



Interactive Flat Panels for Early Childhood Cognitive and Social Development: A Pedagogical Framework

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Abstract

This study aims to analyze the use of Interactive Flat Panels (IFP) in supporting early childhood development at Tunas Rimba II Walikukun Kindergarten. The study used a descriptive qualitative approach with data collection techniques through observation, interviews, and documentation involving 3 teachers and 25 students aged 4–6 years. Data analysis was carried out through data reduction, data presentation, and drawing conclusions referring to the Miles and Huberman model. The results showed that the use of IFP increased children's engagement and motivation to learn through interactive visual media, with most students demonstrating noticeably higher active participation and sustained attention during IFP-based sessions compared to conventional teaching methods, while also contributing to cognitive development, fine motor skills, and social interaction. The main obstacle found was the limited competence of teachers in operating the technology. Therefore, adaptive learning strategies and strengthening of teachers' digital literacy are needed so that the use of IFP can run optimally

Keywords: *Interactive Flat Panel; early childhood; interactive learning; child development*

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Introduction

The digital transformation in education has encouraged Early Childhood Education (PAUD) institutions to increasingly utilize technology to support the learning process. This is reflected in data from the PAUD Directorate, which shows that 183,457 PAUD units, or 90.67% of the total PAUD units recorded in Dapodik, participated in the digital-based Learning Environment Survey (Sulingjar) in 2023. This high level of participation indicates the increasing readiness and involvement of PAUD units in the digital education ecosystem. Along with this development, various technology-based learning tools have begun to be adopted, such as interactive whiteboards, educational tablets, and digital learning applications, to create more engaging, interactive, and developmentally appropriate learning experiences for early childhood. Among these tools, the Interactive Flat Panel (IFP) has emerged as one of the most rapidly adopted innovations, an interactive touchscreen device capable of presenting material in a visual, dynamic, and participatory manner ((Son'any, 2026); (Sari et al., 2026). The use of IFP in the classroom has been shown to encourage student enthusiasm and motivation to learn through its unique visualization and interactivity features (Patta et al., 2025a). Compared to conventional whiteboards or standalone tablets, IFP offers larger-scale, multi-user interactivity that is particularly suited to classroom settings. Early childhood education (ECE) is a crucial phase in establishing the foundation for children's cognitive, motor, language, and socio-emotional development. The multisensory characteristics of IFP combining visual, audio, and tactile elements align closely with the play-based, holistic learning approach that ECE requires (Aisyah & Zahro, 2025);(Farina, 2024); (Hudain et al., 2023).

Studies on interactive technology in early childhood education (PAUD) show that touchscreen and multimedia-based media can improve children's cognitive abilities through direct interaction and visual stimulation (Fatrikah et al., 2024); (Pangarti & Yaswinda, 2023). The use of technologies such as Augmented Reality has also been shown to improve literacy, conceptual understanding, and interactivity in early childhood education (Murdy & Wilyanita, 2023). Ideally, given this potential, IFP implementation in PAUD should be supported by empirical evidence demonstrating its effectiveness across all developmental domains. In reality, however, research specifically examining IFP in the PAUD context remains very limited: most existing studies focus on elementary and secondary levels, emphasizing academic learning outcomes rather than early childhood holistic development (Rustiyana, 2024); (Patta et al., 2025a). This gap is particularly evident in Indonesia, where in-depth studies on IFP's impact on children's cognitive, motor, language, and socio-emotional development within PAUD institutions remain scarce.

The implementation of IFP is not without challenges, particularly regarding teacher competency in operating technology. Research shows that while technology offers great potential, its use is often hampered by a lack of adequate training and resources (Soniran, 2024); (Afifah & Maghfirah, 2026b). Teachers' acceptance of digital learning media varies and is influenced by their perceptions and direct experiences in integrating technology into the teaching and learning process ((Pinem, 2025);(Ningrum & Wardhani, 2022).

