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Implementing large interactive displays in elementary classrooms: An evaluation of teacher adoption, student engagement, and parental perceptions

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Abstract

This study investigates the pilot implementation of large interactive touch display screens in 86 lower-grade classrooms across 12 elementary schools in Taipei City, with a focus on three dimensions: teacher adoption, student engagement and learning outcomes, and parental perceptions. Employing a mixed-methods design, the research integrates quantitative survey data with qualitative insights from teacher interviews, classroom observations, and parent questionnaires. Results demonstrate high levels of teacher acceptance, with perceived ease of use and usefulness yielding mean ratings above 5.0 on a six-point Likert scale. Teachers reported enhanced instructional interactivity and student attentiveness, particularly when leveraging interactive or gamified learning activities. Observations indicated positive effects on student motivation and performance, especially in core subjects such as language and mathematics. Parental feedback, drawn from over 1,000 respondents, reflected broad support, highlighting increased engagement and perceived benefits of learning. Nonetheless, some parents expressed concerns regarding screen time and called for greater transparency around instructional goals. The findings underscore the pedagogical potential of large interactive displays in early elementary education, while also emphasizing the need for robust technical infrastructure, sustained professional development, and proactive home-school communication to ensure long-term efficacy and stakeholder alignment.

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1. Introduction

The digital transformation of education has become a global priority, with school systems worldwide investing in technology to enhance the effectiveness of teaching and learning (Haleem, Javaid, Qadri, & Suman, 2022; Timotheou et al., 2023). Taiwan has actively advanced its digital learning agenda in recent years, particularly accelerated by the global shift toward online learning during the COVID-19 pandemic (Dhawan, 2020). One flagship initiative, the "Classroom Broadband and One Tablet per Student" program, has substantially improved technological infrastructure and facilitated the integration of information and communication technologies (ICT) into classroom practices. Building upon these efforts, the Taipei City Department of Education initiated a pilot program to install large interactive touch display screens, commonly referred to as Interactive Flat Panels (IFPs) or Interactive Whiteboards (IWBs), in lower-grade elementary classrooms.

These large-format interactive displays are designed to replace traditional chalkboards and projectors, offering multimedia capabilities and touch-based functionalities that support more engaging and student-centered instruction. For early elementary students in Grades 1 and 2, who are in a critical stage of cognitive and social development, interactive, intuitive, and visually rich learning experiences are particularly beneficial. Previous research has shown that these technologies can significantly enhance student engagement and academic achievement, particularly in foundational subjects such as language and mathematics. Meta-analytical findings have further confirmed that IWB-supported instruction yields higher cognitive learning outcomes compared to conventional teaching methods. Additional studies have highlighted the positive influence of interactive media on young learners' numeracy skills and intrinsic motivation.

Despite these promising outcomes, the successful integration of large interactive displays in classrooms depends heavily on teacher adoption and technological competence. The Technology Acceptance Model (TAM) (Davis, 1989) provides a widely accepted framework for understanding teachers' willingness to adopt educational technologies. According to TAM, two key factors, perceived ease of use and perceived usefulness, shape individuals' attitudes and behavioral intentions toward technology adoption (Davis, 1989; Venkatesh, Morris, Davis, & Davis, 2003). When teachers perceive a digital tool as both easy to use and pedagogically valuable, they are more likely to integrate it into their instructional routines (Li et al., 2025; Mailizar, Almanthari, & Maulina, 2021). A meta-analytic review further confirmed the robust influence of TAM constructs on teachers' adoption of digital technology (Scherer, Siddiq, & Tondeur, 2019) and systematic reviews have identified self-efficacy, subjective norms, and facilitating conditions as additional predictors (Granić, 2022). However, barriers such as inadequate training, insufficient technical support, or unstable infrastructure can impede the meaningful use (Fitria, 2024).

In addition to teachers' acceptance, parental engagement plays a critical role in the implementation of educational technologies at the elementary level. Parents' understanding and support can enhance the continuity of learning between school and home, while also influencing children's attitudes toward technology-based instruction. Nevertheless, concerns about increased screen time, potential health implications, and the lack of transparency in pedagogical objectives are often cited. A recent nationwide survey in Taiwan reported that more than half of teachers identified parental cooperation as a challenge in integrating digital technologies into teaching (Parenting, 2022). These findings underscore the importance of clear and consistent communication with parents to foster trust and a shared understanding.

1.1. Purpose of the Study

Given this context, the present study seeks to evaluate the pilot implementation of large interactive displays in lower-grade classrooms across Taipei City. Specifically, it addresses the following research questions.

1.1.1. Teacher Adoption and Effectiveness

To what extent does the integration of large interactive display screens enhance teachers' digital teaching capacity and instructional practices? What challenges or support needs are identified?

