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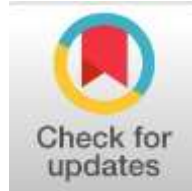
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Interactive Flat Panel Display Innovation For Student Engagement And Learning Motivation

Inovasi Layar Panel Datar Interaktif Untuk Keterlibatan Dan Motivasi Belajar Siswa

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Abstract

General Background Digital transformation alters classroom interaction and learning resources in primary schooling environments. **Specific Background** An Interactive Flat Panel Display combines touch control, visual presentation, and digital applications into a single integrated device. **Knowledge Gap** Despite available hardware, existing studies indicate a lack of context-specific guidance regarding pedagogical integration, technical readiness, and classroom management. **Aims** This literature-based exploratory case study investigates how interactive screens support learner participation and psychological drive at SD Negeri 1 Apuan. **Results** Analysis reveals these digital panels promote behavioral and cognitive involvement through direct manipulation, visual annotations, immediate feedback, and collaborative problem-solving. Furthermore, they nurture intrinsic needs by providing meaningful choices, increasing perceived competence, and fostering social relatedness during shared activities. However, successful implementation heavily relies on teacher facilitation, careful instructional design, preparation time, and equitable turn-taking systems. **Novelty** This study constructs a multidimensional, evidence-informed framework integrating self-determination and multimedia learning theories specifically tailored for localized technology adoption. **Implications** The proposed gradual integration model equips teachers and school leaders to transition from passive presentations to active, learner-centered interactive pedagogy.

Highlights

- Touchscreen technology promotes cognitive effort and behavioral participation through direct manipulation, collaborative tasks, and immediate visual feedback.
- Pedagogical success depends on teacher facilitation, equitable turn-taking, and balancing digital activities with traditional classroom methods.
- A gradual integration framework ensures technical readiness and guides educators toward sustainable, learner-centered instructional designs.

Keywords

Interactive Flat Panel Display; Learning Motivation; Student Engagement; Elementary Education; Technology Integration

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INTRODUCTION

Digital transformation has changed the way schools organize learning resources, classroom interaction, assessment, and teacher preparation. In elementary education, technology can help teachers present abstract concepts through images, animation, video, digital writing, and guided practice. It can also widen opportunities for students to respond during a lesson. However, technology only supports learning when teachers connect its features with clear objectives, suitable content, and active student participation. The device itself cannot replace good pedagogy.

An Interactive Flat Panel Display is a large digital screen with touch control, annotation tools, audio-visual functions, device connectivity, and access to learning applications. Unlike a standard projector, the panel allows teachers and students to manipulate content directly on the screen. A student can drag an object, match an answer, label a diagram, write a calculation, open a link, or present group work. These actions create visible opportunities for participation. They also allow the teacher to give immediate feedback and save the learning process for review.

The present study focuses on SD Negeri 1 Apuan. Official education data identify the school as a public elementary school located in Dusun Apuan Kaja, Apuan Village, Susut District, Bangli Regency, Bali, with NPSN 50102613 [1]. A previous case study at the same school reported the need for stronger innovation in lesson planning, teaching methods, learning tools, classroom processes, and teacher development [2]. The study also emphasized that teachers need to plan, organize, implement, and evaluate innovative learning in a systematic way. This institutional context makes IFPD integration relevant because the device can bring different media and interaction formats into one classroom space.

Student engagement provides the first conceptual focus. Engagement includes behavioral, emotional, and cognitive dimensions [3]. Behavioral engagement appears through attention, participation, task completion, discussion, and persistence. Emotional engagement appears through interest, enjoyment, confidence, and a sense of belonging. Cognitive engagement appears when students invest mental effort, connect ideas, monitor understanding, and use learning strategies. Later research also stresses that engagement should be studied as a multidimensional and context-sensitive construct [4]. An IFPD can influence these dimensions, but each dimension requires different learning activities.

Learning motivation provides the second conceptual focus. Self-determination theory explains that motivation grows when learning supports autonomy, competence, and relatedness [5], [6]. Autonomy refers to meaningful choice and personal agency. Competence refers to the belief that one can understand and complete a task. Relatedness refers to positive connection with teachers and peers. IFPD activities can support these needs when students make choices, receive timely feedback, and solve problems with classmates. Poorly designed activities can have the opposite effect. For example, a long teacher presentation on a bright screen may keep students physically quiet but mentally passive.