Based on this empirical and practical gap where the effectiveness of IFP in supporting early childhood holistic development has not been adequately measured, particularly within the Indonesian PAUD context this study seeks to answer: (1) What is the pattern of IFP utilization in learning activities at Tunas Rimba II Walikukun Kindergarten? (2) To what extent does IFP utilization contribute to children's cognitive, fine motor, language, and social-emotional development? (3) What obstacles do teachers face, and what strategies can overcome them? Accordingly, this study aims to analyze the utilization of IFP in supporting early childhood development at Tunas Rimba II Walikukun Kindergarten, identify the obstacles encountered, and formulate adaptive strategies to optimize its use.

Methodology

This study uses a qualitative approach with an instrumental case study design (Yin, 2018). An instrumental case study was selected — rather than an intrinsic case study, which focuses on understanding the uniqueness of a single case for its own sake, or a collective case study, which compares multiple cases because the primary interest of this research is not TK Tunas Rimba II Walikukun itself, but rather the broader phenomenon of IFP implementation in PAUD, for which this school serves as an illustrative and information-rich case (Yustinaningrum, 2019).

The research participants were selected using purposive sampling technique based on criteria set according to the research objectives (Nurfajriani et al., 2024). The total number of participants was 38 people, consisting of: 2 class teachers who taught Group A and Group B, with inclusion criteria: having at least 2 years of teaching experience, actively using IFP in learning for at least the last 3 months, and willing to participate in the entire series of data collection; 35 students, consisting of 16 children from Group A (aged 4–5 years) and 19 children from Group B (aged 5–6 years), with inclusion criteria: actively registered, attending at least 80% during the observation period, and not having special needs that require individual services; and 1 school principal as a key informant to explore institutional policies related to the procurement and use of IFP. Prior to data collection, all adult participants and guardians of children were given an explanation of the research and asked to sign an informed consent form.

Data were collected using three main instruments. First, a semi-structured interview guide comprising 10 open-ended questions was used with teachers and the school principal, covering IFP usage patterns, perceived impact on children's development, and implementation challenges. Second, an observation checklist was used to record IFP usage frequency, features utilized, and children's engagement behaviors during learning sessions (as summarized in Table 1). Third, documentation in the form of photographs, videos, and lesson materials was collected to triangulate observational findings. The interview guide and observation checklist were reviewed by two experts in early childhood education for content validity prior to use.

Data analysis followed the interactive model of Miles and Huberman (Saputra et al., 2025); ((Farhana & Cholimah, 2024), consisting of three stages. First, data reduction involved selecting and coding raw field notes, interview transcripts, and documentation according to four predetermined categories: IFP usage patterns, cognitive development indicators, motor and social-emotional indicators, and implementation obstacles. Second, data presentation involved organizing the reduced data into thematic narrative summaries and a matrix table (Table 1) to visualize patterns of use across observation sessions. Third, conclusion drawing

involved interpreting these thematic patterns against the research questions, with conclusions verified iteratively as new data emerged during the observation period.

Data validity was ensured through four strategies. First, source triangulation was conducted by comparing data obtained from teachers, students' behavior, and the school principal to confirm consistency across informants. Second, method triangulation was applied by comparing findings across observation, interview, and documentation techniques to reduce single-method bias. Third, member checking was carried out by returning interpreted findings to the two class teachers for confirmation of accuracy. Fourth, prolonged engagement was achieved through repeated classroom observations across a minimum of six weeks, allowing consistent behavioral patterns to be distinguished from incidental occurrences

Results and Discussion

Based on direct observations, in-depth interviews, and documentation studies conducted at Tunas Rimba II Walikukun Kindergarten, we obtained a concrete picture of the implementation of learning using Interactive Flat Panels (IFP). Across the four-week observation period, children consistently engaged with IFP-based activities within each session (Table 1), which recurred two to four times a week and lasted between 5 and 20 minutes depending on the activity type. Concrete indicators of this engagement included children volunteering to touch the screen during educational games, imitating movements or sounds shown on screen, and remaining visibly attentive throughout the delivery of material a level of sustained attention that teachers reported as noticeably longer than in conventional, non-IFP sessions. A representative moment of this learning atmosphere is shown in the following documentation.