1.1.2. Student Engagement and Learning Outcomes

How does the use of interactive displays influence students' motivation, classroom participation, and academic performance across core subjects?

1.1.3. Parental Perceptions and Satisfaction

What are parents' views on the use of interactive displays in their children's classrooms? Are they satisfied with the initiative, and what concerns or suggestions do they express?

By answering these questions, the study aims to provide empirical evidence on the pedagogical value of large interactive displays in early elementary education. The findings will inform educators, school leaders, and policymakers on strategies for scaling educational technologies in ways that promote sustainability, instructional quality, and inclusive stakeholder engagement. The paper's structure comprises a review of relevant literature, followed by a presentation of the research methodology, the results, and a discussion of the implications for future implementation.

2. Literature Review

2.1. Interactive Displays in Education

Large interactive display screens, such as IFPs and IWBs, have become increasingly prevalent in educational contexts worldwide. These technologies are gradually replacing traditional teacher-centered instruction with more interactive and student-centered approaches. Touch-sensitive screens enable both teachers and students to manipulate content directly while integrating a wide range of multimedia resources and real-time annotation tools. Research has consistently demonstrated that interactive displays serve as effective instructional media by providing multimodal learning experiences that engage visual, auditory, and tactile senses simultaneously. A meta-analysis on touchscreen learning further confirmed that touch-based devices can effectively promote young children's learning, particularly in visuo-spatial domains (Xie et al., 2022).

Teachers can project dynamic content, including videos, animations, and educational games, and can annotate or illustrate directly on the display surface. These capabilities extend beyond those of traditional whiteboards by supporting richer forms of interaction and representation. Turopova and Qobulov (2025) emphasized that IFPs, when combined with cloud-based platforms and artificial intelligence technologies, can enhance digital instruction by offering real-time feedback, personalized content, and collaborative learning opportunities. The flexible design of IFPs enables educators to transition smoothly between presenting information, engaging students in discussion, and conducting assessments, thereby enhancing instructional flow and maintaining student attention.

Additionally, interactive displays can be linked with student devices such as tablets to enable blended learning environments. For instance, students can respond to quizzes or contribute ideas that appear instantly on the shared screen. This form of integration aligns with the trend toward one-to-one digital classrooms and has been shown to increase student participation (Elma, Küçük, & Samancı, 2024). However, scholars caution that the full benefits of IFPs are only realized when the technology is thoughtfully embedded within pedagogical practices. Using the screen solely as a passive display tool yields limited instructional value. As Fitria (2024) noted, professional development is essential for equipping teachers with the knowledge and skills needed to design interactive and engaging lessons. Chen (2025) similarly argues that sustained implementation depends on targeted training and institutional support.

2.2. Impact on Student Learning and Engagement

A substantial body of literature has explored the effects of interactive display technologies on student learning outcomes, particularly within primary education. The general consensus among researchers is that, when implemented appropriately, these tools enhance student engagement, motivation, and academic achievement. Shi, Zhang, Yang, and Yang (2021) conducted a meta-analysis of IWB-based instruction, finding significant improvements in cognitive outcomes across various subjects and educational levels.

These positive effects are often attributed to the capacity of interactive displays to accommodate diverse learning preferences. Visual and kinesthetic learners, in particular, benefit from the interactive graphics and hands-on manipulation enabled by such technologies. In early-grade settings, IFPs have been especially effective in supporting learning in mathematics and language arts. Mumpuni and Mulyawati (2024) reported that the use of smartboards in Grade 2 math instruction led to notable gains in students' addition and subtraction skills compared to traditional teaching approaches. Similarly, Mailizar et al. (2021) found that interactive number boards significantly enhance young children's numeracy abilities, suggesting that visual and tactile learning environments promote a deeper conceptual understanding.

In addition to academic outcomes, interactive displays have been associated with reduced learning anxiety and more positive attitudes toward schoolwork. One study found that incorporating Web 2.0 tools alongside interactive whiteboard (IWB) technology in mathematics classrooms led to improved performance and decreased student anxiety. The interactive nature of activities such as quizzes, games, and drag-and-drop exercises helps transform passive learning into active participation. This transformation is considered essential for sustaining student motivation and increasing time-on-task, especially among young learners who are particularly responsive to playful, hands-on experiences. Indeed, a comprehensive meta-analysis on gamification demonstrated significant positive effects on cognitive, motivational, and behavioral learning outcomes (Elma et al., 2024; Sailer & Homner, 2020).

