Perceived Usefulness. Furthermore, Perceived Ease of Use also impacted Intention indirectly ($\beta = 0.14$, $p < 0.05$), indicating that ease of use promotes intention through both Perceived Usefulness and Attitude. Similarly, Perceived Usefulness displayed a modest yet significant indirect effect on Intention ($\beta = 0.15$, $p < 0.05$), solidifying its crucial role in shaping attitudes and behavioral intentions. Additionally, the constructs of Concentration and Perceived Enjoyment contributed positively to Intention indirectly (βCO = 0.12, $p < 0.05$; βPE = 0.17, $p < 0.05$), underscoring the role of engagement and enjoyment in encouraging teachers to embrace gamified mobile learning tools. These observations confirm that cognitive and motivational factors influence not only directly but also indirectly through their effects on attitudes and perceived usefulness, highlighting the multifaceted nature of technology adoption among preschool teachers. The outcomes of these indirect relationships are summarized in Table 5.

Table 5. Results of indirect effects in mediating analysis.

Indirect Effect of	On PU	On ATT	On INT
PEOU	–	0.18	0.14
PU	–	–	0.15
PE	–	–	0.17
CO	–	–	0.12

5. Discussion

This study developed and validated an integrated model combining the technology acceptance model, flow theory, and the theory of planned Behavior to explore the factors influencing preschool teachers' intentions to adopt gamified mobile learning tools. The composite model provided superior predictive power over the individual models, underscoring its robustness in explaining teachers' behavioral intentions towards gamified mobile learning adoption. The analysis confirmed significant direct relationships among perceived usefulness, perceived ease of use, and perceived enjoyment with both attitudes and intentions to adopt these tools. Furthermore, the model highlighted the critical role of perceived behavioral control and subjective norms, reinforcing their influence on adoption intentions. The study illuminated how each factor contributed distinctly to shaping adoption decisions. Specifically, perceived ease of use and perceived usefulness were foundational in enhancing teachers' attitudes towards gamified tools, which in turn, strongly influenced their intentions to adopt. Perceived enjoyment and concentration, representative of the emotional and engagement aspects fostered by gamified learning environments, were also significantly linked to both positive attitudes and direct intentions to use these tools in teaching settings. Additionally, the model elucidated the indirect effects where factors such as perceived ease of use not only impacted perceived usefulness but also indirectly influenced teachers' attitudes and intentions through these cognitive and emotional mediations. This nuanced understanding underscores the complexity of technology adoption in educational contexts and highlights the necessity of considering a broad spectrum of factors, including usability, utility, emotional engagement, and social influences, in fostering effective technology integration in early childhood education.

5.1. Implications

5.1.1. Theoretical implications

The present study delineates theoretical implications for elucidating the determinants of preschool teachers' intentions to adopt gamified mobile learning tools within the realm of early childhood education. It represents a pioneering effort to amalgamate the technology acceptance model, flow theory, and the theory of planned behavior into a unified analytical framework aimed at investigating technology adoption intentions in this specific educational sector. The Technology Acceptance Model has consistently been validated for its ability to explain cognitive factors such as perceived usefulness and ease of use in gamification-based learning (e.g. Ateş & Gündüzalp, 2025a; Bayır & Akel, 2024; Chen & Zhao, 2022; Sipone et al., 2023; Vanduhe et al., 2020; Yan et al., 2022), while Flow Theory has been crucial in highlighting the role of intrinsic motivation and engagement in this context (e.g. Kaya & Ercag, 2023). Simultaneously, the Theory of Planned Behavior has been widely applied to examine the impact of social and psychological dimensions, including subjective norms and perceived behavioral control, on the adoption of gamification-based learning (e.g. Abou Kamar et al., 2024; Ateş & Kölemen, 2025; Mata et al., 2019; Perez et al., 2023). This study constructed a composite conceptual model by integrating these diverse theoretical perspectives, thereby furnishing a more expansive exploration of the multifaceted influences on preschool teachers' adoption intentions. The empirical validation of this model demonstrated its robustness, significantly elucidating the variance in adoption intentions more effectively than any single theoretical framework could achieve independently. This integration highlights the critical necessity of amalgamating cognitive, emotional, and social factors to fully comprehend the complexities of technology adoption processes within early childhood education. The findings affirm that this comprehensive model not only enhances our understanding of these dynamics but also provides superior explanatory power, thereby offering substantive insights into the facilitation of effective technology integration in educational practices.