Figure 1. Learning Atmosphere Using Interactive Flat Panel

Information:

Right : The teacher is guiding the explanation of the material to students.

Left : Children interact directly and observe the display on the IFP screen.

Figure 1 above depicts a learning situation where children are enthusiastically observing the explanation of the material presented on the IFP screen. The teacher acts as a facilitator, guiding the learning process by utilizing various available features. It's clear that the children are highly focused and engaged with the visualizations displayed on the screen. This is clear evidence that the IFP can capture children's attention and concentration longer than conventional learning methods. The children don't just stare silently, but are actively engaged, both physically and mentally, in following each stage of the activity.

Observations show that IFP is used in various learning activities, including delivering material, playing educational games, and presenting children's work. Teachers utilize touchscreen features, moving images, and sound to capture children's attention. The material presented includes introductions to letters, numbers, colors, shapes, and general knowledge about the surrounding environment. Details regarding the pattern and intensity of IFP use at Tunas Rimba Walikukun Kindergarten can be seen in Table 1 below.

Table 1. Patterns of Use of Interactive Flat Panels in Learning

No	Type of activity	Frequency of Use	Duration Per Session	IFP Features Used
1	Delivery of Material	3 - 4 times a week	15 - 20 minutes	Display Images, Videos, Sounds
2	Educational Games	2 - 3 times a week	10 - 15 minutes	Touch Screen, Interactive Quiz
3	Presentation of Children's Work	1 time a week	10 - 15 minutes	Document Camera, Gallery View
4	Pray and Sing	Every day	5 - 10 minutes	Audio and Song Playback

Source: Field Observation Results, 2026

Based on Table 1 above, it can be seen that IFP is most frequently used for delivering lesson materials, with a frequency of 3 to 4 times per week. This indicates that IFP plays a more dominant role as a tool to assist in delivering material, making it more engaging and easier for children to understand. The duration of use implemented by teachers ranges from 5 to 20 minutes per session. This is very appropriate and in line with the characteristics of early childhood, who have short attention spans, so the presentation of material is carried out in stages but is concise and engaging.

However, in practice, the utilization of IFP features has not been optimal. Teachers tend to only use basic features such as video playback or image display, while advanced interactive features such as digital writing tools, media integration, or open internet access are rarely used. This is due to teachers' limited technical knowledge and skills in operating supporting software. This finding supports research findings (Rasmani et al., 2023) which stated that teacher skills are the key to successful technology implementation.

Table 2. Summary of Children's Developmental Achievement Levels

Development Aspects	Highly Developed (%)	Developing as Expected (%)	Starting to Develop (%)	Not Yet Developed (%)
Cognitive	40	50	10	0
Language	35	55	10	0
Physical Motor	30	60	10	0
Social Emotional	45	45	10	0

Source: Results of Child Development Observation Data Processing, 2026

Based on the data in Table 2, it can be seen that in the cognitive aspect, 40% of children are in the "Very Developed" category, and 50% of children are in the "Developing as Expected" category. This means that overall, 90% of children at Tunas Rimba II Walikukun Kindergarten have achieved very good cognitive development after using IFP media in learning. This is in accordance with the findings (Rustiyana, 2024) which state that technology-based media can significantly improve cognitive learning outcomes due to its ability to visualize abstract concepts into real and easy to understand.

Furthermore, IFP has also proven effective in developing language skills and early literacy. Children are more confident in speaking, asking questions, and answering questions due to the fun and relaxed learning environment. Children's vocabulary increases as the narrative explanations in the learning materials are explained. In terms of language, 35% of children have significantly developed, and 55% have achieved expected development. These results support the opinion (Aulia & Nopriansyah, 2025) that interactive media significantly supports the development of language competence in early childhood.