Nevertheless, several researchers caution against assuming that technology alone guarantees meaningful learning. The novelty of digital tools may fade over time, and without appropriate pedagogical scaffolding, their use may lead to only surface-level engagement. Overemphasis on visual stimulation, for instance, may detract from deeper cognitive processing. Concerns have also been raised about excessive screen exposure, with some educators and parents suggesting that it may negatively affect attention spans or reduce opportunities for reflective thinking. These issues highlight the importance of striking a balance between technology use and effective classroom management, as well as incorporating non-digital instructional activities where appropriate.

2.3. Teacher Acceptance and Technology Integration

The introduction of large display technologies into classrooms represents a significant shift in teaching practices, necessitating that educators adapt their instructional strategies accordingly. The TAM offers a theoretical framework (Davis, 1989; Venkatesh et al., 2003) for understanding how teachers adopt and integrate new technologies into their teaching practices. According to TAM, perceived usefulness and perceived ease of use are central factors that influence users' attitudes and intentions to adopt educational innovations.

Teachers are more likely to incorporate interactive displays regularly if they perceive these tools as enhancing instructional quality and if they are confident in their ability to operate them effectively (Mailizar et al., 2021). In contrast, if the technology is perceived as complex or only marginally beneficial, educators may resist its use or limit its application to superficial uses. In a study applying an extended TAM in the context of higher education, Li et al. (2025) found that enabling conditions such as technical support, peer influence, and access to training significantly influenced instructors' willingness to adopt intelligent teaching systems.

In primary and secondary school settings, technical assistance and ongoing professional development are repeatedly identified as critical enablers of teacher acceptance (Chen, 2025). Teachers commonly face obstacles such as steep learning curves, fear of technical malfunction during instruction, and the additional time required to redesign lesson plans. These barriers can be effectively mitigated through structured training programs, school-based peer collaboration, and the sharing of successful implementation practices, supported by research linking teachers' pedagogical beliefs to their technology use patterns (Tondeur, Van Braak, Ertmer, & Ottenbreit-Leftwich, 2017) and studies on TPACK development in teacher education (Omoso & Odindo, 2020; Schmid, Brianza, & Petko, 2021) as Fitria (2024)suggested.

Leadership support and alignment with curriculum goals also influence teacher attitudes. When administrators provide resources, recognize instructional innovation, and integrate technology goals into school planning, teachers are more likely to sustain use. As TAM posits, positive attitudes and behavioral intentions are essential precursors to long-term, meaningful integration. Consequently, evaluating teacher perceptions, readiness, and professional development needs should be an integral part of any educational technology initiative.

2.4. Parental Attitudes and Involvement

Although the literature on parental attitudes toward classroom technology remains relatively limited, the role of parents is increasingly acknowledged as critical to the success of technology integration, especially at the elementary level (Hatzigianni & Margetts, 2014; Li & Rahman, 2025). Parents influence both the home learning environment and school-based decision-making through their levels of support and engagement. Their understanding of in-class technology use can either reinforce or undermine the impact of school-led initiatives.

Studies on one-to-one device programs have shown that involving parents through orientations, newsletters, or informational meetings enhances their awareness and acceptance of digital tools. In the case of interactive displays, many parents recognize the benefits of increased student motivation and improved academic outcomes. However, they also raise concerns about screen time, eye strain, and the lack of clarity around pedagogical goals (Saldanha & Bringolf-Isler, 2023).

A national education survey conducted in Taiwan revealed that more than half of teachers reported parental cooperation as a key challenge in implementing ICT-based instruction (Parenting, 2022). This finding highlights the importance of clear communication between schools and families. Providing regular updates on how the technology is used, explaining its educational purposes, and sharing student work samples can foster trust and build mutual understanding.

Parents' own familiarity with technology also plays a role in shaping their attitudes. Those who are confident using digital tools in their personal or professional lives are typically more supportive of their use in education. In contrast, parents with limited technological experience may express skepticism or discomfort. To address this variation, schools should maintain open channels for dialogue and offer opportunities for parental involvement. Incorporating parent feedback into program evaluation helps ensure a more inclusive and responsive approach to digital transformation in education.

3. Materials and Methods

3.1. Participants and Context

The study took place in Taipei City, Taiwan, where 12 public elementary schools were selected in the 2024 academic year to pilot the installation of large interactive touch display screens in their Grade 1 and Grade 2 classrooms. In total, 86 classrooms across these schools were equipped with the displays (One per classroom). Each class typically has one homeroom teacher who also teaches most subjects at the lower-grade level, so approximately 86 teachers were directly involved in using the new equipment. All these teachers participated in the evaluation. The student population impacted was roughly 2,000 first- and second-grade students (class sizes averaging 23 students).

