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Research on the Application of Digital Technology in Designing Digital Learning Materials to Support Learning Activities For 5-6-Year-Old Preschool Children

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ABSTRACT: This study examines the application of digital technology in designing digital learning materials to support the learning activities of preschool children aged 5-6. The research results indicate that digital learning materials have begun to be utilized; however, implementation remains inconsistent, formats are limited, and effective support for teachers is still inadequate. Appropriately designed digital learning materials contribute to enhancing children's interest, active participation, and the effectiveness of knowledge acquisition, while simultaneously supporting teachers in innovating instructional methods and organizing learning activities. Based on the research findings, the article proposes a seven-step digital learning material design process, developed according to the developmental characteristics of 5–6-year-old preschool children.

Keywords: Digital technology, digital learning materials, preschool education, learning activities for 5–6-year-old children.

I. INTRODUCTION

Digital transformation has become a mainstream trend in global education, regarded as a key factor in driving the innovation of teaching and learning models, educational management, and the development of professional capacity for the teaching staff (NAEYC, 2023; Sosa Alonso et al., 2025). The integration of digital technology into educational activities not only expands access to learning materials but also reshapes the roles of teachers and learners in the learning process. In Vietnam, digital transformation is identified as a strategic goal of the Education and Training sector, aiming to enhance management efficiency, improve the quality of teaching and learning, and develop digital competence for teachers and students at all educational levels (Decision No. 749/QD-TTg, 2020; Decision No. 2222/QD-TTg, 2021).

In preschool education, the comprehensive developmental characteristics of children require teaching methods to prioritize visual experiences, play, and interaction, consistent with the psychophysiological characteristics of children in their early years. International studies emphasize that the use of technology and digital learning materials during this stage must ensure they are "developmentally appropriate" to promote language skills, thinking, and social interaction without causing negative impacts on physical movement, direct communication, and the children's health (NAEYC, 2023; Hirsh-Pasek et al., 2015).

Digital learning materials, including animations, short videos, interactive games, and simulations, are considered potential resources to support vivid and engaging learning activities for preschool children if they are designed appropriately with clear pedagogical orientation (Sosa Alonso et al., 2025). However, the practical implementation in preschool educational institutions in Vietnam shows that digital learning materials are being applied in a fragmented and unsystematic manner. Many materials do not fully meet the requirements for developmental appropriateness, interactivity, and educational value, leading to difficulties in effective field implementation (Ho Sy Hung, 2023).

Furthermore, there is currently no standardized framework for designing digital learning materials specifically for 5–6-year-old preschool children in Vietnam. This poses a challenge for teachers in designing and utilizing digital materials effectively, aligning them with children's developmental characteristics, and

complying with international pedagogical principles (NAEYC, 2023; Sosa Alonso et al., 2025). Based on these limitations, the study "Research on the application of digital technology in designing digital learning materials to support learning activities for 5–6-year-old preschool children" was conducted to clarify the requirements for designing digital learning materials suitable for this age group's developmental characteristics, while proposing a feasible design process to contribute to enhancing the effectiveness of organizing learning activities in preschool education in Vietnam.

II. RESEARCH CONTENT

2.1. Literature review

In recent years, digital transformation has been considered a mainstream trend in global education, playing a key role in innovating teaching and learning methods, enhancing management efficiency, and developing digital competence for teachers (NAEYC, 2023; Sosa Alonso et al., 2025). Digital transformation in education is understood as the process of applying digital technology systems to restructure the organization and implementation of educational activities based on digital platforms, digital data, and standardized processes. This process does not merely involve bringing devices into the classroom but also comprehensively innovating the construction of learning materials, the organization of teaching, the assessment of learning outcomes, and the strengthening of connections between schools, families, and the community (Resolution 57/NQ-CP, 2022; Resolution 71/NQ-CP, 2022).

