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Research Article

EXPLORING PARENTAL ACCEPTANCE OF DIGITAL MATH GAMES ON MOBILE DEVICES FOR PRIMARY SCHOOL CHILDREN

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ABSTRACT

This study delves into the potential of digital math games on mobile devices to enhance the learning experience of primary school children, aiming to instill a sense of hope and optimism in Vietnamese parents. In light of the increasing prevalence of digital games and concerns about screen time and game addiction, the research examines these educational tools' perceived benefits and drawbacks. Using the Technology Acceptance Model (TAM), the study explores perceived ease of use, perceived usefulness, attitudes, and behavioral intentions toward digital math games. Semi-structured interviews were conducted with 32 parents, who were introduced to "Đậu Lém Phiêu lưu ký," a digital math game selected based on educational criteria. The recorded and transcribed interviews revealed a positive shift in parental attitudes, recognizing the games' educational value and expressing willingness to allow their use if they meet quality and affordability standards. However, concerns about screen time, content control, and health impacts were noted, highlighting the need for features like time-setting and screen-lock functionalities in educational games. The study concludes that balancing educational content with engaging gameplay and addressing parental concerns can increase the acceptance and effectiveness of digital math games in primary education. Future research should expand on these findings with larger, quantitative studies to further validate the insights, providing a basis for designing better educational games that align with parents' and students' needs.

Keywords: digital math games; educational technology; elementary students; parental acceptance; Technology Acceptance Model (TAM)

1. Introduction

Digital games have become an integral part of our daily lives. According to the World Health Organization (WHO), statistics indicate that 70-80% of children aged 10-15 enjoy online games, with approximately 10-15% of these children being addicted to online gaming. In 2023, Vietnam had around 24.7 million children, of whom two-thirds had access to

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internet-connected devices at an average age of 9, which is four years earlier than the global average. It should be noted that studies have shown that users or players can easily become addicted during their usage (Liu, 2011). Digital games are becoming increasingly popular and diverse in their genres on various online application stores. Consequently, parents of elementary school students face significant challenges in selecting appropriate games and managing their children's screen time. This issue has become a major concern for many parents and educators, with some parents believing that digital games harm students.

Parental acceptance of digital games on mobile devices often includes negative perceptions due to concerns about the impact on children's development and behavior. Many parents worry about the addictive nature of these games and the potential for increased screen time to affect their children's health and well-being negatively. For instance, research indicates that parental concerns about the adverse effects of digital gaming, such as addiction and its impact on social interactions, can lead to restrictive mediation strategies. Although intended to protect children, these strategies often reflect parents' negative attitudes toward gaming (Van Petegem et al., 2019). Additionally, studies show that parents are apprehensive about the content of mobile games, such as exposure to violence and in-game advertising, which can have detrimental effects on children's mental health and development (Goh et al., 2015). Furthermore, the generational gap in understanding digital gaming can exacerbate negative perceptions, as parents may feel ill-equipped to manage and support their children's gaming activities effectively (Meriläinen, 2021).

However, when approached and utilized objectively, digital technology in general, and digital games in particular, can yield positive effects for users. Numerous studies have demonstrated and elucidated this issue. The benefits and positive impacts of digital games are evident in enhancing children's language development. For instance, when children aged 3 to 7 engage with digital games daily for two weeks, their vocabulary improves significantly (Mehdipour & Zerehkafi, 2013). Furthermore, educational digital games can promote engagement and cognitive motivation through interactive elements and various challenges (Rupp et al., 2010). Prensky (2003) also advocates for learning through digital games, asserting that the 21st century is an era of game-based learning.

Digital math games have been extensively studied worldwide, with substantial empirical evidence supporting their positive impact on math learning, including improved test scores, increased interest, and enhanced motivation. However, it remains uncertain whether parents recognize such games' usefulness and educational value or if they primarily perceive them negatively due to the general view of digital games as mere entertainment. While some research has addressed parental acceptance of digital math games, such as Bourgonjon et al. (2011), these studies focus on the school context rather than home use. Currently, there is a lack of research in Vietnam exploring parents' perspectives on digital math games in the context of both learning and entertainment at home.