For the parent component, the parents of all students in the participating classes were invited to provide feedback, primarily via a survey. This yielded a large sample of parent respondents (on the order of 1,000+ individuals, as detailed below), providing a broad view of parental opinions. The schools in the pilot represented a cross-section of Taipei City's educational districts, ensuring a mix of school sizes and community demographics. Prior to the study, basic training on operating the interactive displays was provided to the teachers, and technical setup (including networking the displays and linking them with student tablets) was supported by the city's education IT staff. The evaluation was conducted after one semester of implementation, allowing teachers and students to have at least a few months of experience with the technology.

3.2. Instruments and Data Collection

We employed a mixed-methods approach to gather both quantitative and qualitative data from three groups of stakeholders: teachers, students (indirectly via teachers' observations and performance records), and parents.

1. Teacher Survey: A comprehensive questionnaire was developed to assess teachers' experiences and attitudes regarding the large interactive display. The survey was based partly on the TAM constructs and other relevant factors identified in the literature. It consisted of Likert-scale items (1 = Strongly disagree, 6 = Strongly agree) covering several domains, including Ease of Use, e.g., "The large display equipment is simple to operate and easy to learn." Integration and Compatibility: e.g., "It is easy to integrate the large display with existing digital teaching resources and platforms." Usefulness for Teaching: e.g., "Using the large display enhances student interest and attention in class," "The large display helps improve student learning outcomes in subjects like Math and Language," "The large display makes my lessons more interactive and efficient." Infrastructure Adequacy: e.g., "Our classroom's network can reliably support the smooth use of the large display and student tablets." Attitude and Satisfaction: e.g., "I have a positive attitude towards having a large display in my classroom." Behavioral Intention: e.g., "I intend to continue using the large display in my teaching," "I would recommend other teachers to use large displays for teaching." The full list of survey items, along with descriptive statistics (means and standard deviations), is provided in the Appendix for reference and validation.

Professional Development and Support: e.g., "The school has provided sufficient training and resources for using the large display," "I am willing to attend more training related to using the large display or digital teaching," "I am interested in participating in professional communities or workshops on digital teaching."

These items were designed to capture not only the core TAM perceptions but also context-specific issues, such as technical support and willingness to engage in further learning. The survey was administered online, and 100% of the 86 teachers responded (with a few incomplete responses handled by listwise omission in analysis, yielding an effective sample of $N \approx 84$). The internal consistency of the survey was high (Cronbach's alpha = 0.91 for the overall instrument), indicating reliability.

2. Teacher Interviews and Observations: To complement the survey data, we conducted semi-structured interviews with 2 experienced teachers (one Grade 1 and one Grade 2 teacher) selected from the pilot schools. The interview questions probed deeper into how the teachers incorporated the large displays into their daily teaching, the pedagogical strategies they used, the challenges they faced, and the perceived impact on student learning. Sample questions included: "Can you describe a typical lesson where you used the large display? What activities did you do and how did students respond?" "What do you find most useful about the large display, and what limitations have you encountered?" "How has the large display changed your teaching approach, if at all?", and "In your opinion, has the large display affected your students' learning or behavior? Do you have any specific examples?". Each interview lasted about 45 minutes and was audio-recorded and transcribed for analysis. In addition to interviews, the research team conducted informal classroom observations during school visits. We observed several lessons across different schools to see the large display in action (focusing on aspects like student engagement, teacher ease with the technology, and any technical issues). Notes from these observations provided contextual understanding and were later cross-referenced with teacher reports.

3. Student Learning Data: While the study did not implement a uniform test across schools, we gathered indicative data on student learning outcomes from available sources. Teachers provided input on student performance or learning gains that they attributed, at least in part, to the use of the large display. For example, some teachers shared results from classroom quizzes or exercises conducted through the display (such as interactive quizzes using an educational platform). We also logged usage statistics from a common digital learning platform nicknamed "Cool AI" (A Taipei City educational platform) that several schools used in conjunction with the displays. This platform provided data on student participation rates in online exercises and the achievement levels in certain subjects. Additionally, teachers qualitatively commented on changes in student motivation or class participation since using the displays. These student-related data were treated

cautiously and used mainly to triangulate with teacher and parent perceptions, rather than as rigorous pre-post measurements (since many confounding factors exist). Nonetheless, they offered useful illustrations of the displays' potential impact on learning processes.

4. Parent Survey: To capture parental perceptions, we distributed a questionnaire to parents of all students in the involved classes. The parent survey included Likert-scale items (same 6-point agreement scale) covering: Perceived Impact on Child: e.g., "I believe using the large display in class helps my child's learning," "The large display increases my child's interest and engagement in learning," "Using the large display improves my child's learning outcomes, especially in subjects like Math and Language." Attitudes Toward Educational Technology: e.g., "I think digital technology should be an important part of school teaching," "I support the school in expanding the use of large displays in teaching." Willingness to Support and Engage: e.g., "I am willing to learn about how the school is using the large display for teaching," "I am willing to participate in school events or activities related to digital learning (Including the use of the large display)."