In research on designing digital learning materials, the TPACK (Technological Pedagogical Content Knowledge) model is selected by many studies because it emphasizes the integration of content knowledge, pedagogical knowledge, and technological knowledge, helping teachers design teaching and learning activities suitable for curriculum goals and the characteristics of learning through play in preschool education (Mishra & Koehler, 2006). Reports from UNESCO and the OECD emphasize that technology only truly possesses value when used appropriately according to the context, based on scientific evidence, ensuring equity in educational access, and not replacing the central role of the teacher in direct pedagogical interactions (UNESCO, 2023; OECD, 2025). Thus, both TPACK and international recommendations agree on the view that technology is a tool to support the effective design of digital learning materials and does not replace the role of the teacher.

Smart digital learning materials in preschool education are digital resources capable of recording learning progress, adjusting task levels, and providing immediate feedback, supporting teachers in monitoring and personalizing activities for each child. They help children interact directly, saving data on actions and completion levels, from which teachers have a basis for making timely decisions suitable for the children's abilities and interests (McPake, Plowman & Stephen, 2013; Zhang & Quintana, 2012). The application of smart learning materials helps enhance educational efficiency and maintain learning interest while supporting teachers in designing and adjusting activities accurately.

The International Literacy Association (ILA) also emphasizes that rich digital resources play an important role in developing early language and literacy skills for children if used intentionally and in accordance with the children's psycho-cognitive developmental characteristics. Digital learning materials should be designed to complement traditional learning experiences, helping children gain a deeper understanding of the structure and function of text in a digital environment, rather than completely replacing direct or non-digital activities (International Literacy Association, 2019).

Papadakis and Kalogiannakis (2017), as well as Hsin, Li, and Tsai (2014), emphasize that digital learning materials, including multimedia, interactive, and smart resources, play an important role in preschool education. The authors argue that digital learning materials not only support teachers in organizing play-learning activities effectively but also enhance the interest, engagement level, and interaction capability of children, thereby contributing to promoting the comprehensive development of children in early learning environments.

Couse and Chen (2010) point out that combining devices such as iPads with interactive digital learning materials can enhance children's active participation in play-learning activities while promoting exploration and problem-solving abilities. Neumann (2018) classifies digital learning materials into groups: multimedia materials, interactive materials, and smart materials, emphasizing that selecting materials suitable for the children's needs and cognitive abilities is a key factor in enhancing the learning experience, interest, and interaction level in the classroom. These results provide an important theoretical basis for building a classification framework and guidance for effective digital learning material design in preschool education.

Rideout and Robb (2019) emphasize that technology can be integrated as a tool to support off-screen activities, helping children apply knowledge and skills to practice while enhancing initiative and problem-solving abilities. The International Literacy Association (ILA, 2019) also points out that rich digital learning materials play an important role in developing early language and literacy skills for children while supporting effective experiential learning activities. These studies highlight the role of digital learning materials in directing experiential education for preschool children, following the "watch short – do real" model, to promote practical

skills, experience, and creative thinking, while creating a theoretical basis for designing digital learning materials that are both attractive and encourage children to explore and develop comprehensively.

In Vietnam, many studies have analyzed the current status, potential, and challenges of applying digital learning materials in preschool education within the context of digital transformation. Practical surveys show that preschool teachers have begun using digital tools and resources such as Smart TVs, tablets, and interactive software to illustrate content, organize play-learning activities, and increase interest for children, but the level of implementation is still limited due to a lack of equipment, technical skills, and specific guidance (Tran Viet Nhi et al., 2021). Research also emphasizes that digital transformation not only expands the application of digital learning materials but also shapes methods for organizing activities, assessing learning progress, and supporting the personalization of education for preschool children (Truong & Nguyen, 2024; Pham & Nguyen, 2025). Furthermore, experimental studies on digital storytelling and other creative applications show that Vietnamese teachers are gradually integrating digital learning materials into activity design; however, the application remains scattered, lacks a system, and has no standardized process to ensure uniform effectiveness across educational institutions (Le & Lu, 2025). Thus, although digital learning materials have been recognized as an important tool in preschool educational innovation, domestic studies still point to the need to establish pedagogical principles, design guidelines, and unified implementation processes to enhance the quality and effectiveness of using digital learning materials for each age group and child's ability.