The use of touchscreens on IFPs indirectly trains children's fine motor skills. Finger movements to touch, swipe, or point at objects on the screen develop hand-eye coordination and finger dexterity. This activity provides a fun and engaging learning experience compared to writing or drawing on paper, which can sometimes be boring. Based on Table 2 above, in terms of physical and motor skills, 30% of children achieved the highly developed category, and 60% achieved expected development.

This aligns with the findings of (Sianipar et al., 2025) and (Syofiyanti et al., 2025), who stated that interactive screen-based technology can significantly increase children's focus and enthusiasm (Rustiyana, 2024) also confirmed that enjoyable learning experiences through IFP have been proven effective in increasing learning interest. Beyond just visual appeal, this high level of engagement also builds children's intrinsic motivation to continue trying and exploring, which is a crucial asset in the early learning process ((Jasiah et al., 2023); (Pinem, 2025)).

This increased engagement directly impacts children's cognitive development. Through the animated displays, educational videos, and interactive games presented by IFP, children gain concrete experience in understanding abstract concepts that were previously difficult to grasp through verbal exposure or static images alone. Teachers report that children's understanding of colors, numbers, geometric shapes, and cause-and-effect sequences has measurably improved after using IFP in their learning.

Drawing on multimedia learning theory (Mayer), the combination of visual and auditory input on the IFP reduces children's cognitive load when processing abstract concepts. This is consistent with (Pangarti & Yaswinda, 2023), who found that multimedia-based learning significantly improves early childhood cognitive abilities compared to conventional methods. (Fatrikah et al., 2024) reinforces this by emphasizing that interactive media allows for the optimization of cognitive development through rich visual stimulation. IFP's ability to present multisensory content combining text, sound, images, and movement creates a more memorable and enjoyable learning experience for children (Hilmiah & Salehudin, 2024). The integration of digital educational games also encourages the development of children's language skills, as stated by ((Aulia & Nopriyansyah, 2025) and (Susilo et al., 2024), who highlight the role of digital innovation in supporting early childhood language and literacy development.

The use of video-based media in IFP has also been shown to support children's creativity, as confirmed by (Asmara et al., 2023), who found that technology-based learning media positively influences creativity in early childhood. In addition to cognitive development, children's fine motor skills also receive meaningful stimulation through direct interaction with the IFP touchscreen. Activities such as drawing, matching images, pressing virtual buttons, and dragging objects with fingers train children's hand-eye coordination in a repetitive and enjoyable way. Unlike traditional motor skills training, which can often feel monotonous, interaction with IFP provides a playful dimension that makes children unaware that they are practicing motor skills.

(Rejeki et al., 2025) emphasized that developing digital literacy through interactive media also stimulates early childhood psychomotor skills. (Sitanggang et al., 2025) added that integrating technology with play in preschool environments provides a meaningful context for children's physical development. The fine motor stimulation that occurs in this enjoyable learning context also contributes to building children's confidence in exploring technological devices independently, which is the initial foundation for digital literacy (Mannassai et al., 2026).

Another consistently observed developmental dimension is increased social interaction among children. IFP, as a tool placed at the front of the classroom and used collectively, creates a natural context for children to discuss, share opinions, take turns, and collaborate on tasks. Activities such as taking turns answering on-screen questions or solving puzzles together foster positive social dynamics in the classroom. (Mahardika et al., 2023) found that educational games and interactive media significantly contribute to the creativity and social interaction of early childhood.

(Patta et al., 2025b) also emphasized that the use of interactive panels in the classroom significantly impacts teaching dynamics and encourages collaboration. (Aisyah & Zahro, 2025) specifically demonstrated that IFP in the context of early childhood education (PAUD) can transform children's interaction patterns to be more open and collaborative. The social interactions fostered through this medium not only strengthen children's communication skills but also prepare them to work together in an increasingly technology-dependent environment (Ramadhani et al., 2024).