School-Home Communication: e.g., "The school has clearly explained how and why the large display is being used in teaching," "I understand how the teachers use the large display in the classroom." The survey was made available online (With paper copies upon request to ensure accessibility). In total, 1,232 parents responded (approximately a 60–70% response rate across the schools). This high response count provides a robust sample of parent opinions. The parent survey's internal reliability was acceptable ($\alpha = 0.88$). In addition to the quantitative items, the parent survey included open-ended questions that allowed parents to freely express their thoughts. Three key open-ended questions were: (1) "How has your child reacted to the use of the large display in the classroom?" (Seeking descriptions of any changes in enthusiasm, behavior, or comments children made at home about the experience), (2) "Do you think the large display has been beneficial for your child's learning? Why or why not?" (probing reasons and any specific examples or concerns), and (3) "How would you like the school and teachers to use the large display to better support your child's learning? Do you have any suggestions or expectations?" These questions elicited rich qualitative feedback from parents, which was content-analyzed as described below.

5. Technical Staff Interviews: Recognizing the importance of the technical environment, we also interviewed 2 school IT administrators (or coordinators) involved in supporting the project. The aim was to document any technical issues (e.g., network bandwidth, hardware malfunctions) and solutions implemented, as well as to get an expert assessment of the infrastructure's adequacy. These short interviews (Approximately 30 minutes each) provided context on whether all classrooms had stable internet connectivity, how tablet-device integration was managed, and whether any technical training was provided to teachers from an IT perspective.

3.3. Data Analysis

We employed both quantitative and qualitative analysis techniques. Quantitative Analysis Involved Survey data from teachers and parents, which were analyzed using descriptive statistics and cross-tabulations. We computed mean ratings and standard deviations for each survey item, overall and by school. Given the generally high agreement levels, we were attentive to identifying any relative differences – for instance, which items scored slightly lower, indicating areas of concern. We also aggregated certain items into composite scales corresponding to TAM constructs (for teachers) or overall satisfaction (for parents) to see overall trends. Independent-samples t-tests and ANOVA were used sparingly to check for any significant differences (e.g., comparing responses between Grade 1 and Grade 2 teachers, or between parents from different schools). However, no major demographic group analyses were needed, as our focus was on the combined results.

In the Results, we present key statistics to illustrate the findings (for example, overall mean scores and notable highs/lows). The student usage/performance data from the "Cool AI" platform were analyzed to produce simple indicators (like percentage of students reaching proficiency in a given math skill) for illustrative purposes.

Qualitative: The open-ended responses from parents (and any written comments from teachers' survey or interview transcripts) were analyzed using thematic content analysis. Two researchers independently reviewed the responses and coded recurring themes or points of feedback. For instance, in parent responses, clear themes emerged, including visual advantages (comments about the clarity of the big screen), increased engagement (comments about children being more interested), concerns about eye health, concerns about distraction/overuse, the need for communication, and suggestions for interactive use. We then discussed and merged these into a set of broader themes with representative quotes. Teacher interview transcripts were similarly coded for themes like teaching benefits, challenges, student reactions, and suggestions. These qualitative insights are integrated into the discussion of results to provide depth and examples that complement the survey findings.

All data collection was conducted in accordance with ethical standards for educational research. Participation was voluntary and anonymous for parents and teachers (with the exception of the two teachers and IT staff interviewed, who gave consent and are not identified by name). The findings were later shared with the participating schools and the education department to inform decisions on the program's future.

By combining quantitative measures with qualitative feedback, the study aims to present a comprehensive evaluation of the large interactive display initiative. In the next section, we report the results, organized by the perspectives of teachers, students, and parents, and discuss these findings in light of the research questions and existing literature.

4. Result and Discussion

After one semester of using large interactive displays in Grade 1-2 classrooms, the evaluation yielded strong evidence of positive impacts, as well as insights into areas that needed improvement. We present the findings in three parts: A. Teacher adoption and experience, B. Student engagement and learning outcomes, and C. Parental perceptions and feedback. Quantitative results are summarized with key statistics, followed by qualitative observations and interpretations. Where relevant, we connect these results to the literature to discuss consistencies or discrepancies with other studies.