Digital transformation is becoming an inevitable trend in education, driving innovation in teaching-learning methods and enhancing the digital competence of teachers. In preschool education, interactive digital learning materials support the organization of play-learning activities, increasing children's interest and active participation while contributing to the development of language and thinking skills. The TPACK framework provides a basis for designing digital learning materials suitable for curriculum goals and the characteristics of learning through play; however, practice in Vietnam shows that implementation still lacks standardization. Therefore, it is necessary to design and use digital learning materials in a unified and effective direction to improve the quality of preschool education.

2.2. Research methodology

The study utilizes a combined approach of theoretical and practical research. The primary methods include the analysis and synthesis of domestic and international scientific documents related to digital transformation, digital learning materials, and preschool education to build a theoretical foundation; surveys and pedagogical observations to collect information on the current status of digital learning material application and the engagement levels of 5–6-year-old preschool children in learning activities; expert consultation to appraise the suitability and feasibility of principles and design processes; and the application of the design-illustration method to construct and clarify a digital learning material design process suitable for the Vietnamese preschool education context. Each method is used to address specific research objectives while ensuring the validity and feasibility of the proposed design process.

2.3. Developmental characteristics of 5–6-year-old preschool children and pedagogical requirements in digital learning material design

5–6-year-old preschool children are at a key developmental stage, with clear progress in the physical, cognitive, linguistic, social-emotional, and aesthetic fields, thereby creating an important foundation for learning readiness when transitioning to primary school. Correctly identifying the developmental characteristics of children at this stage is decisive for the design and use of appropriate digital learning materials in preschool education (Ministry of Education and Training, 2021).

Regarding physical development, 5–6-year-old children show clear progress in physical strength as well as gross and fine motor skills; children have the ability to coordinate movements more flexibly and perform many hand operations more accurately. However, children still have a need for regular movement and find it difficult to maintain passive activities for long periods. Therefore, the design and use of digital learning materials need a reasonable combination of interaction on devices with physical movement activities, hand operations, and practical experiences to maintain learning interest and ensure children's harmonious physical development.

In terms of cognitive development, older preschool children begin to form the ability for purposeful observation, comparison, classification, and solving simple tasks through experience and action. However, children's thinking is still mainly based on images and direct operations, while abstract thinking is only at the beginning stage. Therefore, children's knowledge acquisition process will be more effective when supported by visual elements, multimedia, and interactive activities linked to familiar contexts, helping children “learn by doing” and gradually form initial concepts.

Regarding language development, 5–6-year-old children experience strong growth in both vocabulary and expression capability. Children can use more complete sentences, recount events in sequence, and express

personal thoughts through communication with friends and adults. Domestic studies show that organizing storytelling, exchange, and linguistic interaction activities plays an important role in developing coherent speech and preparing pre-reading and writing skills for older preschool children. This places a requirement that digital learning materials prioritize communication and linguistic interaction factors, creating conditions for children to listen, respond, and express their thoughts during the learning process (Truong, 2023; Truong & Ngo, 2024).

From an aesthetic perspective, older preschool children begin to form the ability to perceive beauty through colors, shapes, sounds, and rhythms, while showing clear interest in vivid images, familiar characters, and expressive stories. Children's aesthetic emotions are closely linked with visual experiences and positive feelings; therefore, digital learning materials need to be designed with harmonious colors, clear layouts, friendly images, and moderate movement, avoiding the abuse of technical effects that cause sensory overload. The aesthetic element in learning materials not only plays a role in attracting attention but also contributes to nurturing positive emotions, stimulating imagination, and supporting children's comprehensive development.

Regarding the social-emotional aspect, 5–6-year-old children gradually form self-awareness and know how to cooperate, share, and comply with rules in group activities; however, children's emotions are not yet stable and are easily influenced by impacts from the surrounding environment. Children need a psychologically safe learning environment that encourages experimentation, accepts mistakes, and encourages the bold expression of personal opinions. In this context, digital learning materials need to create conditions for children to interact, cooperate, and communicate in meaningful learning situations under the teacher's pedagogical guidance and support.