The findings of this investigation resoundingly confirm Hypotheses 1 and 4, illustrating the substantial impact of the technology acceptance model constructs – perceived usefulness and

perceived ease of use – on preschool teachers' intentions to adopt gamified mobile learning tools. These constructs substantially explain the variance in adoption intentions, accentuating the critical role of cognitive factors in shaping technology adoption decisions within early childhood education (Dong & Xu, 2021). The analysis highlights that preschool teachers who perceive gamified tools as both useful and user-friendly are more likely to cultivate positive attitudes towards their adoption. This relationship between functional perceptions and favorable attitudes underscores the essential role of usability and perceived utility in facilitating the adoption of technology among educators (Ateş & Gündüzalp, 2025b; Ateş & Yilmaz, 2024; Köroğlu, 2024; Tian & Wang, 2024; Zhang & Yang, 2025). Further, by analyzing technology acceptance through the TAM framework, this study provides actionable insights into enhancing educational outcomes by fostering an environment supportive of integrating innovative learning tools. This enriched comprehension is pivotal for crafting targeted interventions that promote the effective integration of gamified learning, thereby optimizing pedagogical practices and enriching educational experiences for young learners. Such findings bridge theoretical gaps by demonstrating the significant influence of TAM constructs on preschool teachers' adoption intentions, aligning with previous studies to highlight the importance of understanding and leveraging cognitive dynamics for successful technology integration in education (Hong et al., 2021).

The empirical findings from this study validate Hypotheses 5–8, anchored in flow theory, demonstrating that perceived enjoyment and concentration are critical determinants of preschool teachers' intentions to utilize gamified mobile learning tools in their instructional practices. These constructs significantly contributed to explaining the variance in teachers' adoption intentions, thereby deepening our understanding of the motivational and engagement-related aspects within the decision-making processes of technology adoption in early childhood education settings (Kim & Kim, 2015). The analysis indicates that preschool teachers who experience high levels of enjoyment and are deeply immersed in using gamified tools are more likely to adopt these technologies. This alignment of intrinsic motivation with positive behavioral intentions highlights the significant influence of flow theory in elucidating how emotional and experiential factors drive technology adoption decisions (Gupta, 2024; Huang et al., 2023; Liang et al., 2024; Shree, 2025; Zhan et al., 2024). Moreover, these findings affirm the importance of considering both the pleasurable and immersive attributes of educational technologies as pivotal in fostering educators' readiness to integrate innovative tools into their teaching repertoire. This study thereby enriches the theoretical framework by substantiating the constructs of Flow Theory as essential in predicting technology adoption, aligning with prior research that emphasizes the role of motivational dynamics in educational technology contexts (Ateş & Garzón, 2022; Hu et al., 2024; Huang et al., 2023 Thomas et al., 2024, may).

The results of this study robustly substantiate Hypotheses 9–11, which are grounded in the theory of planned behavior, illustrating that attitude, subjective norms, and perceived behavioral control are potent predictors of preschool teachers' intentions to adopt gamified mobile learning tools. Collectively, these constructs significantly account for variations in adoption intentions, emphasizing the vital role of psychological and social factors in shaping technology adoption behaviors in early childhood educational contexts (Şakır, 2024; Wu, 2024). The analysis underscores that preschool teachers who hold positive attitudes toward gamified tools and perceive a strong endorsement from their peers and administrators are more inclined to integrate these technologies into their teaching practices. Moreover, the perception of having control over the effective use of these technologies further bolsters their intentions to adopt (Bali et al., 2024; Huang & Lii, 2023). This evidence highlights the importance of aligning individual beliefs and the perceived support from the educational community to enhance motivation and thereby increase the likelihood of technology adoption. The findings extend the theoretical implications of TPB by demonstrating its efficacy in explaining the adoption of educational technologies within the specific framework of early childhood education, providing a deeper understanding of how subjective norms and perceived behavioral control interact with individual attitudes to shape adoption outcomes (Hamad

et al., 2024; Rad et al., 2023). This comprehensive understanding helps in crafting strategies that bolster these factors, thus fostering an environment conducive to the successful integration of gamified learning technologies.