4.1. Teacher Adoption and Experience

Survey data from approximately 84 lower-grade teachers revealed a high level of acceptance and satisfaction with the large interactive displays. On a 6-point Likert scale, the overall mean rating across all items was 5.45, indicating strong agreement with favorable statements. Several items approached the maximum score of 6.0, including positive attitudes toward the technology (M = 5.8), willingness to continue using it (M = 5.8), and the perception that it enhances classroom interactivity (M = 5.7). Teachers found the displays easy to operate (M = 5.6), quickly integrable into daily teaching (M = 5.5), and compatible with existing digital tools.

Teachers consistently reported instructional benefits, such as increased student engagement (M = 5.2) and improved learning outcomes (M = 5.3). Interview data corroborated these findings, with teachers citing examples like using multimedia for science demonstrations, gamified quizzes, and real-time polling. These features were seen as particularly effective in sustaining attention and motivating students, especially those who are typically less engaged.

Technical challenges were minimal but noted. Network stability, while generally sufficient (M = 5.4), occasionally caused disruptions, especially when streaming videos or syncing multiple devices. Teachers suggested enhancing bandwidth and providing more responsive technical support. A few users reported difficulties with device pairing or initial setup, although most issues were resolved over time.

Professional development was another area of interest. While most teachers felt that the initial training was adequate (M = 5.3), some expressed a desire for ongoing learning opportunities, particularly advanced techniques and peer sharing of best practices. Participation in external digital teaching communities received a slightly lower rating relative to the overall mean (M = 5.4 vs. overall M = 5.45), reflecting time constraints rather than lack of interest. Teachers preferred that additional training be flexible or embedded within their work schedules.

Qualitative data also highlighted a positive shift in teaching practices. Teachers integrated multimedia content more regularly, facilitated interactive exercises, and used the displays for formative assessment. For instance, teachers used tablets to collect student responses, then displayed results instantly on the large screen for immediate feedback. These changes reflect a meaningful shift toward more student-centered and data-informed instruction.

Nonetheless, some teachers emphasized the importance of pedagogical alignment, cautioning against the overuse of visually stimulating tools without clear learning objectives. This underscores the need for ongoing support to ensure technology is used strategically rather than superficially.

In sum, the pilot demonstrated strong teacher buy-in and effective integration of large displays into early-grade teaching. High perceived ease of use and usefulness predicted continued usage intentions, consistent with the Technology Acceptance Model (Mailizar et al., 2021). Although minor challenges remain, they are addressable through improved infrastructure, sustained training, and collaborative learning. Overall, teachers viewed the displays not as novelties but as valuable assets that enhanced both teaching and student engagement.

4.2. Student Engagement and Learning Outcomes

Teachers widely reported that the introduction of large interactive displays significantly enhanced student engagement in lower-grade classrooms. Across all observed classes, teachers noted higher levels of attention, increased participation, and greater enthusiasm, particularly during interactive segments that involved gamified activities or multimedia content. Even typically reserved students were more willing to engage, as the interactive features provided alternative modes of expression. Observations revealed that students frequently volunteered to use the display, collaborated in groups, and responded more actively during lessons.

Teachers emphasized the value of the displays in supporting a variety of instructional strategies. In language lessons, visuals and audio aids enriched vocabulary instruction, while in math, interactive diagrams and instant feedback helped students grasp abstract concepts. Survey responses reinforced these findings: the item "the display helps improve student learning outcomes" received a mean score of 5.3 on a 6-point scale. Although subjective, this finding aligns with previous studies that have demonstrated improved basic skills and learning outcomes through the use of IWBs (Mumpuni & Mulyawati, 2024; Shi et al., 2021).

While the study did not employ a formal pre-post design, several anecdotal indicators suggested academic gains. For example, teachers reported improved quiz scores over time and greater homework completion when tasks were assigned via familiar digital platforms introduced through the display. One Grade 1 teacher observed over 90% participation in a follow-up digital activity, compared to lower engagement with traditional assignments. These trends suggest a possible spillover effect, where in-class use of technology encourages at-home learning.

While not statistically conclusive, data from the Cool AI platform showed that approximately 85% of students in participating schools achieved a "proficient" level in key mathematics modules. Teachers linked these gains to the use of visual scaffolds and real-time feedback enabled by the large interactive displays. This platform-based evidence, when triangulated with classroom observations and teacher reports, provides an encouraging indication of the displays' instructional value, particularly in numeracy education.

Parental feedback further supported these findings. Many parents noted that their children described the lessons as "fun" or "cool" and appeared more motivated to learn. They appreciated the clarity of the visuals and the interactivity, although a few expressed concerns about screen time and the long-term efficacy of learning. These concerns align with broader debates in the literature on striking a balance between engagement and cognitive depth in digital learning (Parenting, 2022).