International recommendations emphasize that at the preschool age, children learn most effectively through experience, learning through play, and direct social interaction; digital technology only has true value when used as a supporting tool, suitable for the child's developmental characteristics and not replacing the teacher's pedagogical role (UNESCO, 2019). The OECD also points out that the attention span and self-regulation ability of preschool children are limited; therefore, digital learning materials need to be designed to be concise, visual, reduce cognitive load, and connect with off-screen movement and communication activities to promote children's comprehensive development (OECD, 2020). Recent studies in Vietnam also confirm that 5–6-year-old children have made significant progress in cognition, language, and cooperation skills, yet the sustainable development of these capacities still depends heavily on a high-interaction learning environment and the teacher's pedagogical guidance.

2.4. Principles for designing digital learning materials for 5–6-year-old preschool children

Firstly, ensuring alignment with the goals of preschool education. The design of digital learning materials must stem from the goal of comprehensive development for older preschool children according to the Preschool Education Program, including the fields of cognition, language, emotion-social, aesthetics, and physical health. Each learning material must have clearly defined specific educational goals and a role in the process of organizing activities for children, such as warming up, exploring, practicing, or applying. Digital learning materials are not intended for one-way knowledge transmission or to “pre-teach” primary school content, but rather play a supporting role for children to experience, explore, and form skills through directed activities and play (Ministry of Education and Training, 2018; Zosh et al., 2017).

Secondly, appropriateness for the developmental characteristics of 5–6-year-old preschool children. Digital learning materials should be designed based on the developmental characteristics of cognition, language, attention span, and motor skills of 5–6-year-olds. Content should be manageable, using concise commands, limiting written text, and prioritizing clear, visual images. Learning tasks should be simple but with appropriate challenge, such as comparison, classification, arrangement, or recognizing patterns. Learning materials need to be linked to familiar situations in daily life, creating opportunities for children to observe, manipulate, and experiment. The duration of use should be short, divided into clear steps, and prioritize active interaction over long-term passive observation (NAEYC & Fred Rogers Center, 2012; Hirsh-Pasek et al., 2015).

Thirdly, harmonious integration of technology, pedagogy, and content. The design of digital learning materials must ensure a close combination of educational content, activity organization methods, and the technology used according to the TPACK approach. In this, technology is selected based on content goals and the form of activity organization for children, rather than being the pre-determining factor. Teachers need to simultaneously determine the content children need to form, the appropriate way to organize activities, and the most effective supporting technological tools. This approach contributes to limiting the abuse of technology that diminishes the pedagogical value of learning materials (Mishra & Koehler, 2006; Koehler et al., 2013).

Fourthly, promoting children's initiative, experience, and interaction. Digital learning materials should be designed with a child-centered orientation, encouraging children to participate actively in the learning process. Each material needs clear tasks, specific operational requirements, and timely feedback so children can recognize results and adjust their performance. Forms of interaction must be linked to learning goals, avoiding formalistic elements that cause distraction. Digital learning materials should support a child's learning cycle

consisting of brief observation, experience or practice, and exchange or sharing, whereby technology contributes to enhancing the quality of the learning experience instead of replacing the children's practical activities (Hirsh-Pasek et al., 2015; Rideout & Robb, 2019).

Fifthly, ensuring feasibility in the conditions of Vietnamese preschool education. Digital learning materials need to be suitable for the actual conditions of Vietnamese preschool educational institutions, where levels of equipment investment, preparation time, and teachers' digital competence still vary. Therefore, materials need to have appropriate capacity, be easy to use, have simple operations, and be deployable on multiple devices, prioritizing offline usage functions. Scenarios for using learning materials should be clear so that teachers can conveniently organize activities for children individually or in small groups. Simultaneously, learning materials must ensure digital environmental safety for children and be suitable for the cultural and educational context of Vietnamese preschools (Ministry of Education and Training, 2021; NAEYC, 2020).

2.5. Digital learning material design process for 5–6-year-old preschool children

Based on pedagogical principles and the developmental characteristics of older preschool children, the study proposes a seven-step digital learning material design process. This process is constructed to be easily implemented in preschool classroom practice while maintaining flexibility and repeatability for improvement and quality enhancement over time (NAEYC, 2020; Ministry of Education and Training, 2021).