In this study, we aim to introduce Vietnamese parents with primary school-aged children to a digital math game. By doing so, we seek to understand their acceptance of this type of game. Our research question is: "*How do parents of primary school children perceive and accept an introduced digital math game and digital math games in general?*"

2. Content

2.1. Theoretical background

2.1.1. Digital educational game

Play is recognized as a vital activity that contributes to the holistic development of primary school students. Children can experience and assimilate new knowledge naturally through play activities. Several studies have highlighted that play plays a significant role in children's learning process and cognitive development (Fisher et al., 2012; Piaget, 1962), alters thinking patterns, and promotes social participation and cooperation (Gestwicki, 2017). Additionally, engaging in play activities positively impacts the child's zone of proximal development (ZPD) (Slutsky & DeShetler, 2017; Vygotsky, 1978).

Associated with play activities, games are considered one of the critical elements. According to Juul (2003), a game is a system consisting of specific rules where players strive to achieve the highest possible outcome, with different outcomes indicating various values. Historically, educators have emphasized that games are essential to teaching and learning activities (Liu, 2011). From another perspective, digital games are viewed as a new medium; they are created and delivered by encoding symbolic systems and sounds, providing an immersive mode for users (Yengin, 2011). Digital games are often regarded as a form of entertainment and an effective tool for engaging students in learning activities. In related research, von Gillern and Alaswad (2016) discussed that the application of digital games in education is defined as a learner-centered teaching method designed to enhance students' learning motivation (von Gillern & Alaswad, 2016). Through these studies, digital games can be understood as an interactive virtual environment comprising specific binding rules where players need to overcome challenges at certain levels. By experiencing digital games integrated with educational content, students can naturally improve their skills and acquire new knowledge by completing the tasks and challenges presented by the game to achieve corresponding outcomes.

2.1.2. Benefits of digital math games on students learning

The benefits of digital games in students' learning process have been discussed in various studies, notably highlighting the enhancement of student interaction with mathematics (Kebritchi et al., 2010). Specifically, digital games engage students in problem-solving or knowledge acquisition through the experience of facing challenges presented by the game (Huang, 2011). Consequently, players can develop critical thinking and creativity, which are crucial and necessary skills for students in the current and future (Bai et al., 2012). Besides these benefits, digital games also positively impact students with relatively low starting points (Griffiths, 2002).

Digital math games on smartphones have been extensively studied and documented. For instance, research has shown that smartphone-based educational games significantly increase students' interest and engagement in mathematics learning. These games incorporate interactive and dynamic elements that make problem-solving and knowledge acquisition more appealing to students (Laksita et al., 2020). Additionally, mobile games in mathematics education have been found to improve students' cognitive skills and problem-solving abilities. Studies indicate that students who engage with mobile learning games demonstrate higher levels of creativity and critical thinking (Piriyasurawong & Ruangvanich, 2019). Furthermore, mobile math games effectively promote active learning and social interaction among students, which are crucial for their academic development (Yang et al., 2022).

2.1.3. Parental acceptance of digital educational games

Users' acceptance of digital educational games is often studied using theoretical frameworks related to the general acceptance of technology, with the Technology Acceptance Model (TAM) by Davis (1989) being particularly prominent. TAM posits that perceived usefulness and ease of use are the primary factors influencing the acceptance and use of technology. In the context of parental acceptance of digital educational games, research has shown that various factors, including beliefs about learning opportunities, social influences, perceived negative effects of gaming, and personal innovativeness, play significant roles. For instance, Bourgonjon et al. (2011) developed a model that explained and predicted parental acceptance of video games in classrooms, highlighting that these factors significantly influence parents' attitudes toward educational games.

Further research, such as Bassiouni et al. (2019), extended TAM to understand the family dynamics around video game acceptance, showing that social influences and intrinsic motivations significantly impact behavioral intentions towards video games. Similarly, Park et al. (2019) examined the adoption of digital learning devices among Korean students. They found that perceived playfulness can offset perceived risk, thereby influencing parental acceptance of new educational products. Research by Dele-Ajayi et al. (2019) on teachers' perspectives revealed that perceived usefulness, syllabus connectedness, and self-efficacy are significant predictors of intentions to adopt digital game-based learning, suggesting that similar factors could influence parental acceptance in educational contexts. Understanding these factors can help developers design better educational games that are likely to be embraced by both parents and students.