Despite the significant positive impact of IFP, this study also identified several obstacles that require serious attention. The most prominent obstacle is teachers' limited technical competence in optimally operating IFP. Most teachers interviewed admitted that they had only utilized basic IFP features, such as displaying slides and videos, while more advanced interactive features such as real-time annotation, collaborative whiteboards, and educational application integration had not yet been utilized. This condition reflects the findings of (Afifah & Maghfirah, 2026a), who identified limited technological competence as a major challenge for kindergarten teachers in various regions.

(Soniran, 2024) corroborates these findings by stating that technology integration in early childhood education (PAUD) is often hampered by a lack of adequate training for educators. (Irmawati et al., 2025) cautions that the use of digital media in PAUD must be balanced with careful pedagogical considerations to

prevent it from becoming merely passive entertainment for children. However, this optimistic picture should be weighed against caution expressed elsewhere in the literature. (Nurhidayah, 2026) found that greater screen time duration and intensity among Indonesian preschool children was associated with a higher risk of suboptimal personal–social development, as excessive exposure reduces opportunities for direct social interaction. (Maulidia & Muthi, 2025), (Bernard et al., n.d.) in a systematic scoping review of screen time research in early childhood, reported that undesirable or non-significant associations with developmental outcomes were far more common than desirable ones. The present findings suggest that this risk can be mitigated when IFP use remains teacher-guided and time-bounded, as observed at Tunas Rimba II Walikukun Kindergarten. Reliance on technology without proper guidance risks diminishing the quality of interactions between teachers and children, which is the core of early childhood learning (Riana et al., 2025).

In response to these challenges, this study identifies several adaptation strategies that can be implemented to optimize the use of IFP in early childhood education institutions. Based on these findings, three strategies are recommended to optimize IFP use in early childhood education institutions: strengthening teacher capacity through ongoing technical and pedagogical training, developing lesson plans that systematically integrate IFP features according to children's developmental milestones, and strengthening collaboration between schools and parents to ensure continuity of technology-based learning experiences from school to home. First, strengthening teacher capacity through ongoing technical and pedagogical training is an urgent need. (Maharani et al., 2026) emphasized that teachers' role in fostering children's cognitive development in the digital era depends heavily on their ability to utilize technology creatively and effectively.

(Rasmani, 2023) also demonstrated that interactive multimedia learning training programs for early childhood education (PAUD) teachers have been shown to increase the effectiveness of digital media use in the classroom. Second, developing lesson plans that explicitly integrate IFP features according to children's developmental milestones needs to be systematic, so that IFP use is not incidental but rather planned and directed (Fauziddin et al., 2021). Third, strengthening collaboration between schools and parents to support the continuity of technology-based learning experiences is also a crucial factor. (Latif et al., 2023) emphasized that strategic collaboration between PAUD institutions and parents in the digital era, including through parenting programs, contributes significantly to the effectiveness of children's learning.

(Nurmahfudhah & Widyasari, 2025) added that parents' understanding of digital-based media in supporting their children's learning needs to be continuously improved to ensure continuity of stimulation from school to home. By combining these three strategies, the use of IFP at Tunas Rimba Walikukun Kindergarten has the potential to provide a much more optimal and sustainable impact on the holistic development of early childhood (Bintang et al., 2024);(Riskia et al., 2025).

Conclusion

The use of Interactive Flat Panels (IFPs) at Tunas Rimba Walikukun Kindergarten has been proven to have a positive impact on early childhood development, particularly in increasing learning engagement, cognitive stimulation, fine motor development, and social interaction. The visual and interactivity advantages of IFPs make them an effective and enjoyable learning medium for early childhood. However, the effectiveness of IFPs depends heavily on the teacher's pedagogical and technical competence in integrating technology into the learning process. This research underscores the need for a comprehensive implementation strategy, including ongoing teacher training, the development of adaptive lesson plans, and collaboration between schools and parents. Further research is needed to assess the long-term impact of IFP on various aspects of child development and to develop a standardized IFP implementation model in early childhood education institutions.

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