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Interactive Flat Panel as a Digital Learning Media to Enhance Motivation and Understanding of IPAS Concepts

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Abstract

Background: The insufficient drive to comprehend IPAS concepts among pupils constitutes a significant barrier to achieving active and meaningful learning in elementary schools. The implementation of Interactive Flat Panels as a digital learning tool is anticipated to improve learning motivation and promote a more effective comprehension of concepts. **Methods:** This research aims to explore how Interactive Flat Panels affect students' motivation to learn and their understanding of IPAS concepts. The approach used is quantitative, following a quasi-experimental design, particularly the Nonequivalent Control Group Design. The sample for the study includes 48 students, divided into an experimental group with 25 students and a control group with 23 students. Information about learning motivation was obtained through a questionnaire, while data on conceptual understanding was collected via an assessment. The Independent Sample t-Test was used for data analysis. **Results:** The study results showed a significant difference in motivation for learning between the experimental group and the control group, with mean scores of 47.20 and 42.43, respectively, and a significance level of 0.001 ($p < 0.05$). The experimental group demonstrated a better understanding of IPAS concepts than the control group, with average scores of 76.92 and 72.04, respectively, and a significant value of 0.001 ($p < 0.05$). **Conclusion:** The results show that using the Interactive Flat Panel greatly boosts student enthusiasm and understanding of IPAS concepts. As a result, the Interactive Flat Panel can serve as a powerful digital teaching resource to enhance the quality of the IPAS educational experience and results in primary schools.

INTRODUCTION

The shift towards digital transformation in education has brought about a change from a teacher-focused learning approach to one that centers around students (Okoye et al., 2025). The growth of educational technology is now not just a way to share information

but also acts as a driver for engaging, cooperative, and significant learning opportunities (Sezer, 2017). A commonly used innovation in primary school classrooms is the Interactive Flat Panel (IFP), a touch-enabled device that integrates multimedia features, internet connectivity, and educational applications into a unified system (Jayadi, 2025; Trisniawati, 2026). Utilizing IFP enables teachers to present material in a visual, interactive, and relevant way, which boosts student involvement during the learning process (Hartanto & Wahyuningsih, 2026). Studies indicate that Interactive Flat Panels have the potential to enhance participation, drive motivation, and improve the quality of learning exchanges by offering more captivating and student-oriented content (Hasanah & History, 2026). The urgency of examining IFP use has become increasingly evident as digital learning infrastructure is being introduced on a large scale in Indonesian schools. In 2025, the national learning digitalization program targeted 288,865 schools and learning centers for IFP provision, with more than 173,000 schools having received and utilized the devices by November 2025 (Ministry of Primary and Secondary Education, 2025). This rapid expansion makes empirical evaluation increasingly important to ensure that the availability of IFP is accompanied by meaningful improvements in classroom learning rather than merely increasing access to digital equipment.

In primary education, the study of Natural and Social Sciences (IPAS) requires that pupils grasp scientific ideas and connect that understanding to day-to-day experiences (Isdartuti Hamidah et al., 2024; Jannah et al., 2023). In actual teaching scenarios, IPAS learning often relies on traditional lecture styles and standard media, resulting in students becoming passive recipients of information (Nasirotunnisa & Haroky, 2025). This scenario leads to lowered motivation for learning and insufficient grasp of concepts. Motivation to learn is a fundamental aspect that influences student involvement in their educational journey, whereas conceptual understanding is a key indicator of student achievement in gaining meaningful knowledge (Blumenfeld et al., 1991; Mayangsari & Mahardhika, 2019). A lack of interactive learning brings about diminished attention from students and difficulties in recognizing links between different subjects (Fryer et al., 2025).

A multitude of research conducted in the past five years has shown that incorporating interactive technologies into teaching practices improves the quality of learning (Asad et al., 2021). This enhancement occurs by boosting student involvement, increasing motivation for learning, and elevating academic success (Serrano et al., 2019; Tene et al., 2024). Research focused on Interactive Flat Panels indicates that these tools promote cooperative learning, boost motivation, and enhance student involvement through multimedia tasks and hands-on interaction with touch screens (Aisyah & Zahro, 2025). Another analysis reveals that Interactive Flat Panels provide a more engaging educational experience, encouraging learners to become more actively involved in their learning compared to traditional media presentati (Riyadi & Ningsih, 2024). A thorough evaluation of immersive technology-driven education shows that interactive learning settings boost student motivation, participation, and academic results through more authentic educational experiences (Fernandes et al., 2022).