Multimedia learning theory also helps explain how interactive displays can support understanding. Students learn through verbal and visual channels with limited working-memory capacity. Clear signaling, coherent visual design, segmenting, and active processing can reduce unnecessary mental load [7], [8]. A panel can improve explanation when the teacher reveals information in small steps, highlights key parts, links images with spoken explanation, and lets students manipulate relevant content. The same panel can overload students when it presents too many animations, decorations, sounds, and written details at once. Therefore, visual attractiveness should not be treated as evidence of learning quality.

Recent studies support the educational potential of interactive displays. Hartanto and Wahyuningsih found that IFPD use in elementary education supported behavioral engagement, cognitive engagement, enthusiasm, interactive quizzes, and group discussion, while teacher facilitation remained a central condition [12]. Riyadi and Ningsih reported positive implications of IFPD use for social studies learning, especially in motivation and classroom participation [13]. Indriansyah found that touch interaction, stylus use, and shared screen activities strengthened motivation and collaboration [14]. A broader review of interactive flat panels, smart televisions, and digital learning platforms also reported positive effects on participation, motivation, visualization, and assessment [15].

Evidence on interactive multimedia in elementary education gives a similar message. A systematic review by Aryfien, Atmojo, and Matsuri found that multimedia-based interactive learning media were commonly associated with engagement, motivation, and improved learning outcomes, although teacher digital competence remained a concern [16]. Studies on interactive e-modules, game-based learning, and collaborative digital design show that active use, feedback, and student control can strengthen motivation and learning, while unnecessary complexity can increase cognitive load [17]-[21].

Despite these findings, schools need context-specific guidance. A device may be available, but teachers may use it only as a large presentation screen. Students may watch content without touching, discussing, explaining, or creating anything. Technical problems may also interrupt lessons. Some students may dominate the screen, while others remain observers. These risks show why implementation must be examined through pedagogy, classroom management, teacher capacity, and evaluation.

This study addresses one specific question: How can IFPD use be organized to enhance student engagement and learning motivation at SD Negeri 1 Apuan? The study has three objectives. It identifies the main engagement and motivational mechanisms associated with IFPD use. It analyzes the conditions that may enable or limit implementation in the school context. It also proposes a practical implementation and evaluation framework for teachers and school leaders.

METHOD

A. Research Design

This research used a qualitative exploratory case analysis. The case was SD Negeri 1 Apuan, while the main phenomenon was the pedagogical use of IFPD to support student engagement and learning motivation. The design did not measure a treatment effect or report classroom outcomes that had not been directly observed. Instead, it integrated school-context documents, recent empirical evidence, and established theory to build an evidence-informed implementation model. This approach was selected because detailed classroom observation records, interview transcripts, and student survey data were not supplied for the present manuscript.

The case analysis followed five steps. First, the study defined the school context and the two outcome concepts. Second, it identified relevant documents and empirical studies. Third, it extracted evidence on instructional features, student responses, teacher roles, and implementation barriers. Fourth, it coded the evidence into themes. Fifth, it compared the themes with engagement theory, self-determination theory, and multimedia learning principles.

B. Data Sources and Selection

The evidence base included four source groups. The first group contained the official profile of SD Negeri 1 Apuan. The second group contained a prior case study on innovative learning management at the school. The third group contained empirical or review studies on IFPD, interactive displays, and interactive digital media published mainly from 2021 to 2026. The fourth group contained established theoretical sources on engagement, motivation, multimedia learning, teacher digital competence, and qualitative analysis. Sources were included when they addressed at least one of the following points: active participation, cognitive effort, interest, motivation, collaboration, multimedia design, teacher competence, or implementation management.

Source group	Main contribution	Use in analysis
Official school profile	School identity and location	Case boundary
School case study	Need for innovative learning management and teacher development	Institutional context
IFPD and interactive-media studies	Observed benefits, barriers, and classroom practices	Theme development
Engagement, motivation, and multimedia theory	Concept definitions and explanatory mechanisms	Interpretation

Table 1. *Evidence Sources Used in the Case Analysis*

C. Data Analysis

The study applied a structured thematic analysis. Evidence units were coded using short labels such as direct touch participation, visual attention, immediate feedback, collaborative problem solving, teacher facilitation, technical readiness, equitable turn-taking, and cognitive overload. Related codes were grouped into broader themes. The analysis moved repeatedly between source evidence and conceptual categories. This process followed the logic of data familiarization, coding, theme construction, review, definition, and reporting [24].