5.1.2. Practical implications

The findings of this study offer several actionable insights that can significantly impact the successful adoption and integration of gamified mobile learning tools in early childhood education. The practical implications drawn from the results emphasize the need for targeted strategies aimed at enhancing preschool teachers' cognitive, motivational, and behavioral readiness for technology adoption, particularly in the context of gamified learning tools.

One of the central findings of this study is the strong influence of perceived ease of use and perceived usefulness on teachers' intentions to adopt gamified mobile learning tools. This underscores the importance of developing tools that are intuitive, easy to navigate, and offer clear educational benefits. Educational technology developers should prioritize creating interfaces that are simple yet effective, allowing teachers with varying degrees of technological proficiency to engage with the tools seamlessly. Additionally, the tools must be designed to demonstrate clear utility in the classroom, whether through improving student engagement, enhancing lesson delivery, or simplifying the teaching process. By aligning the design of gamified tools with teachers' practical needs and the constraints of early childhood education settings, developers can significantly increase the likelihood of widespread adoption. Practical steps could include user testing with actual preschool teachers during the development phase, incorporating their feedback to ensure that the tools align with the realities of early childhood education. Providing user-friendly tutorials and support documentation can further ease the initial learning curve, making the transition to using these tools smoother for educators.

The study reveals that perceived enjoyment and concentration play pivotal roles in preschool teachers' attitudes and intentions to adopt gamified learning tools. These findings highlight the necessity of making educational technologies not only functional but also enjoyable and immersive. Gamified tools that foster a sense of fun and engagement are likely to be more readily accepted by teachers, as they align with the interactive and playful nature of early childhood education. For practical implementation, training programs should focus on showcasing the enjoyable aspects of gamified learning tools and how these can be integrated into day-to-day teaching in an engaging manner. Providing examples of successful use cases and creating opportunities for teachers to experience the tools firsthand in a low-pressure environment can help foster a positive attitude toward their adoption. Moreover, developers can enhance engagement by including features that allow teachers to personalize the gamified experience, making it more relevant and exciting for both educators and students.

The study also underscores the importance of ongoing support in promoting the adoption of gamified mobile learning tools. Teachers are more likely to embrace and effectively use these tools if they have access to consistent training and technical support. This highlights the role of educational institutions and administrators in creating an environment that not only introduces new technologies but also supports their sustained use through professional development initiatives. Schools should invest in providing comprehensive training sessions, not just at the initial stages of implementation but on an ongoing basis, ensuring that teachers are comfortable and confident in using the tools. Additionally, creating peer support networks where teachers can share tips, challenges, and successes can help foster a collaborative environment that encourages technology use. Regular updates on how the tools are evolving and how they can continue to support educational outcomes will also keep teachers engaged and motivated to use the tools effectively.

5.2. Limitations and suggestions for future studies

While this study provides valuable insights into the factors influencing preschool teachers' adoption of gamified mobile learning tools, several limitations should be acknowledged to contextualize the

findings. One limitation is the absence of analysis of demographic factors such as gender, age, and teaching experience, which could have an impact on technology adoption behaviors. Previous research has shown that these variables may influence how teachers interact with and adopt new technologies. Future studies should consider including these demographic variables to explore how they mediate or moderate the relationships between key constructs like perceived ease of use, perceived usefulness, and enjoyment.

Another limitation of the study is its cross-sectional design, which restricts the ability to observe changes in attitudes and behaviors over time. A longitudinal research design could provide a more dynamic view of how teachers' intentions to adopt gamified learning tools evolve as they gain more experience with the technology. Longitudinal studies would offer deeper insights into the long-term sustainability of technology adoption, tracking shifts in use and attitudes across multiple time points.