Nevertheless, current research mainly focuses on aspects such as learning motivation, student involvement, or perceptions of Interactive Flat Panels independently. There is a notable lack of empirical evidence addressing the concurrent impacts of these factors on both learning motivation and conceptual comprehension, especially in the context of primary education utilizing IPAS. Additionally, there is a shortage of experimental research assessing the effectiveness of Interactive Flat Panels in Indonesian

elementary schooling. This research gap is particularly relevant in the context of the rapid expansion of IFP provision. Nationally, the government initially targeted 288,865 schools and learning centers through the 2025 Digital Learning Program, while more than 173,000 schools had received and utilized IFPs by November 2025. At the provincial level, West Java, for example, recorded 14,139 IFP units distributed across 2,553 early childhood education institutions, 8,384 elementary schools, 1,932 junior secondary schools, 191 senior secondary schools, 163 special schools, 861 vocational schools, and 55 equivalency education units as of December 13, 2025 (Ministry of Primary and Secondary Education, 2025). These figures indicate that IFP has moved beyond a limited technological intervention and has become part of a broader national effort to transform classroom learning. However, the expansion of infrastructure also increases the need for evidence concerning whether and how IFP contributes to students' motivation and conceptual understanding, particularly at the primary school level.

At SDN Dupok 2 Bangkalan, the use of Interactive Flat Panel technology is quite limited, with just one panel designated for classroom teaching in the academic year 2025/2026. The availability of only one IFP at the school also illustrates the importance of examining how limited digital infrastructure can be utilized effectively for learning. This situation exemplifies the restricted availability and application of Interactive Flat Panels in primary education, highlighting the growing necessity for empirical evidence to ascertain their instructional efficacy. In the absence of such evidence, educational institutions and policymakers face challenges in obtaining a scientific basis for strategizing technology acquisition and enhancing its implementation within classroom settings. Hence, there is a critical need for experimental studies investigating the combined effects of Interactive Flat Panels on students' learning motivation and conceptual understanding, which would yield evidence-based insights for technology integration in elementary education.

Initial findings at SDN Dupok 2 Bangkalan indicate that IPAS education continues to encounter various obstacles. Despite the availability of digital tools, their implementation has not been fully leveraged to foster an engaging and learner-centered educational environment. Instruction is mainly focused on the teacher, leading to minimal student involvement and challenges in grasping complex IPAS ideas. If these issues are not addressed, it is likely that students will experience a decline in motivation and understanding of key concepts, which may negatively influence their academic performance and their ability to cultivate the critical thinking and problem-solving abilities essential for learning in the 21st century. These circumstances highlight the pressing need for effective digital educational resources that not only captivate students' interest but also enhance their understanding of concepts through participatory learning opportunities.

Interactive Flat Panels offer features that fulfill these needs by merging text, images, videos, animations, simulations, and interactive tasks into one educational tool (Wasliman et al., 2026). The touch screen capability enables learners to directly engage with the educational material, resulting in a more interactive, cooperative, and student-focused learning experience (Ayu Saputri Bahar & Iriandy, 2025). Interactive learning settings are thought to improve focus, curiosity, motivation to learn, and give a clearer understanding of concepts through visual representation of materials and hands-on learning experiences (Zhu, 2025). This study is novel as it explores the effects of Interactive Flat Panels on both motivation to learn and comprehension of IPAS concepts using a quantitative experimental approach with elementary school students. The research

intends to offer solid proof regarding the effectiveness of Interactive Flat Panels as a digital tool for enhancing the quality of IPAS education, while also providing suggestions to teachers and educational institutions to maximize the use of technology in support of 21st-century learning. The aim of this research is to evaluate how Interactive Flat Panels influence students' motivation to learn and their understanding of IPAS concepts at SDN Dupok 2 Bangkalan.

METHODS

This research utilized field studies applying a quantitative framework through a quasi-experimental design that included a nonequivalent control group. Implementing a true experimental design was impractical due to the inability to randomly assign students within the current classroom arrangements at the school for the sake of the study. Thus, the existing classes remained intact as the experimental and control groups to maintain the authentic educational environment. Both groups underwent a pretest before the intervention to assess their initial levels of learning motivation and understanding of concepts. The results from this pretest were analyzed to ensure that the two groups had similar starting abilities, showing an even distribution of low-, average-, and high-achieving students prior to the intervention. The experimental group was instructed with the Interactive Flat Panel technology, while the control group received education through traditional instructional media.

To ensure that the effect examined was specifically associated with the use of Interactive Flat Panel (IFP), both groups received the same instructional model, learning objectives, learning materials, teacher, and instructional duration. The learning process used a direct instructional approach combined with guided discussion, questioning, individual tasks, and evaluation. The intervention was conducted in six meetings, with each meeting lasting 2 × 35 minutes. The selected learning material concerned a specific Grade VI IPAS theme related to the learning objectives addressed during the intervention.