To research parental acceptance of digital games for their children, Davis's (1989) TAM was chosen as this study’s theoretical framework. The model has four factors: perceived ease of use, perceived usefulness, attitude, and behavioral intention to use. This guided the classification and grouping of codes during the coding of interview data. It should be noted that the TAM by Davis (1989) is traditionally applied to understand the acceptance and usage intentions of individuals directly interacting with a technology. In this study,

however, TAM is adapted to evaluate parents' acceptance of digital math games that their children will use. Here, the parents are not the primary users; their children are. This indirect relationship necessitates a focus on how parents perceive the technology's benefits and ease of use for their children rather than for themselves.

Parents evaluate the "perceived usefulness" based on their children's learning outcomes and educational enhancement. This includes the potential improvement in math skills and engagement with learning through digital games. Parents assess perceived ease of use based on how easily their children can navigate and use the digital math games with minimal supervision and frustration. Additionally, they consider how user-friendly the interface is for children and the amount of parental intervention required. Finally, the behavioral intention in this context refers to parents' willingness to facilitate and encourage using digital math games. This involves allowing children access to the technology and supporting its integration into their learning routine (Venkatesh & Davis, 2000).

2.2. Research method and participants

Our study adopted a qualitative approach within a natural setting to provide a perspective on parental views and evaluations of digital educational games for teaching mathematics. A selected digital math game was introduced to parents and semi-structured interviews were conducted with them. The interview questions explored perceived ease of use, perceived usefulness, attitudes, and behavioral intentions toward digital math games, focusing on four guided questions below:

1. Do parents perceive this game as beneficial for students' learning? (perceived usefulness)
2. After observing the students' experience, do parents consider this game appropriate for primary school children? (perceived ease of use)
3. What are parents' attitudes towards the digital math game introduced? (attitudes)
4. Are parents willing to allow their children to continue using educational games in the future? (behavioral intentions)

During the interviews, more questions and prompts were asked to collect more information about the phenomenon relating to these aspects of technology acceptance.

We employed a purposive sampling method to select participants. The criteria for selection were as follows: (1) parents or guardians of primary school students, (2) those who allow their children to use mobile devices at home, and (3) parents who are directly involved in their children's education (as in Vietnam, children may live with grandparents while parents provide financial support without directly staying and supporting the children's study at home). Ultimately, we selected 32 parents for interviews. These parents had an average age of 33, ranging from 23 to 42 years old. Among them, 11 out of 27 parents were freelancers, while the rest held office-based jobs. All participants had economic conditions ranging from moderately well-off to affluent, sufficient to meet their children's educational and electronic equipment needs. The collected data were then synthesized and interpreted

using content analysis methods (Lincoln & Guba, 1985). This process allowed us to draw conclusions and make recommendations for future research.

2.3. Game selection

We utilized a 10-criteria evaluation scale from California State University (2007) to select a game suitable for the research objectives. Additionally, we included a criterion that the game is "*compatible with the 2018 Mathematics Curriculum*" to align with the educational context in Vietnam. A game can be considered as meeting the criteria if the game's content and activities align with the specific learning objectives, competencies, and skills required in the curriculum and support the curriculum's goals for student learning. The selection scale covered specific aspects such as game organization and design, educational content design, instructional delivery, and game-based learning. The game selection process was as follows:

1. **Keyword Search**: The team searched for keywords such as "Math game," "Game Toán," and "Toán Tiểu học" on Google Play and the App Store.
2. **Including criteria**: The game's content is related to mathematics content in the primary education curriculum; the language is Vietnamese (some games have options for users to choose languages)
3. **Initial Selection**: The top 60 most prominent games were selected and installed.
4. **Evaluation**: The games were tested and assessed based on the established criteria. Two researchers (authors 5 and 6) independently evaluated the games and then compared and discussed their scores to ensure objectivity. In cases of discrepancies, the team re-evaluated the games to reach a consensus.

Ultimately, the research team selected the top 10 games with the highest evaluations based on the criteria. Due to the constraints of this paper, we do not present and discuss these games here; they are detailed in the final report of a project that encompasses this research. The highest-ranked game, "Đậu Lém Phiêu lưu ký," was chosen to be introduced to participants. This game is structured around the content framework of primary school mathematics across five grades, corresponding to five distinct games. In addition to developing exercises aligned with the curriculum, the selected game integrates new knowledge forms or reviews content for students during their gameplay experience.