Trustworthiness was strengthened through source triangulation. Claims about IFPD benefits were not based on one article. They were compared across empirical studies, reviews, and theory. Negative conditions were also retained. These included passive presentation, limited teacher skill, preparation demands, technical interruption, unequal access, and excessive multimedia stimulation. The analysis therefore focused on both opportunity and risk.

D. Scope and Limitation

The study provides an evidence-informed framework for SD Negeri 1 Apuan. It does not claim that student engagement or motivation at the school has already increased. Direct confirmation requires field observation, interviews, student questionnaires, and learning records during an actual IFPD implementation. The proposed indicators in this article can support that next stage.

RESULTS AND DISCUSSION

A.School Context and the Need for Structured Innovation

SD Negeri 1 Apuan operates within a public elementary education context in Susut District, Bangli Regency [1]. The earlier school-based case study described a need for teachers to update pedagogical approaches, methods, learning tools, and classroom management [2]. It also noted that innovative learning requires planning, organization, implementation, and supervision. This finding is important because IFPD integration is not a single classroom action. It is a small change-management process.

The first requirement is instructional purpose. Teachers need to decide what students should understand or do before selecting a digital feature. A panel may be used for demonstration, guided practice, collaborative problem solving, formative assessment, or student presentation. These functions demand different lesson structures. A demonstration may need teacher annotation. Guided practice may need student rotation. Collaborative problem solving may need group roles. Formative assessment may need immediate response and discussion.

The second requirement is organizational support. Teachers need access to the device, a stable power supply, prepared files, suitable applications, and basic technical assistance. School leaders need a schedule, maintenance routine, safe-use procedure, and simple monitoring system. Without these arrangements, the device may remain unused or may be used by only a small number of teachers.

The third requirement is professional learning. Digital competence includes more than operating buttons. Teachers must know how to select media, sequence information, manage participation, ask productive questions, and evaluate whether students are learning. Research on teacher digital competence shows that training becomes more effective when it connects technology with pedagogy, collaboration, reflection, and school support [11], [23].

B.Theme 1: Behavioral Engagement through Direct Participation

The strongest immediate contribution of IFPD is the creation of visible participation opportunities. Students can touch, drag, write, sort, match, circle, highlight, vote, and present. These actions increase the number of ways a student can respond. They also make participation public, which allows the teacher to observe thinking and give feedback. Studies of IFPD use report increased involvement in touch-based tasks, interactive quizzes, group discussion, and stylus activities [12]-[15].

Behavioral engagement should not be measured only by excitement near the screen. A student may be eager to touch the panel but may not understand the task. Useful indicators include on-task behavior, response frequency, task completion, participation across different students, and persistence after an error. Teachers should also monitor students who do not volunteer. A rotation system can ensure that each student receives an opportunity to interact directly or contribute from a group.

The panel is most effective when direct interaction remains short and purposeful. For example, a teacher can ask one student to label a plant part, another to explain the label, and a group to compare the result with a real sample. This sequence links physical action, verbal explanation, peer attention, and content understanding. It is stronger than asking several students to press answers without explanation.

Equitable participation is a key classroom-management issue. A small group of confident students may dominate the panel. The teacher can prevent this by assigning roles such as screen operator, reader, checker, explainer, and recorder. Roles should rotate. This method allows students who are waiting for their turn to remain cognitively active.

C.Theme 2: Cognitive Engagement through Visualization and Feedback

IFPD can support cognitive engagement when it helps students process relationships, sequences, patterns, and explanations. The teacher can enlarge a diagram, reveal one step at a time, annotate a text, compare two examples, or replay a short segment. These functions can direct attention to relevant information. Multimedia learning research supports the use of signaling, segmenting, coherence, and learner interaction to manage cognitive load [7]-[9].

The panel can also make student thinking visible. A student may solve a mathematics problem on the screen while explaining each step. The teacher can pause, ask classmates to evaluate the method, and correct an error without erasing the entire process. This creates a shared record of reasoning. It supports deeper engagement because students do not only see the final answer. They examine the process.

Immediate feedback strengthens cognitive engagement when it explains why an answer is correct or incorrect. Simple right-or-wrong effects may increase excitement but provide limited learning value. Better feedback directs attention to a rule, asks a follow-up question, or invites revision. Interactive learning environments are more effective when feedback and student control are aligned with task complexity [21].