In both groups, the teacher began each lesson by introducing the learning objectives and activating students' prior knowledge. The teacher then presented and explained the IPAS material, asked guiding questions, facilitated discussion, provided examples, guided students in completing learning tasks, and concluded the lesson through evaluation and reflection. Students in both groups were involved in observing the learning material, responding to questions, participating in discussions, completing learning tasks, and answering evaluation questions.

The experimental group received the same learning activities with the support of an Interactive Flat Panel. The IFP was used to present text, images, videos, animations, simulations, and interactive learning materials related to the selected IPAS topic. Students participated in touchscreen-based activities, including observing visual representations, identifying concepts displayed on the screen, answering questions directly through the touchscreen, matching information, and interacting with visual or simulation-based learning materials. The teacher used presentation software, an internet browser, and interactive educational applications to support the learning activities. These activities were intended to provide students with visual and direct learning experiences that could increase attention, curiosity, participation, and understanding of IPAS concepts.

In contrast, the control group completed equivalent learning activities using conventional instructional media, including textbooks, printed worksheets, printed

images, and verbal explanations from the teacher. Students observed the presented material, listened to teacher explanations, answered questions, participated in discussions, completed worksheets, and carried out the same learning tasks as the experimental group. Therefore, the instructional model, teaching methods, learning objectives, learning content, teacher, number of meetings, and instructional duration were kept consistent between the two groups. The main difference was the instructional medium, namely the use of IFP in the experimental group and conventional instructional media in the control group.

After the intervention, both groups took a posttest to measure changes in learning motivation and conceptual understanding. The research took place during the second semester of the 2025/2026 academic term at SDN Dupok 2 Bangkalan. The study involved all fourth-grade students, amounting to 48 participants, with 25 students in the experimental group and 23 students in the control group. The participants came from two pre-existing fourth-grade classes. The classes remained intact and were not reorganized by the researchers. One class was designated as the experimental group and the other as the control group. Individual random assignment was therefore not conducted. The difference in group size reflected the original class composition. A saturated sampling technique was utilized because all fourth-grade students at SDN Dupok 2 Bangkalan were included in the study. Because the groups were based on pre-existing classes, potential selection bias could not be completely eliminated. To examine the initial condition of the groups, both classes completed the same pretest before the intervention. The pretest results were considered when interpreting differences observed after the intervention.

Data were gathered through classroom observations, a learning motivation questionnaire, an IPAS conceptual understanding test, and documentation. The learning motivation questionnaire was developed based on five indicators: attention during learning, interest in the learning material, active participation, persistence in completing learning activities, and enthusiasm for learning. Each statement was measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The initial questionnaire consisted of 30 items, resulting in a possible total score range of 30–150. The reported motivation scores in the main analysis represented total questionnaire scores rather than average item scores. The conceptual understanding test was developed based on the learning objectives and indicators of the selected Grade VI IPAS topic. The test measured students' ability to identify concepts, explain concepts, classify information, interpret relationships between concepts, provide examples, and apply concepts to situations related to everyday experiences. The initial test consisted of 25 items, with each item scored according to the predetermined scoring rubric. The final conceptual understanding score was converted to a 0–100 scale to facilitate interpretation and comparison between the two groups.

Before data collection, the instruments were developed based on the research variables and relevant theoretical foundations. The learning motivation instrument was based on the concept of learning motivation, emphasizing students' attention, interest, participation, persistence, and enthusiasm during learning activities. The conceptual understanding test was developed based on the concept of conceptual understanding and the learning objectives of the selected IPAS unit. The instruments were designed to correspond directly with the two main outcomes examined in this study: learning motivation and IPAS conceptual understanding. The preliminary instruments were evaluated by three experts consisting of an elementary education expert, an IPAS learning

expert, and an educational assessment expert. The experts reviewed the relevance of the items to the indicators, clarity of language, suitability for fourth-grade students, content accuracy, and alignment between the instruments and the research variables. Based on the expert evaluation, several revisions were made, particularly by simplifying statements that could be difficult for elementary students to understand, removing ambiguous expressions, improving the alignment between items and indicators, and adjusting the organization of several items.

After the revision process, the instruments were piloted with fourth-grade students from another class who were not included in the 48 students participating in the main study. The pilot test involved 30 students with characteristics comparable to those of the research participants. The pilot testing was conducted before the main research data collection and did not involve either the experimental or control group. Therefore, the students participating in the instrument trial were completely separate from the actual research sample. Item validity was examined using the Pearson Product Moment correlation at a significance level of 0.05. An item was considered valid when the calculated correlation coefficient was greater than the critical r-value. From the 30 initial learning motivation items, 25 items met the validity criterion and five items were excluded. From the 25 initial conceptual understanding test items, 20 items met the validity criterion and five items were excluded. The items that did not satisfy the predetermined validity criterion were removed from the final instruments.