Teachers also reported improvements in classroom dynamics, including increased peer collaboration and a decrease in behavioral issues. The engaging nature of the technology helped maintain students' focus and reduced idle time. However, challenges were noted. Some students became distracted by excessive on-screen elements, and a few parents reported mild eye strain among their children. These issues underscore the importance of moderation, ergonomic design, and pedagogically purposeful technology use.

In summary, the large interactive displays were highly effective in enhancing student engagement and offered promising signs of improved learning outcomes, particularly in foundational subjects. While further research is needed to quantify the academic impacts, evidence from teacher observations, platform analytics, and parental feedback suggests positive shifts in both motivation and participation. The effective use of displays appears to bridge in-class and at-home learning, contributing to more dynamic, student-centered instruction. Future implementations should continue to monitor learning efficacy while promoting healthy, balanced digital use.

4.3. Parental Perceptions and Feedback

Parental survey results and open-ended responses provided an important external perspective on the implementation of large interactive displays. Overall, parents expressed strong support for the initiative, while also offering constructive feedback related primarily to communication and implementation practices.

Quantitative findings indicated high levels of parental satisfaction. On a six-point Likert scale, parents generally agreed that the use of large interactive displays was beneficial to their children's learning ($M \approx 5.1$), increased learning interest ($M \approx 5.1$), and improved learning effectiveness in core subjects such as language and mathematics ($M \approx 4.9$–5.0). In addition, more than 90 percent of parents endorsed the integration of digital technology into school teaching and supported the further expansion of the display program. One of the highest-rated items reflected parents' willingness to understand how the displays were used pedagogically ($M \approx 5.2$–5.3), suggesting strong interest in instructional transparency and engagement.

In contrast, items related to school-parent communication received comparatively lower ratings. Parents reported only moderate agreement that schools had clearly explained the purposes and instructional use of the displays ($M \approx 4.3$–4.8). Although these scores did not indicate opposition, they reveal a perceived information gap. Qualitative comments confirmed that parents generally trusted the initiative but desired clearer explanations regarding instructional goals, usage frequency, and expected learning benefits. This finding highlights communication as a key area for improvement rather than a source of resistance.

Analysis of open-ended responses revealed several recurring themes. Parents most frequently noted enhanced visual clarity, higher student engagement, and richer instructional content as key benefits. Many reported that their children spoke more enthusiastically about classroom learning and were more motivated to participate in related activities at home. Some parents also observed gains in children's confidence and willingness to participate, particularly when students were given opportunities to interact with the display in front of peers.

At the same time, parents expressed several concerns. The most common concerns involved screen time and eye health, followed by questions about the long-term effectiveness of learning and the balance between digital and traditional learning activities. A smaller number of parents raised concerns about differences in teacher proficiency and the risk of over-reliance on visually stimulating content. Importantly, these concerns were typically framed as conditions for continued support rather than objections to the technology itself.

Parents also offered practical suggestions, including increasing interactive student participation, ensuring high-quality and age-appropriate content, establishing clear guidelines for healthy screen use, and providing ongoing professional development for teachers. Many of these recommendations closely aligned with principles already emphasized in the educational technology literature and echoed teachers' own reflections.

In summary, parental perceptions of the large interactive display initiative were overwhelmingly positive. Parents viewed the technology as beneficial for student engagement and modernization of instruction, while emphasizing the importance of balanced use, pedagogical quality, and transparent communication. Strengthening school-parent communication and articulating clear guidelines for instructional and healthy use are likely to further consolidate parental support and enhance the program's sustainability.

4.4. Discussion

The findings of this pilot study demonstrate that large interactive display screens can have a positive impact on early elementary education when integrated thoughtfully. Teachers showed high acceptance and reported that the displays enhanced lesson interactivity, student attention, and instructional efficiency, key indicators aligned with the Technology Acceptance Model. Despite minor technical issues, strong behavioral intention to continue usage suggests sustainable adoption, particularly when paired with adequate training and support.

Student engagement significantly improved, with increased participation, motivation, and collaborative behaviors observed across classrooms. While conclusive evidence on academic achievement is limited, formative assessments and teacher-reported learning improvements indicate potential learning gains. These outcomes reinforce the view that interactivity and multimodal content can support diverse learners, especially in foundational subjects.

Parents generally viewed the initiative favorably, citing enhanced learning interest and clarity. However, communication gaps emerged as a key area for improvement (Y. Li & Rahman, 2025; Sánchez-Prieto, Huang, Olmos-Migueláñez, García-Peñalvo, & Teo, 2019). Clearer messaging around pedagogical goals, screen time management, and usage practices is essential to maintaining parental trust and support.