Cognitive overload remains a risk. Bright colors, animation, sound, and moving objects can compete for attention. The teacher should remove decorative elements that do not support the objective. Text should remain brief. Images should be clear. Audio and animation should be used only when they add information. Younger students also need time to look away from the screen, manipulate physical objects, talk with peers, and write by hand.

D.Theme 3: Learning Motivation through Autonomy, Competence, and Relatedness

The motivational value of IFPD can be explained through autonomy, competence, and relatedness [5], [6]. Autonomy grows

when students make meaningful choices. They may select an example, choose a solution path, or decide which evidence supports an answer. The choice should remain limited and relevant. Too many options can confuse students.

Competence grows when students understand the task, receive timely feedback, and see progress. A teacher can use the panel to present a clear challenge, offer hints, and display improvement across several attempts. Interactive e-module and digital-game studies show that responsiveness and structured challenge can support motivation and learning in elementary settings [17]-[19]. The goal is not to make every task a game. The goal is to help students experience success through effort and strategy.

Relatedness grows through shared activity. Students can solve a problem together, discuss a displayed image, or present group work. The panel becomes a common focus that supports communication. Collaboration studies show that digital activities can strengthen interaction when students have clear roles and a shared product [14], [20]. Teacher language remains important. Students need encouragement, respectful correction, and recognition of different contributions.

Enjoyment can support motivation, but it should not become the only target. Novelty may produce a temporary rise in enthusiasm. Sustainable motivation requires meaningful tasks, increasing competence, and regular opportunities for student agency. Teachers should therefore vary the activity while maintaining consistent learning goals.

IFPD use	Expected mechanism	Observable indicator
Touch and stylus task	Direct response and visible participation	More students complete on-screen or group tasks
Visual annotation	Attention to key information	Students explain highlighted relationships
Interactive quiz with discussion	Feedback and competence	Students revise answers and state reasons
Group problem on shared screen	Collaboration and relatedness	Students share roles and justify decisions
Student presentation	Agency and confidence	Students explain work and answer questions

Table 2. IFPD Features, Engagement Mechanisms, and Observable Indicators

E.Theme 4: Teacher Facilitation as the Main Determinant

Across the reviewed studies, teacher facilitation appears as the main determinant of IFPD effectiveness. Hartanto and Wahyuningsih reported that benefits were stronger when teachers designed student-centered activities [12]. Tyas and colleagues also found that IFP potential depended on lesson design, teacher technological literacy, and school support [22]. These findings show that the same device can produce different classroom experiences.

A low-level use pattern treats the IFPD as a large television or projector. The teacher displays slides and speaks for most of the lesson. Students may enjoy the image quality, but participation remains limited. A medium-level pattern adds short quizzes, annotation, and occasional student turns. A high-level pattern organizes inquiry, group problem solving, student explanation, collaborative creation, and formative feedback. The school should aim for gradual movement from low-level to high-level use.

Teacher preparation should begin with a small set of reliable functions. These may include opening a lesson file, writing and erasing, saving annotations, using a timer, displaying an image or short video, and running a simple quiz. After teachers feel confident, they can add collaborative applications and student-created content. This staged approach reduces anxiety and technical disruption.

Lesson planning also needs a backup. The teacher should keep a printed task or whiteboard alternative in case of a technical problem. A backup does not reduce the value of technology. It protects learning time. It also helps teachers remain calm and flexible.

F.Theme 5: Risks and Implementation Barriers

Five barriers need attention. The first is uneven teacher competence. Some teachers may use the panel confidently, while others may avoid it. Peer mentoring and short practice sessions can reduce this gap. The second is preparation time. Interactive materials often take longer to prepare than conventional slides. A shared school repository can reduce repeated work.

The third barrier is technical reliability. Connectivity, software updates, cables, sound, touch calibration, and file compatibility can interrupt lessons. The school needs a simple checklist and a person who can provide first-level support. The fourth barrier is unequal student access. One panel cannot provide simultaneous direct touch for an entire class. Group roles, response cards, mini whiteboards, and verbal reasoning can keep all students involved.

The fifth barrier is excessive screen-centered instruction. An IFPD should support a balanced lesson. Students still need books, handwriting, physical materials, outdoor observation, discussion, and movement. The device should connect these experiences rather than replace them. UNESCO also warns that educational technology should serve learning needs and equity, not become an end in itself [25].