Reliability was examined using Cronbach's Alpha to determine the internal consistency of the instruments. In this example, the learning motivation questionnaire produced a Cronbach's Alpha coefficient of 0.91, while the conceptual understanding test produced a coefficient of 0.88. Both coefficients exceeded the commonly applied minimum criterion of 0.70, indicating acceptable internal consistency. Following the validity and reliability analysis, the final instruments consisted of 25 learning motivation items and 20 conceptual understanding items. These final instruments were subsequently used for the main research data collection. The research concentrated on a particular IPAS theme that was presented during the intervention, rather than encompassing the entire Grade VI IPAS syllabus. In alignment with this focus, the conceptual understanding test was designed to evaluate students' comprehension of the learning objectives associated with the selected IPAS unit. The same assessment procedures were applied to both groups through pretesting before the intervention and posttesting after the intervention.

Data analysis utilized IBM SPSS Statistics version 26. Descriptive statistics were initially calculated to describe the learning motivation and conceptual understanding scores of the experimental and control groups. Normality was assessed using the Shapiro–Wilk test, while homogeneity of variance was examined using Levene's Test. The Shapiro–Wilk results showed significance values of 0.673 and 0.650 for learning motivation and 0.632 and 0.372 for conceptual understanding in the experimental and control groups, respectively, indicating that the data were normally distributed. Levene's Test produced significance values of 0.061 for learning motivation and 0.869 for conceptual understanding, indicating homogeneous variances between the groups. Because the assumptions for parametric analysis were satisfied, hypothesis testing was conducted using the Independent Samples t-test at a significance level of 5% ($\alpha = 0.05$). A significance value (Sig. 2-tailed) below 0.05 indicated a statistically significant difference between the experimental and control groups. The analysis produced a t-value of 4.426 for learning motivation and 5.206 for conceptual understanding, with both significance values below

0.001. These findings indicated statistically significant differences between the experimental and control groups in both learning motivation and IPAS conceptual understanding.

RESULT AND DISCUSSION

The findings from the descriptive study about the use of the Interactive Flat Panel (IFP) in improving students' engagement and comprehension of IPAS principles are as follows:

Table 1. Data from the descriptive analysis of the research

Variable	Groups	N	Mean	SD
Learning motivation	Experiment	25	47.20	2.198
	Control	23	42.43	3.964
Concept understanding	Experiment	25	76.92	3.989
	Control	23	72.04	3.612

As shown in Table 1, the experimental group obtained a higher mean posttest learning-motivation score (47.20, SD = 2.198) than the control group (42.43, SD = 3.964). These values are mean composite questionnaire scores; higher scores indicate stronger learning motivation. For IPAS concept understanding, the experimental group obtained a mean score of 76.92 (SD = 3.989), compared with 72.04 (SD = 3.612) in the control group. Thus, the posttest descriptively shows higher scores in the experimental group for both outcomes. Figure 1 presents the corresponding comparison.

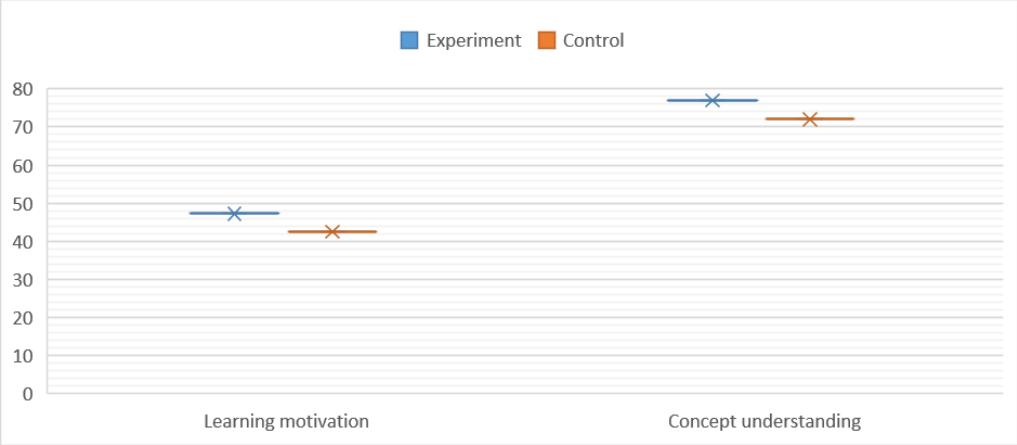


Figure 1. Comparison of Student Motivation and IPAS Concept Understanding Between the Experimental and Control Groups

Here is the normality prerequisite test for the student motivation variable and the understanding of the IPAS concept.