Step 1. Analyzing educational goals and learning content

Teachers need to clearly identify which developmental goal of older preschool children the digital learning material is designed to support, including cognition, language, emotion-social, physical, or aesthetic fields, as well as determining the timing of using the material within the educational activity process (warm-up, exploration, practice, or application). The selected content must closely follow the Preschool Education Program, focusing on a central learning task with a suitable volume for a single use, avoiding the integration of too much knowledge that causes overload or deviates from educational goals (Ministry of Education and Training, 2021).

Step 2. Analyzing learner characteristics of 5–6-year-old children

Analyzing learner characteristics aims to ensure that digital learning materials are suitable for the cognitive ability, attention, language, and operational skills of older preschool children. Teachers need to anticipate the level at which children understand the task, their ability to interact with the device, and difficulties that may arise during use. On that basis, the content and form of presentation are adjusted towards concise commands, visual images, simple feedback, and support suggestions when children encounter difficulties, matching the developmental characteristics of children at this age (Hirsh-Pasek et al., 2015).

Step 3. Selecting formats and types of digital learning materials

Based on educational goals and actual classroom conditions, teachers select suitable types of digital learning materials, such as multimedia materials to illustrate and suggest content, interactive materials for children to directly perform learning tasks, or instructional materials to connect on-screen activities with off-screen experiences. The selection needs to consider available equipment, internet connection conditions, and the form of activity organization (whole class, small group, or individual), ensuring feasibility in the Vietnamese preschool education context (NAEYC, 2020; Rideout & Robb, 2019).

Step 4. Designing content, scenarios, and interactions

Digital learning materials are built according to a clear scenario, with a logical sequence from the opening situation, task assignment, the child performing operations, receiving feedback, to moving to the next activity. Interactions need to be directly linked to learning goals, encouraging children to think, operate, and experience instead of just passive observation. At the same time, teachers prepare open-ended questions to lead and encourage children to express their thoughts and exchange during the learning process (Hirsh-Pasek et al., 2015).

Step 5. Designing the interface and multimedia elements

The digital learning material interface needs to be designed to be simple, easy to observe, and friendly to older preschool children. Each screen should focus on one specific task; icons and buttons must be clear, recognizable, and easy to operate. The use of images, sounds, and videos should be at a moderate level, avoiding overlap or excessive length that causes distraction for the children. Simultaneously, learning materials must ensure digital environmental safety, containing no advertisements, external links, or requirements for children's personal information (NAEYC, 2020; UNICEF, 2019).

Step 6. Testing, evaluation, and adjustment

After design, digital learning materials need to be tested on a small scale, such as in one activity or with one group of children, to evaluate suitability and use effectiveness. The evaluation focuses on children's ability to understand tasks, convenience in operation, and effectiveness in supporting the achievement of educational goals. Based on the teacher's observations and feedback, the material is adjusted in terms of content, interaction, or interface to better suit preschool classroom practice (Reeves & McKenney, 2013).

Step 7. Finalization and implementation in practice

After being adjusted, the digital learning material is finalized and officially implemented in preschool educational activities. The material should be stored in an easy-to-use format, exploitable online or offline, accompanied by brief instructions for teachers regarding goals, organization methods, and follow-up off-screen activities. During use, teachers continue to observe, evaluate, and update the material to enhance the effectiveness of supporting learning activities and comprehensive development for older preschool children.

The seven-step digital learning material design process for older preschool children is built based on pedagogical principles and the developmental characteristics of 5–6-year-olds. This process ensures systematicity, feasibility, and repeatability, supporting teachers in designing, implementing, and adjusting digital learning materials suitable for preschool educational goals and actual classroom conditions, thereby contributing to enhancing the quality of organizing educational activities in the current digital transformation context.

2.7. Illustration of applying the digital learning material design process in preschool education

To clarify the feasibility, flexibility, and application value of the digital learning material design process for older preschool children, the study illustrates the application of this process through a specific material design situation in the context of Vietnamese preschool education. The selected illustration case is digital learning material supporting the activity "Getting acquainted with Mathematics: Identifying and comparing quantities within the range of 10" for 5–6-year-old preschool children in an older preschool class.

In Step 1, the educational goal of the digital learning material is clearly defined, focusing on helping children recognize quantities, compare more-less, and develop logical thinking and reasoning through experiential activities. The content of the material is built following the requirements of the current Preschool Education Program, selecting a central learning task suitable for the duration and characteristics of a learning activity, and is arranged for use during the exploration stage to evoke interest and create a foundation for subsequent activities.