Risk	Likely effect	Practical response
Limited teacher skill	Passive or infrequent use	Short training, peer mentoring, model lessons
Long preparation time	Teacher resistance	Shared templates and reusable lesson files
Technical interruption	Lost learning time	Pre-lesson checklist and offline backup
Student domination	Unequal participation	Rotating roles and structured turns
Excessive screen use	Fatigue and shallow attention	Blend digital, print, physical, and outdoor tasks

Table 3. *Implementation Risks and Practical Responses*

G. Proposed Implementation Framework for SD Negeri 1 Apuan

A gradual four-stage framework is proposed. Stage one is readiness. The school identifies teacher needs, checks the device and room, prepares a usage schedule, and selects two or three priority subjects. Teachers practice core functions through short sessions. Stage two is guided pilot use. Each teacher prepares one short IFPD-supported activity with a clear objective and a backup plan. A colleague observes the lesson using a simple checklist.

Stage three is pedagogical expansion. Teachers add student rotation, group roles, formative quizzes, and student presentation. They also adapt materials for different learning needs. Stage four is evaluation and institutionalization. The school reviews usage frequency, student participation, teacher confidence, technical problems, and examples of student work. Effective lesson files are stored in a shared folder and improved for the next semester.

The proposed sequence fits the earlier recommendation that innovative learning at SD Negeri 1 Apuan should be planned, organized, implemented, and supervised [2]. It also reflects evidence that technology integration improves when teachers receive continuous, context-based support [11], [23]. A one-time technical workshop is not sufficient. Teachers need practice, classroom feedback, and time to redesign lessons.

H. Suggested Evaluation Indicators

Evaluation should combine process and outcome indicators. Process indicators show how the device is used. Outcome indicators show whether student behavior and motivation change. The school can collect data through short observations, teacher reflection, student questionnaires, focus-group discussion, and samples of student work. Baseline data should be collected before the pilot so that later changes can be interpreted more carefully.

Area	Indicator	Possible evidence
Behavioral engagement	Attention, participation, task completion, persistence	Observation checklist
Cognitive engagement	Explanation, question quality, strategy use, revision	Student work and discussion notes
Motivation	Interest, confidence, choice, willingness to participate	Short student questionnaire
Teacher	Student-centered	Peer

Area	Indicator	Possible evidence
practice	use, feedback, equitable turns	observation and reflection
Implementation	Technical reliability, preparation time, frequency of use	Usage log and support record

Table 4. *Suggested Indicators for an IFPD Pilot*

I. Implications for Teaching and School Management

For teachers, the main implication is to design from the learning objective rather than from the available application. A useful planning question is: What should students do with the content? The answer may be explain, compare, classify, calculate, predict, revise, or create. The IFPD feature should support that action.

For school leaders, the main implication is to treat IFPD integration as professional development and learning management. Leaders should provide time for preparation, recognize teacher experimentation, organize peer sharing, and track problems without blaming teachers. They should also protect equitable access across classes.

For students, the main implication is that screen interaction should include responsibility. Students need rules for safe touch, turn-taking, respectful feedback, and care of the device. They should understand that the panel is a learning tool, not only an entertainment screen.

For future research, a field-based mixed-method study is recommended. Researchers can compare baseline and post-implementation engagement, administer a validated motivation questionnaire, observe several lessons, interview teachers and students, and analyze learning products. Such research would provide direct evidence about the effect of IFPD use at SD Negeri 1 Apuan.

J. Limitations of the study

This study has several limitations that should be acknowledged. First, the study does not include primary empirical data collected directly from students or teachers. The analysis is based on existing literature and an evidence-informed interpretation of IFPD implementation. Therefore, the findings cannot establish a causal relationship between IFPD use and improvements in student engagement or learning motivation.

Second, the study focuses on the context of SD Negeri 1 Apuan. Differences in school facilities, teacher competencies, student characteristics, and technological readiness may influence the applicability of the findings to other elementary school contexts. Therefore, the proposed framework should be considered context-sensitive rather than universally applicable.

Third, the four-stage implementation framework proposed in this study readiness, guided pilot, pedagogical expansion, and evaluation/institutionalization has not yet been empirically tested through classroom intervention. Its effectiveness in improving student engagement and learning motivation therefore remains to be validated.