Table 2. Results of the Research Normality Test

Variable	Groups	Sig.	Description
Learning motivation	Experiment	0.673	Normal
	Control	0.650	Normal
Concept understanding	Experiment	0.632	Normal
	Control	0.372	Normal

Table 2 indicates that the outcomes from the Shapiro–Wilk normality assessment illustrate that all data concerning learning motivation and comprehension of the IPAS concept display significance (Sig.) figures exceeding 0.05. The significance figures for the learning motivation category are recorded as 0.673 for the experimental group and 0.650 for the control group. In terms of the IPAS concept understanding category, the significance figures stand at 0.632 for the experimental group and 0.372 for the control group. Consequently, all data across both groups demonstrate a normal distribution, thereby satisfying the normality assumption. The findings from the homogeneity prerequisite examination for the variables of student motivation and comprehension of the IPAS concept are detailed as follows:

Table 3. Results of the Research Homogeneity Test

Variable	df1	df2	Sig.	Description
Learning motivation	1	46	0.061	Homogen
Concept understanding	1	46	0.869	Homogen

The results from the homogeneity test presented in Table 3 indicate that the significance value for the learning motivation variable is 0.061, while the significance value for the concept understanding variable is 0.869. Since both values are greater than 0.05, it suggests that the variance in data between the experimental and control groups is homogeneous. Thus, the homogeneity assumption has been satisfied, allowing for the data to be analyzed using a parametric test, specifically the Independent Sample t-Test, to explore the differences in averages between the two groups with the results as follows:

Table 4. Independent Samples t-Test Results for Student Motivation and IPAS Concept Understanding

Variable	t	df	Sig. (2-tailed)	Description
Learning motivation	4,426	46	< 0.001	Significant
Concept understanding	5,206	46	< 0.001	Significant

Based on Table 4, the Independent Samples t-test yielded a t value of 4.426 for learning motivation and 5.206 for IPAS concept understanding, with $p < 0.001$ for both outcomes. Because both p values are below 0.05, the posttest results indicate statistically significant differences between the experimental and control groups. Students who received Interactive Flat Panel-supported instruction recorded higher posttest learning-motivation and IPAS-concept-understanding scores than students in the control group. The posttest results indicate that students in the Interactive Flat Panel-supported class recorded higher learning motivation and IPAS concept understanding than students in the control class. The experimental group's mean learning-motivation score was 47.20, compared with 42.43 in the control group; its mean concept-understanding score was 76.92, compared with 72.04. The Independent Samples t-test showed $p < 0.001$ for both outcomes. Within the limits of a quasi-experimental design, these findings show a statistically significant association between Interactive Flat Panel-supported instruction and higher posttest scores.

One possible explanation for the higher motivation scores is that an Interactive Flat Panel can create a more engaging learning experience by involving students directly with learning materials (Hartanto & Wahyuningsih, 2026; Widianto & Suprayitno, 2026).

Compared with conventional media, it enables teachers to incorporate visuals, videos, animations, simulations, and interactive activities that may encourage participation (Febrianti & Sukenti, 2026; Son'any, 2026; Wahyuning Tyas et al., 2026). Such activities can support attention, curiosity, and active engagement (Endang Susetyawati et al., 2026) (Fryer et al., 2025). This interpretation is consistent with constructivist perspectives, which emphasize learners' active engagement with meaningful materials and experiences (Kocevar-Weidinger, 2004; Romdhon et al., 2024).

The findings are consistent with Nurfadillah et al. (2026)teractivity, student involvement, and learning motivation in Islamic Religious Education for Grade VIII students. The present study differs in three respects: it used a quasi-experimental design with a control group, examined both learning motivation and IPAS concept understanding, and was conducted with Indonesian primary-school students. Citra & Siti (2025) similarly reported a positive relationship between Interactive Flat Panel use and student motivation in senior secondary education, whereas Kusniyati et al. (2026) reviewed its potential to support participation and enthusiasm in elementary education. These differences in design, participants, and learning outcomes position the present study as evidence specific to primary-level IPAS learning.

This research indicates that, beyond augmenting learning motivation, the application of Interactive Flat Panels has a considerable impact on the grasp of IPAS concepts. The findings suggest that delivering content in a visual and interactive format aids students in understanding abstract IPAS concepts in a more tangible manner (Fadilah et al., 2025; Luckin & Cukurova, 2019). The use of multimedia resources, including images, videos, simulations, and interactive tasks, enriches students' ability to connect concepts with their everyday experiences (Alim et al., 2020; J. Ikhsan et al., 2019; Mayer, 2024). The educational process emphasizes not only the transmission of knowledge but also promotes observation, exploration, dialogue, and personal interpretations of concepts that ultimately lead to a more profound understanding (Kozanitis & Nenciovici, 2023).

The results of this research are reinforced by K. Ikhsan (2026), who articulates that Interactive Flat Panels improve students' grasp of subjects through enhanced visual aids and hands-on activities, which in turn boosts cognitive learning results. This aligns with the study conducted by Darmayanti et al. (2025), which reveals that interactive learning supported by technology significantly heightens students' engagement and comprehension of topics when compared to conventional teaching techniques. Furthermore, investigations regarding the use of interactive screen technology in elementary education demonstrate that Interactive Flat Panels foster more participatory learning, enhance understanding of concepts, and build students' digital skills (Hanin et al., 2025).