The reliance on self-reported data is another potential limitation, as this method is subject to biases like social desirability and subjective interpretation. While self-reported data provides valuable insights into attitudes and perceptions, future research could benefit from incorporating observational data or objective usage metrics. Such data would provide a more accurate and comprehensive view of how teachers actually use gamified learning tools, offering a clearer picture of adoption patterns.

Additionally, the findings of this study may not be fully generalizable beyond the context of preschool education. The sample was limited to preschool teachers, and while this provides valuable insights into early childhood education, future studies could expand the scope to include educators from different educational levels, such as primary or secondary education. Comparative studies could provide a broader understanding of how adoption patterns vary across different teaching contexts.

Although the study focuses on understanding teachers' adoption intentions, it does not examine the pedagogical outcomes associated with the use of gamified mobile learning tools. Future research should investigate how the adoption of these tools influences teaching practices and student outcomes. Understanding the impact on instructional strategies and learning would offer practical insights into the effectiveness of gamified tools in real classroom environments. To build on the findings, future research should include demographic factors, adopt longitudinal designs, incorporate mixed methods, and expand the study to other educational levels. Additionally, exploring the impact of gamified tools on pedagogy and student learning outcomes would provide a more holistic understanding of their benefits. By addressing these areas, future studies can offer a more comprehensive view of the factors driving technology adoption in early childhood education and contribute to the development of more effective educational tools for both teachers and students.

6. Conclusion

The present study provides valuable insights into the factors that shape preschool teachers' decisions to adopt gamified mobile learning tools. It highlights the critical role of perceived ease of use and perceived usefulness in fostering positive attitudes toward technology adoption. When teachers perceive these tools as both user-friendly and advantageous for their teaching practices, they are more inclined to integrate them into their classrooms. This reflects the importance of cognitive assessments in shaping teachers' willingness to embrace new technologies. Furthermore, the study emphasizes the role of intrinsic motivation, particularly enjoyment and concentration, in influencing teachers' adoption intentions. Teachers who find gamified tools enjoyable and can remain focused while using them are more likely to develop a stronger inclination to adopt these tools. This suggests that beyond practical benefits, the emotional and immersive experiences provided by the technology significantly impact teachers' readiness to integrate it into their teaching practices. Social factors also play a vital role, as subjective norms and perceived behavioral control emerge as important determinants of adoption intentions. The study indicates that teachers who feel supported by their peers and believe they have control over using the technology are more

confident in their ability to implement these tools. This highlights the importance of a supportive school environment that encourages technological innovation and empowers teachers to feel capable of integrating new tools effectively. Overall, the study underscores the need for a balanced approach that considers both the cognitive and emotional dimensions of technology adoption, as well as the influence of the social environment. These findings offer a comprehensive understanding of the factors driving preschool teachers' adoption of gamified learning tools and pave the way for future research to explore these dynamics in greater depth.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributor

Ayşegül Şakır is an Associate Professor at Kırşehir Ahi Evran University, where she serves in the Department of Elementary Education, specializing in Preschool Education within the Faculty of Education. Her academic focus is rooted in the Social-Humanities and Administrative Sciences, specifically in Child Development and Preschool Education. Ayşegül holds a distinguished position with an ORCID identifier of 0000-0002-2979-7899 and an unique researcher ID of 46939. Ayşegül began her academic journey at Hacettepe University, where she earned her undergraduate degree in Child Development and Education from the School of Home Economics from 1979 to 1984. She continued her education at Gazi University, where she received her Master's degree in Child Development and Education from the Institute of Social Sciences in 1987. Her thesis investigated the relationship between social adaptation and parental attitudes among 14–18 year-olds attending Hacettepe University State Conservatory. Ayşegül then returned to Hacettepe University for her doctoral studies, receiving her PhD in 1990 from the Institute of Health Sciences, where she focused on the heterosexual development of students aged 14–18 at the Hacettepe University State Conservatory. Since joining Ahi Evran University in 2021, Ayşegül has been an active contributor to the faculty, teaching and mentoring within the realm of early childhood education. Her scholarly work and collaborations continue to influence the field, enriching the educational experiences of her students and shaping future educational practices.

ORCID

Ayşegül Şakir http://orcid.org/0000-0002-2979-7899

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