Figure 1. *Icons of the game "Đậu Lém Phiêu lưu ký" (captured from Apple Store)*

2.4. Results and discussion

We transcribed the audio recordings, coded the data, and established codes, categories, and themes. The results of this process are presented in Table 1.

Table 1. *Codes, Categories, and Themes generated from interview data*

Themes	Categories	Codes	Examples
Perceived Usefulness	Learning through play (n = 10)	Learning while playing	Parent 1: My child can learn by playing this fun game.
	Learning opportunities (n = 25)	Knowledge acquisition	Parent 5: I see it as supportive of the child's knowledge acquisition.
		Calculating skill improving	Parent 8: I see that this game is helpful for my children's learning mathematics.
		Revising on-class knowledge	Parent 24: I see that the calculations in the game are like those in the teacher's homework, so doing more of the same while playing is good.
Perceived Ease of Use	Struggle while playing (n = 1)	Gameplay confusing	Parent 23: Initially, the kid does not know how to play, but after a while, he seems to enjoy the game.
	Suitably play (n = 2)	Easy-to-follow graphic and audio	Parent 4: I find the visuals easy and easy to follow, and the Vietnamese pronunciation is clear.
Attitude	Positive Attitude (n = 31)	Willingness to pay if they meet the requirements	Parent 4: I think it depends on the quality. If the game can prove its worth and deliver quality content, spending on it will not be a problem.
		The importance of educational content	Parent 25: I find this game acceptable. They should play this than other harmful games. This one helps them review their lessons.
		Similar products' consumption encouragement	Parent 17: My child plays games daily, and I support it if it is for 10 minutes of educational gaming.
	Unsupportive attitude (n = 1)	Unchallenging questions	Parent 5: The difficulty needs to be more evenly distributed across the content. The child might get bored if presented with easy questions that do not require much thinking.
Behavioral Intention to Use	Parent's concern (n = 28)	Student's health	Parent 23: Playing for a short while is acceptable; avoid staring at the screen too long. Just play for a bit, take a break, and then continue later; otherwise, it may harm visual health.
		Learning performance	Parent 16: I am afraid that he will keep playing without studying. The games he usually plays are pointless, so I fear they may affect his learning.

	Non-controllable mobile device usage	Parent 25: Playing those games is harmful. Since seeing classmates with phones, my child has been asking to connect on Zalo and play games together, leading to neglect of studies.
	Concerns about children's exposure to unhealthy games	Parent 2: This game involves both learning and playing, unlike the usual violent shooting games.
	The quality of digital games	Parent 20: I will allow my children to play this game if it is quality.
	Reasonable cost for digital games	Parent 8: I am willing to pay if the game's fee is reasonable and aligns with educational purposes. But if it is too high, I will not. There are many free educational games available.
Parent's requirements (n = 10)	A need for usage time management feature	Parent 18: I think the game should have a time-setting feature. For example, playing for a certain number of minutes should complete a game session, and then they can play again after a set period.
	Reasonable price	Parent 12: I am open to educational games, but the cost should be within the family budget. If it is unreasonable, I prefer to use the money for additional tutoring. 100,000 to 200,000 VND is reasonable.
	The appropriate mobile device usage duration	Parent 26: Effects on health cannot be overlooked, so I only allow for a maximum of 30-minute play sessions. Playing too much is not beneficial.
Usage intention (n = 31)	Satisfactory, beneficial game quality	Parent 9: I will allow my child to continue playing if the game maintains its educational value.
	Reasonable game price	Parent 13: If the fee is reasonable, I will pay for it.
	Child's usage demand	Parent 1: I will pay if my child wants to use it.
	Controlling child's usage	Parent 16: When playing games, I must sit next to them to ensure they do not exit this game to play other games.
No intention to use (n = 1)	Health and learning performance concerns	Parent 5: I do not want my child to play too much because excessive screen time can harm their eyes! Moreover, they can get absorbed and stop studying.

Note:
n: number of participants.
The transcriptions of the participant's responses were translated into English.