This study indicates that the Interactive Flat Panel serves dual purposes as both a digital display and an interactive educational resource, thus improving the quality of the IPAS learning experience. By utilizing multimedia options and enabling direct interaction via the touchscreen, it promotes student-focused learning, boosts motivation, and aids in better understanding of concepts (Cavanagh & Kiersch, 2023; Mariono et al., 2024; Purbatua, 2020). Consequently, teachers should optimize the use of Interactive Flat Panels by designing collaborative, engaging, and contextual learning experiences to fully harness the potential of this technology. This research suggests that implementing digital tools in IPAS education is a successful approach to elevate the standard of education in elementary institutions and to support the integration of 21st-century learning methods.

CONCLUSION

The findings indicate that students receiving Interactive Flat Panel-supported instruction demonstrated significantly higher learning motivation and IPAS concept understanding than students in the control group. Within the limitations of the quasi-experimental design, Interactive Flat Panels may be a useful digital medium for supporting active and student-centered IPAS learning. Teachers may use Interactive Flat Panels through engaging, relevant, and contextual learning activities to support student interest and concept understanding. Future studies should involve broader participant groups, report pretest-posttest changes and instrument-development statistics in full, and examine Interactive Flat Panels in combination with clearly specified instructional models.

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

CONFLICTING INTEREST STATEMENT

The authors declare that they have no known financial interests or personal relationships with any individuals or organizations that could influence or potentially introduce bias into the research reported in this article.

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Suhartini: Conceptualization, Methodology, Data Collection, and Writing – Original Draft. Sulis Janu Hartati: Supervision, Data Analysis, and Writing – Review & Editing. Nuril Huda: Validation, Supervision, and Writing – Review & Editing.

REFERENCES

Aisyah, N., & Zahro, F. (2025). Transforming early childhood education through digital play and interactive flat panels. *MUMTAZ: Jurnal Pendidikan Agama Islam*, *5*(3), 992–1012.

Alim, J. A., Fauzan, A., Arwana, I. M., & Musdi, E. (2020). Model of geometry realistic learning development with interactive multimedia assistance in elementary school. *Journal of Physics: Conference Series*, *1471*(1), Article 012053. https://doi.org/10.1088/1742-6596/1471/1/012053

Asad, M. M., Hussain, N., Wadho, M., Khand, Z. H., & Churi, P. P. (2021). Integration of e-learning technologies for interactive teaching and learning process: An empirical study on higher education institutes of Pakistan. *Journal of Applied Research in Higher Education*, *13*(3), 649–663. https://doi.org/10.1108/JARHE-04-2020-0103

Bahar, A. S., & Iriandy. (2025). Enhancing the digital classroom experience through the integration of Interactive Flat Panel and Tug of Knowledge as cloud-based learning media. *Information Technology Education Journal*, *4*(4), 784–794. https://doi.org/10.59562/intec.v4i4.11189

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist*, *26*(3–4), 369–398. https://doi.org/10.1080/00461520.1991.9653139

Cavanagh, T. M., & Kiersch, C. (2023). Using commonly-available technologies to create online multimedia lessons through the application of the Cognitive Theory of Multimedia Learning. *Educational Technology Research and Development*, *71*(3), 1033–1053. https://doi.org/10.1007/s11423-022-10181-1

Citra, D. I., & Siti, I. (2025). Transformasi digital dalam pengelolaan sistem pendidikan: Pemanfaatan Interactive Flat Panel (IFP) dalam meningkatkan motivasi belajar peserta didik kelas 10 di SMAN 9 Gowa. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *10*(4), 1–12. https://doi.org/10.23969/jp.v10i04.39726

Darmayanti, H., Khosiyono, B. H. C., Nisa, A. F., & Supriyadi, D. (2025). Enhancing elementary students' interest and conceptual understanding of the solar system through edutainment-based interactive learning media. *AL-ISHLAH: Jurnal Pendidikan*, *17*(3), 3241–3252. https://doi.org/10.35445/alishlah.v17i3.7064

Fadilah, N., Misbahudholam, A. R. M., & Kuswandi, I. (2025). Pengaruh media pembelajaran interaktif Wordwall terhadap hasil belajar IPAS di sekolah dasar. *Jurnal Ilmiah Pendidikan Citra Bakti*, *12*(1), 56–66. https://doi.org/10.38048/jipcb.v12i1.4701

Febrianti, A., & Sukenti, D. (2026). The use of digital Interactive Flat Panel (IFP)-based learning media by teachers in learning to write news texts in Grade VIII at SMPN 1 Tanah Putih for the 2026 school year. *Sosioedukasi: Jurnal Ilmiah Ilmu Pendidikan dan Sosial*, *15*(2), 125–136.