Overall, the integration of large displays in lower-grade classrooms was successful, providing a model for scalable, child-centered digital learning. Future implementations should prioritize infrastructure readiness, ongoing teacher development, and parent-school engagement to ensure long-term impact and equity.

4.5. Limitations

Several limitations should be acknowledged. First, this study did not employ a controlled pre-post experimental design, which limits the ability to draw causal conclusions regarding the impact of large interactive displays on student academic achievement. The student learning data relied primarily on teacher observations, platform analytics, and anecdotal reports rather than standardized assessments. Second, the qualitative component involved interviews with only two teachers and two IT administrators across 12 schools, which may not fully capture the diversity of experiences and challenges encountered in different school contexts. Third, the evaluation was conducted after only one semester of implementation, a period that may be insufficient to assess long-term sustainability, the potential novelty effect, or shifts in teacher and student behavior over time. Fourth, the parent survey, while large in scale, was voluntary and may be subject to self-selection bias, with more engaged or supportive parents being overrepresented. Finally, the study was situated within the specific educational and cultural context of Taipei City, and caution should be exercised when generalizing the findings to other regions or school systems with different technological infrastructures, teacher training models, or parental expectations.

5. Conclusion

This study investigated the implementation and impact of large interactive display screens in lower-grade elementary classrooms, offering empirical evidence on how such technologies influence teaching practices, student engagement, and stakeholder perceptions. The findings present a comprehensive picture of how technology, when thoughtfully integrated into early education settings, can serve as a catalyst for pedagogical innovation.

The research reveals that teachers demonstrated strong acceptance and effective adoption of the displays, facilitated by their perceived ease of use and instructional utility. The technology enabled more interactive, visually enriched lessons that encouraged greater student participation and helped shift classroom dynamics toward more learner-centered approaches. From the students' perspective, the displays increased motivation, attentiveness, and involvement in learning tasks. Though this study did not apply a controlled pre-post testing framework, qualitative and formative evidence suggested improved comprehension, confidence, and voluntary engagement both in and outside the classroom. Importantly, parents also viewed the initiative positively, recognizing its benefits while raising valid concerns about screen time and the need for better communication from schools.

These findings contribute to the growing body of research affirming the pedagogical value of large-format interactive technologies in early childhood education. They also emphasize the importance of human factors in the adoption of technology. Even advanced educational tools can fall short if teacher training, infrastructural reliability, and stakeholder communication are not adequately addressed. Our study illustrates that the effectiveness of technology is not inherent, but rather constructed through alignment with instructional goals, professional capacity, and environmental readiness.

From a practical standpoint, the study points to several implications for policy and practice. Continued teacher professional development and peer support mechanisms are crucial for enhancing the pedagogical application of such tools. Ensuring a robust technical infrastructure, particularly in terms of network stability and in-class support, will further strengthen the initiative's sustainability. Schools must also develop transparent communication strategies to engage parents as active partners in the learning process and to address concerns about screen exposure and learning balance.

Future research should investigate the longitudinal effects of interactive display use on academic outcomes, particularly in literacy and numeracy, across diverse school contexts. Comparative studies exploring differential implementation models and the interplay between display screens and other digital learning tools, such as tablets or AI-based platforms, could yield valuable insights. Furthermore, studies investigating how teacher collaboration networks shape ongoing technology use may reveal scalable models for professional growth.

In conclusion, this study confirms that large interactive display screens, when introduced with pedagogical intention and stakeholder support, can substantially enrich the learning experience in early elementary education. The success of this pilot offers a promising model for educational systems seeking to modernize classrooms while preserving developmental appropriateness and instructional quality.

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Appendix. Summary of teacher survey responses.

Teacher survey item	Mean (SD)
The large display is easy to operate and learn to use.	5.6 (0.5)
I can quickly integrate the large display into my daily teaching.	5.5 (0.6)
It is easy to combine the large display with existing digital resources.	5.5 (0.5)
Our classroom network provides adequate support for the use of displays and tablets.	5.4 (0.6)
Using the large display increases my students' interest and attention.	5.2 (0.7)
Using the large display makes my classes more interactive.	5.7 (0.4)
I believe using the large display can improve student learning outcomes.	5.3 (0.6)
I have a positive attitude toward having a large display in my class.	5.8 (0.4)
Technology (Like the large display) can effectively assist teaching.	5.8 (0.4)
I intend to continue using the large display in my teaching.	5.8 (0.4)
I am willing to attend further training related to using the large display.	5.7 (0.5)
I would recommend that other teachers try using a large display.	5.6 (0.5)
The school has provided sufficient training and resources for the display.	5.3 (0.8)
I am willing to participate in more digital teaching communities or workshops.	5.4 (0.7)