- **Parental Perceptions and Acceptance**

We found that the perceived usefulness of the game significantly impacts user attitudes and behavioral intentions. Parents' recognition of the educational and entertainment value of the game led to positive feedback regarding their attitudes. They considered the game appropriate for students to both learn and play, as it combines entertainment with the review of knowledge and the improvement of their children's mathematical skills. One parent stated, "*I want my child to play more; it helps them exercise their mind with calculations, and it is both entertaining and educational*" (Parent 6). Another parent mentioned, "*Playing this way is less boring, and my child can use addition, subtraction, multiplication, and division*" (Parent 13). Additionally, a parent observed, "*I see that the calculations in the game are similar to those in the homework given by the teacher, so doing more of the same while playing is good. It is a game, but it also has educational value*" (Parent 24).

- **Positive Attitudinal Shift and Usage Intentions**

Given these positive values, parents have developed a more novel and favorable perspective on digital educational games. They are increasingly inclined to allow their children to continue using educational games like those introduced for learning and entertainment. Initially, some parents perceived gaming as harmful and potentially detrimental to users, mainly primary school students. For example, Parent 25 remarked, "*Playing those games is harmful. Since seeing classmates with phones, my child has been asking to connect on Zalo and play games together, leading to neglect of studies.*"

However, after observing and indirectly experiencing the game, this parent had a change of heart, stating, "*I find this game acceptable. They should play this than other harmful games. This one helps them review their lessons.*" Similar shifts in perception were noted among other participants, such as Parent 2, who said, "*This game involves both learning and playing, unlike the usual violent shooting games.*" Parent 16 added, "*This game is educational, unlike other games I do not allow them to play*." Parent 20 also noted, "*They should play educational games like this rather than waste time on other pointless games.*" These positive responses indicate a significant shift towards accepting digital educational games for their children.

The positive attitude shift has led to favorable feedback regarding the intention to use educational games. We recorded that 31 out of 32 parents intended to use similar educational games in the future. This trend was further evidenced by their willingness to pay for these games, provided they meet quality standards and serve their children's educational needs. Several parents highlighted this willingness: "*I find the game reasonably priced between 100,000 to 200,000 VND, as long as it keeps my child engaged*" (Parent 20); "*I would allow my child to continue playing if the game maintains its educational value*" (Parent 9); "*I am willing to pay if my child wants to use it*" (Parent 1). However, some parents were cautious about the cost, suggesting that a reasonable fee should range from 100,000 to 200,000 VND.

One parent explicitly mentioned rejecting high-priced games: "*If the game's fee is reasonable and aligns with educational purposes, I am willing to pay. But if it is too high, I will not. There are many free educational games available*" (Parent 8). These insights indicate that cost is a crucial factor for parents when considering educational games, suggesting that game designers need to balance quality with affordability to appeal to potential users.

- **Observations on non-acceptance**

There was a case where one parent (Parent 5) expressed no intention of using similar educational games in the future. This reluctance stemmed from concerns about their child's health and academic performance when given free access to mobile devices: "*I do not want my child playing too much because excessive screen time can harm their eyes! Plus, once they start playing games, they get absorbed and stop studying.*" This parent also noted that the difficulty level of the game's exercises was not varied enough, with most tasks being too easy, which could lead to boredom: "*The difficulty needs to be more evenly distributed across the content. The child might get bored if they are continually presented with easy questions that do not require much thinking.*"

Based on Csikszentmihalyi's Flow Theory (2014), which posits that tough challenges can lead to frustration and disengagement, while overly easy tasks can result in boredom. To maintain an optimal learning experience, educational games need to balance the difficulty of challenges according to the learner's capabilities. We recommend that digital educational games incorporate an initial diagnostic mechanism to personalize the learning experience. Compared with other commercial games, we noticed that users can select their difficulty level (easy, medium, hard) to match their skills. This feature enables learners to engage with the game at a level appropriate for their abilities, ensuring a more balanced and engaging experience.

- **Parental concerns and Recommendations for future use**

In addition to the insights gained from positive feedback, we also explored specific concerns and expectations from parents regarding the future use of digital educational games for their children. Health and academic performance are primary concerns for parents when allowing their children to use digital math games. This observation aligns with the participants' view about digital games in Bourgonjon et al.'s (2011) study. In our study, Parent 18 suggested incorporating a feature to set usage time limits: "*I think the game should have a time setting feature. For example, playing for a certain number of minutes should complete a game session, and then they can play again after a set period.*" Many parents agreed that 30 minutes per session is appropriate for children to use the game.