Fernandes, F. A., Rodrigues, C. S. C., Teixeira, E. N., & Werner, C. (2022). *Immersive learning frameworks: A systematic literature review*. arXiv. https://doi.org/10.48550/arXiv.2208.14179

Fryer, L. K., Shum, A., King, R. B., & Lau, P. (2025). How does interest in a course interact with course learning? *Learning and Instruction*, *98*, Article 102106. https://doi.org/10.1016/j.learninstruc.2025.102106

Hamidah, F. I., & Kusrina, T. (2024). Pengembangan bahan ajar IPAS model discovery learning untuk meningkatkan hasil belajar. *Journal of Education Research*, *5*(3), 2841–2849. https://doi.org/10.37985/jer.v5i3.1172

Hanin, D. S., Suci, H., Bayu, P. W., & Hermawan, W. S. (2025). Integrasi interaktif flat panel dan smart TV dalam penggunaan platform interaktif (Wordwall, Liveworksheets, Kahoot) dalam pengembangan bahan ajar digital untuk meningkatkan partisipasi belajar siswa. *Jurnal IKA: Ikatan Alumni PGSD UNARS*, *16*(2), 85–96.

Hartanto, P., & Wahyuningsih, D. (2026). The impact of Interactive Flat Panel Displays (IFPD) on student engagement and learning motivation. *Golden Ratio of Data in Summary*, *6*(2), 79–88. https://doi.org/10.52970/grdis.v6i2.2131

Hasanah, N. (2026). Implementation of project-based learning assisted by interactive flat panel on students' learning independence and understanding of mathematical concepts. *Desimal: Jurnal Matematika*, *9*(2), 111–133.

Ikhsan, J., Akhyar, M., & Nais, M. K. (2019). The effects of science-on-web learning media on junior high school students' learning independency levels and learning outcomes. *Journal of Turkish Science Education*, *16*(2), 231–239. https://doi.org/10.12973/tused.10277a

Ikhsan, K. (2026). Analisis peran Interactive Flat Panel (IFP) dalam mendukung hasil belajar matematika siswa kelas VI SDN Labuhan Lalar. *Journal of Elementary Education Research*, *2*(2), 45–54. https://doi.org/10.70716/jeer.v2i2.312

Jannah, R., Arafat, Y., & Heldayani, E. (2023). Pengaruh penggunaan media diorama terhadap hasil belajar IPA siswa kelas V SD. *Didaktik: Jurnal Ilmiah PGSD FKIP Universitas Mandiri*, *9*(3), 1210–1220. https://doi.org/10.31949/didaktik.v9i3.1098

Jayadi, U. (2025). The role of Interactive Flat Panel (IFP) in shaping Indonesia's digital learning policy: A vision for educational reform in the Prabowo–Gibran era. *International Journal of Education and Digital Learning (IJEDL)*, *3*(6), 301–310. https://doi.org/10.47353/ijedl.v3i6.354

Kocevar-Weidinger, E. (2004). Beyond active learning: A constructivist approach to learning. *Reference Services Review*, *32*(2), 141–148. https://doi.org/10.1108/00907320410537658

Kozanitis, A., & Nenciovici, L. (2023). Effect of active learning versus traditional lecturing on the learning achievement of college students in humanities and social sciences: A meta-analysis. *Higher Education*, *86*(6), 1377–1394. https://doi.org/10.1007/s10734-022-00977-8

Kusniyati, E., Widiarti, N., & Widiyatmoko, A. (2026). The use of HOTS-based digital science mathematics stories with the Interactive Flat Panel (IFP) utilization in elementary school (Literature review 2020-2025). *DIDAKTIKA*, *6*(1), 108–121.

Luckin, R., & Cukurova, M. (2019). Designing educational technologies in the age of AI: A learning sciences-driven approach. *British Journal of Educational Technology*, *50*(6), 2824–2838. https://doi.org/10.1111/bjet.12861

Mariono, A., Khotimah, K., & Pradana, H. D. (2024). Interactive multimedia for educational technology master students. *Advances in Social Science, Education and Humanities Research*, *789*, 14–24. https://doi.org/10.2991/978-2-38476-152-4_3

Mayangsari, S. N., & Mahardhika, L. T. (2019). Characteristics of learning media that motivate learners. *European Journal of Research in Social Sciences*, *7*(1), 45–54.