Finally, this study primarily discusses student engagement and learning motivation as potential outcomes of IFPD integration. Other learning outcomes, such as academic achievement and subject-specific learning gains, are not directly measured. Future research should employ empirical or quasi-experimental designs involving larger samples and validated instruments to examine the effects of IFPD on student engagement, learning motivation, and learning outcomes.

Future research is recommended to employ a quasi-experimental design with a larger sample and validated instruments to measure changes in student engagement, learning motivation, and academic achievement in specific subjects more precisely. Such an approach could provide stronger empirical evidence regarding the effectiveness of IFPD on various aspects of learning outcomes.

CONCLUSION

Interactive Flat Panel Display has strong potential to enhance student engagement and learning motivation at SD Negeri 1 Apuan. Its main contribution lies in the integration of direct touch, visual explanation, shared problem solving, immediate feedback, and student presentation. These features can support behavioral participation, cognitive effort, interest, confidence, and collaboration.

The analysis also shows that the device does not improve learning automatically. The quality of teacher facilitation, lesson design, digital competence, preparation, technical support, equitable participation, and screen-time balance determines the result. SD Negeri 1 Apuan should therefore adopt IFPD through a gradual process that begins with readiness, continues with guided pilot lessons, expands toward student-centered activities, and ends with routine evaluation.

The findings reveal a connection among the three theoretical frameworks employed in this study. The student engagement perspective suggests that interactive activities facilitated by IFPDs can foster behavioral and cognitive engagement among students. Self-Determination Theory explains that such engagement flourishes when IFPD usage supports competence,

meaningful choice, and social connectedness within the learning process. Meanwhile, multimedia learning theory posits that a combination of visual information, text, annotations, and demonstrations—when purposefully designed to avoid overloading cognitive processes—can aid student comprehension. Thus, these three theories complement one another: the IFPD provides an interactive environment, teacher pedagogy guides its application, and the resulting learning experience—supporting engagement, meeting psychological needs, and facilitating multimedia processing—forms the foundation for motivation and learning engagement.

The article provides an evidence-informed framework rather than a measured treatment effect. A direct classroom study is needed to verify changes in engagement and motivation. The suggested indicators can guide that evaluation and help the school build a sustainable model of interactive digital learning.