Another concern is the risk of children accessing inappropriate games when given free access to mobile devices. Parent 16 shared, "*When playing games, I have to sit next to them to ensure they do not exit this game to play other unsuitable ones.*" This worry stems from

the fact that some games integrate advertisements that promote additional game plays or continuations after a loss, which can naturally attract students. Such ads can lead students to unintentionally explore other games, potentially diverting their attention from educational content and leading to game addiction.

Given these concerns, it is clear that parents are willing to pay for games that meet essential criteria. Therefore, we recommend that game designers avoid embedding advertisements within educational games and incorporate features that prevent users from exiting the game to access other content. By addressing these issues, developers can create a more user-friendly and controlled environment for children. This approach ensures that children remain focused on educational content and empowers parents to manage their children's gaming activities better. These measures will likely enhance parental acceptance and willingness to invest in digital math games for their children's education.

3. Conclusion

This study explored parents' views and acceptance of digital math games on mobile devices to provide a fresh perspective and facilitate parental awareness of their benefits. We selected a representative digital math game to introduce to parents, followed by conducting semi-structured interviews and analyzing the data using the TAM framework.

The results revealed that parents involved in the study developed a more positive outlook on educational digital games. Initially harboring negative views about students using digital games, parents began to accept and even encourage their children to continue using similar educational games like "Đậu Lém phiêu lưu kí" for both learning and entertainment after observing and indirectly experiencing the game. However, as discussed in the study, some parents remained concerned and opposed their children's use of digital games due to health impacts and content control issues.

This research offers valuable practical conclusions and suggests several design improvements for digital math games for primary school students. These include carefully integrating learning and play elements, differentiating exercise difficulty, incorporating initial diagnostic mechanisms, time-setting features, and screen-lock functionalities. These considerations are crucial for future game designers aiming to better align digital games with user preferences and needs.

In summary, this study provides positive and practically significant results relevant to the current context and trends in digital learning. Future research can build on these findings to conduct large-scale quantitative studies with more extensive survey samples, further exploring and validating the insights gained here.

❖ ***Conflict of Interest:*** *Authors have no conflict of interest to declare.*

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TRÒ CHƠI HỌC TOÁN CẤP TIỂU HỌC TRÊN THIẾT BỊ DI ĐỘNG: NGHIÊN CỨU SỰ CHẤP NHẬN CỦA PHỤ HUYNH

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TÓM TẮT

Nghiên cứu khám phá sự chấp nhận của phụ huynh Việt Nam đối với các trò chơi kĩ thuật số học toán trên thiết bị di động cho trẻ em tiểu học. Mô hình chấp nhận công nghệ (TAM) đã được sử dụng để khám phá quan điểm của phụ huynh liên quan đến tính dễ sử dụng, tính hữu ích, thái độ và ý định cho con em sử dụng trò chơi kĩ thuật số học toán. Chúng tôi thực hiện phỏng vấn bán cấu trúc với 27 phụ huynh, được giới thiệu về "Đậu Lém Phiêu lưu ký," một trò chơi kĩ thuật số học toán được chọn dựa trên các tiêu chí giáo dục. Kết quả nghiên cứu cho thấy sự thay đổi tích cực trong thái độ của phụ huynh, nhận ra giá trị giáo dục của các trò chơi và bày tỏ sự sẵn lòng cho con em họ sử dụng nếu các trò chơi này đáp ứng tiêu chuẩn chất lượng và giá cả hợp lí. Một số lo ngại về thời gian sử dụng màn hình, kiểm soát nội dung và lo lắng ảnh hưởng đến sức khỏe cũng được ghi nhận. Nghiên cứu đề xuất tương lai có thể tiến hành nghiên cứu định lượng để xác nhận thêm các thông tin chi tiết, cung cấp cơ sở cho việc thiết kế các trò chơi giáo dục tốt hơn phù hợp với nhu cầu của cả phụ huynh và học sinh.

Từ khóa: trò chơi kĩ thuật số; công nghệ giáo dục; học sinh tiểu học; sự chấp nhận của phụ huynh; mô hình TAM