Mayer, R. E. (2024). The past, present, and future of the Cognitive Theory of Multimedia Learning. *Educational Psychology Review*, *36*(1), Article 24. https://doi.org/10.1007/s10648-023-09842-1

Nasirotunnisa, S., & Haroky, F. (2025). Pengaruh media diorama terhadap peningkatan hasil belajar IPAS siswa sekolah dasar. *Jurnal Basicedu*, *9*(5), 1759–1786. https://doi.org/10.31004/basicedu.v9i5.10681

Nurfadillah, A., Syafruddin, & Irwan. (2026). Utilization of Interactive Flat Panel (IFP) technology in Islamic religious education learning to build learning motivation of class VIII students of Muhammadiyah Middle School, Bima City. *Literacy: Indonesian Teachers' Journal*, *5*(2), 88–97.

Okoye, K., Campos, E., Das, A., Chakraborty, V., Ghosh, M., Chakrabarti, A., & Hosseini, S. (2025). Impact of digitalized-education upon sustainable education and practice: A systematic review and meta-analysis of literature based on pre-intra-and-post pandemic and rural education development. *Sustainable Futures*, *10*, Article 100851. https://doi.org/10.1016/j.sftr.2025.100851

Purbatua, M. (2020). Multimedia interaktif sebagai media pembelajaran pada masa pandemi Covid 19. *Al-Fikru: Jurnal Ilmiah*, *14*(1), 33–42. https://doi.org/10.51672/alfikru.v14i1.33

Riyadi, R., & Ningsih, T. (2024). Implikasi media Interactive Flat Panel Display (IFPD) terhadap proses belajar IPS bagi siswa madrasah. *ELSE (Elementary School Education Journal)*, *8*(3), 244–255. https://doi.org/10.30651/else.v8i3.24401

Romdhon, J., Masrifah, M., Shiyama, N. M., & Suharyati, H. (2024). Applying constructivist learning theory to enhance student learning outcomes in elementary schools. *International Journal of Sustainable Development & Future Society*, *2*(2), 62–69. https://doi.org/10.62157/ijsdfs.v2i2.73

Serrano, D. R., Dea-Ayuela, M. A., Gonzalez-Burgos, E., Serrano-Gil, A., & Lalatsa, A. (2019). Technology-enhanced learning in higher education: How to enhance student engagement through blended learning. *European Journal of Education*, *54*(2), 273–286. https://doi.org/10.1111/ejed.12330

Sezer, B. (2017). The effectiveness of a technology-enhanced flipped science classroom. *Journal of Educational Computing Research*, *55*(4), 471–494. https://doi.org/10.1177/0735633116671325

Son'any, L. (2026). Pemanfaatan Interactive Flat Panel (IFP) sebagai wadah investasi masa depan dengan pendekatan prospektif-retrospektif di lembaga pendidikan Islam. *DIKSI: Jurnal Kajian Pendidikan dan Sosial*, *7*(1), 156–164.

Susetyawati, E. M., Shabila, N. D., & Siswanto, H. D. (2026). Penerapan Interactive Flat Panel pada pembelajaran matematika berbasis Student-Centered Learning. *Jurnal Media dan Teknologi Pembelajaran*, *1*(2), 77–84.

Tene, T., Marcatoma Tixi, J. A., Palacios Robalino, M. L., Mendoza Salazar, M. J., Vacacela Gomez, C., & Bellucci, S. (2024). Integrating immersive technologies with STEM education: A systematic review. *Frontiers in Education*, *9*, Article 1410163. https://doi.org/10.3389/feduc.2024.1410163

Trisniawati, S. (2026). The effectiveness of digital collaboration through interactive flat panel displays in stimulating early numeracy skills. *Golden Ratio of Data in Summary*, *6*(2), 65–78. https://doi.org/10.52970/grdis.v6i2.2130

Tyas, S. W., Arifuddin, M., & Mansur, H. (2026). Exploring teachers' and students' perspectives on the utilization of interactive flat panels in deep learning approaches. *Jurnal Teknologi Pendidikan*, *28*(2), 180–195. https://doi.org/10.17509/e.v25i2.98806

Wasliman, E. D., Gaffar, M. A., Saofanita, & Kusnadi, F. S. (2026). Management of Interactive Flat Panel (IFP) utilization to enhance learning quality in junior high schools: A comparative study at SMPN 1 Bojongsoang and SMPN 1 Dayeuhkolot. *Priviet Social Sciences Journal*, *6*(7), 119–131. https://doi.org/10.55942/pssj.v6i7.1993

Widianto, A., & Suprayitno, K. (2026). The impact of Interactive Flat Panel Display-based digital games with a cognitive scaffolding approach on the improvement of early childhood literacy and numeracy. *Golden Ratio of Social Science and Education*, *6*(2), 89–102. https://doi.org/10.52970/grdis.v6i2.2141

Zhu, W. (2025). Research on interactivity of visual communication design based on digital media technology. *Journal of Cases on Information Technology*, *27*(1), Article 28. https://doi.org/10.4018/JCIT.365421