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References

1. Ministry of Primary and Secondary Education, Republic of Indonesia, "SD Negeri 1 Apuan, NPSN 50102613," Education Unit Reference Data, 2026.
2. N. L. P. Y. Anggreni, N. N. Murniasih, and I. K. Sudana, "Innovative Learning Management in a Disruptive Era: A Case Study of Apuan 1 Public Elementary School," in Proceedings of PROSPEK II, Denpasar, Indonesia, 2023, pp. 293-297.
3. J. A. Fredricks, P. C. Blumenfeld, and A. H. Paris, "School engagement: Potential of the concept, state of the evidence," Review of Educational Research, vol. 74, no. 1, pp. 59-109, 2004, doi: 10.3102/00346543074001059.
4. J. J. Appleton, S. L. Christenson, and M. J. Furlong, "Student engagement with school: Critical conceptual and methodological issues," Psychology in the Schools, vol. 45, no. 5, pp. 369-386, 2008, doi: 10.1002/pits.20303.
5. E. L. Deci and R. M. Ryan, "The what and why of goal pursuits: Human needs and the self-determination of behavior," Psychological Inquiry, vol. 11, no. 4, pp. 227-268, 2000, doi: 10.1207/S15327965PLI1104_01.
6. R. M. Ryan and E. L. Deci, Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness. New York, NY, USA: Guilford Press, 2017.
7. R. E. Mayer, "The past, present, and future of the cognitive theory of multimedia learning," Educational Psychology Review, vol. 36, art. 8, 2024, doi: 10.1007/s10648-023-09842-1.
8. J. C. Castro-Alonso, B. B. de Koning, L. Fiorella, and F. Paas, "Five strategies for optimizing instructional materials: Instructor- and learner-managed cognitive load," Educational Psychology Review, vol. 33, no. 4, pp. 1379-1407, 2021, doi: 10.1007/s10648-021-09606-9.
9. B. Ceken and N. Taskin, "Multimedia learning principles in different learning environments: A systematic review," Smart Learning Environments, vol. 9, art. 19, 2022, doi: 10.1186/s40561-022-00200-2.
10. C.-H. Chen and C.-C. Tsai, "In-service teachers' conceptions of mobile technology-integrated instruction: Tendency towards student-centered learning," Computers & Education, vol. 170, art. 104224, 2021, doi: 10.1016/j.compedu.2021.104224.
11. G. Knezek, R. Christensen, A. Smits, J. Tondeur, and J. Voogt, "Strategies for developing digital competencies in teachers: Towards a multidimensional synthesis of qualitative data survey instrument," Computers & Education, vol. 193, art. 104674, 2023, doi: 10.1016/j.compedu.2022.104674.
12. P. Hartanto and D. Wahyuningsih, "The impact of Interactive Flat Panel Displays on student engagement and learning motivation," Golden Ratio of Data in Summary, vol. 6, no. 2, pp. 79-88, 2026, doi: 10.52970/grdis.v6i2.2131.
13. R. Riyadi and T. Ningsih, "The implication of Interactive Flat Panel Display media on the learning process of social science for madrasah students," ELSE: Elementary School Education Journal, vol. 8, no. 3, pp. 329-341, 2025, doi: 10.30651/else.v8i3.24401.
14. R. T. Indriansyah, "The role of Interactive Flat Panel Display in enhancing students' learning motivation and collaboration," Dinamika Sosial: Jurnal Pendidikan Ilmu Pengetahuan Sosial, vol. 4, no. 4, 2025, doi: 10.18860/dsjpips.v4i4.19859.
15. H. D. Septiyaningtiyas, S. Handhayani, B. P. Winata, and H. W. Setiadi, "Integration of interactive flat panels and smart TV with Wordwall, Liveworksheets, and Kahoot to increase student learning participation," Jurnal IKA PGSD, vol. 16, no. 2, pp. 254-267, 2025, doi: 10.36841/pgsdunars.v16i2.7524.
16. W. N. Aryfien, I. R. W. Atmojo, and M. Matsuri, "Interactive learning media for better learning outcomes in elementary school: A systematic literature review," Mimbar Sekolah Dasar, vol. 12, no. 1, 2025.
17. R. Alyusfitri, N. Gistituati, Yerizon, A. Fauzan, and Yarman, "The effectiveness and relationship of student responses toward learning outcomes using interactive multimedia-based e-modules in elementary schools," International Electronic Journal of Elementary Education, vol. 16, no. 5, pp. 573-584, 2024, doi: 10.26822/iejee.2024.354.
18. B. Rayan and A. Watted, "Enhancing education in elementary schools through gamified learning: Exploring the impact of Kahoot! on the learning process," Education Sciences, vol. 14, no. 3, art. 277, 2024, doi: 10.3390/educsci14030277.
19. C. Cubillos, S. Roncagliolo, D. Cabrera-Paniagua, and R. M. Vicari, "A digital math game and multiple-try use with primary students: A sex analysis on motivation and learning," Behavioral Sciences, vol. 14, no. 6, art. 488, 2024, doi: 10.3390/bs14060488.

10.3390/bs14060488.

20. N. L. Laakso, T. S. Korhonen, and K. P. J. Hakkarainen, "Developing students' digital competences through collaborative game design," *Computers & Education*, vol. 174, art. 104308, 2021, doi: 10.1016/j.compedu.2021.104308.
21. U. Tugtekin and H. F. Odabasi, "Do interactive learning environments have an effect on learning outcomes, cognitive load and metacognitive judgments?" *Education and Information Technologies*, vol. 27, no. 5, pp. 7019-7058, 2022, doi: 10.1007/s10639-022-10912-0.
22. S. W. Tyas, M. Arifuddin, M. Mastur, and H. Mans, "Exploring teachers' and students' perspectives on the utilization of interactive flat panels in deep learning approaches," *EDUTECH*, 2026.
23. A. Bentri and A. Hidayati, "Improving digital pedagogy competence through in-service training for elementary school teachers," *Journal of Physics: Conference Series*, vol. 2582, art. 012064, 2023, doi: 10.1088/1742-6596/2582/1/012064.
24. M. Naeem, W. Ozuem, K. Howell, and S. Ranfagni, "A step-by-step process of thematic analysis to develop a conceptual model in qualitative research," *International Journal of Qualitative Methods*, vol. 22, pp. 1-18, 2023, doi: 10.1177/16094069231205789.
25. UNESCO, *Global Education Monitoring Report 2023: Technology in Education, A Tool on Whose Terms?* Paris, France: UNESCO, 2023.