In Step 2, learner characteristics are analyzed based on the limited intentional attention, the dominance of visual-graphic thinking, and the simple-level technological operation capability of 5–6-year-old children. Based on this, the digital learning material is designed with short, clear commands, combining images and situations familiar to children's lives in the Vietnamese context such as toys, animals, fruits, or daily life activities. The interactive operations are mainly simple touch, select, or drag-and-drop, accompanied by visual and immediate feedback to support children in self-adjusting actions and maintaining learning interest.

In Step 3, the type of digital learning material selected is interactive material combined with multimedia, allowing children to directly participate in learning tasks such as counting quantities, comparing groups of objects, and selecting suitable answers. The selection of this type is suitable for the goals of developing children's thinking and active participation while meeting the common infrastructure conditions in Vietnamese preschool educational institutions, where materials are often displayed via television or a computer connected to a projector during whole-class or small-group learning activities.

In Step 4, the content and scenario of the digital learning material are constructed in a logical and consistent sequence, starting from an opening situation linked to a story or familiar context, followed by the assignment of specific learning tasks, the child performing interactive operations, receiving direct feedback from the system, and moving to the next task. During the use of the material, the teacher plays the role of organizer and supporter, using open-ended questions to encourage children to think, express opinions, and exchange with friends, thereby enhancing social interaction and language in the learning activity.

In Step 5, the digital learning material interface is designed to be simple, friendly, and suitable for the visual characteristics of older preschool children. Each screen focuses only on one specific learning task; colors are harmonious, images are sharp, and operational icons are clearly expressed and easily recognizable. The use of sound and effects is controlled at a moderate level to support learning content without causing distraction. Simultaneously, the material ensures digital environmental safety, containing no advertisements, external links, or requests for children's personal information.

In Step 6, the digital learning material is tested on a small scale with a group of children to evaluate suitability in terms of content, form, and the ability to support achieving educational goals. The evaluation process focuses on observing children's level of task understanding, ability for independent operation, interest level in participating, and the effectiveness of feedback support within the material. Based on the test results and teacher feedback, the material is adjusted regarding presentation speed, task difficulty level, interaction method, and feedback form to better suit the practice of organizing preschool educational activities.

In Step 7, after being finalized, the digital learning material is officially implemented in educational activities in the older preschool class. The material is stored in a format convenient for repeated use, accompanied by brief instructions for teachers on goals, organization, and follow-up off-screen activities, such as movement games, small group activities, or experiences with real learning tools to consolidate and expand knowledge for the children.

Through the above illustration, it can be affirmed that the digital learning material design process for older preschool children is not only theoretical but also possesses the ability for flexible and effective application in the preschool education context. Adhering to the process helps teachers proactively design, implement, and adjust digital learning materials suitable for educational goals, children's developmental characteristics, and actual classroom conditions, thereby contributing to enhancing the quality of organizing educational activities in the current digital transformation context.

III. CONCLUSION

The study has clarified the increasingly important role of digital learning materials in preschool education within the context of digital transformation, particularly for 5–6-year-old preschool children. Results show that digital learning materials, when designed in accordance with educational goals and children's psychophysiological characteristics, have the ability to visualize learning content, enhance interactivity, and promote interest and initiative in children during their participation in activities. However, educational effectiveness is only ensured when digital learning materials are used as a supporting medium, closely linked with direct experiential activities, instead of completely replacing traditional forms of learning.

Based on the TPACK theoretical framework, the study has systematized the principles of digital learning material design and proposed a closed seven-step design process, ensuring the integration of content, pedagogical methods, and technology. The illustration of the process through the "Getting acquainted with Mathematics" teaching scenario shows the feasibility and flexible application capability of the model within the common infrastructure conditions at Vietnamese preschool educational institutions today.

The results of this study contribute to supplementing the theoretical and practical basis for designing and using digital learning materials in preschool education, while suggesting directions for developing digital competence for teachers and perfecting conditions to ensure the quality of digital learning material implementation in the coming time.

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