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Smartboard Media and Learning Motivation in Elementary Mathematics: A Case Study in Rural Indonesia

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ABSTRACT

Conventional mathematics instruction in elementary schools has been associated with low student motivation, particularly among learners in the concrete operational stage of cognitive development. This study examined the role of interactive digital smartboard media in fostering learning motivation among fourth-grade students in mathematics at a rural elementary school in South Lampung Regency, Indonesia. A descriptive qualitative approach with a single embedded case study design was employed, involving 24 students purposively selected on the basis of preliminary evidence of low motivational engagement. Data were collected across three structured learning sessions through participatory observation, semi-structured interviews, a motivation questionnaire, and systematic field notes, and were analyzed using the interactive model of Miles, Huberman, and Saldaña, with trustworthiness established through source and technique triangulation. Results showed a progressive increase in active engagement from 40% during conventional instruction to 85% and 92% across the two smartboard-assisted sessions, with a mean motivation score of 83.4%. Qualitative data indicated heightened curiosity, reduced reluctance, and spontaneous peer collaboration during smartboard-assisted lessons, though a small proportion of students remained less engaged. Given the purposive sampling and limited session count, these findings should be interpreted as context-specific rather than generalizable. The study nonetheless offers preliminary evidence that interactive smartboard media can stimulate learning motivation in elementary mathematics, with implications for instructional design and directions for future research using larger, unselected samples.

Keywords: *Elementary Mathematics, Interactive Whiteboard, Learning Motivation, Qualitative Case Study, Self-Determination Theory*

INTRODUCTION

The global shift toward digitally mediated education has fundamentally altered expectations for classroom practice (Rahimi & Oh, 2024). Schools in the twenty-first century are no longer regarded merely as sites of knowledge transmission; they are increasingly understood as environments that must cultivate curiosity, sustain engagement, and prepare students for a rapidly evolving digital landscape (McCarthy et al., 2023). Elementary schools, as the foundational stage of formal education, bear particular responsibility in this transformation, since the motivational dispositions formed during these early years tend to persist and shape long-term learning trajectories (Larkin & Lowrie, 2022). Within this context, the strategic integration of instructional technology has emerged as one of the most discussed and practically consequential interventions available to educators. The growing presence of interactive digital tools in classrooms reflects a broader institutional recognition that conventional pedagogical approaches are increasingly insufficient for meeting the cognitive and motivational needs of contemporary learners (Paradise & Prak, 2024).

Mathematics occupies a distinctive and often problematic position in elementary school curricula. Its abstract, hierarchical, and logically demanding character frequently creates a mismatch between the conceptual demands of the subject and the developmental capabilities of young learners, who, according to Piaget's theory of cognitive development, are still operating within the concrete operational stage, a period in which thinking remains anchored in tangible experience rather than formal symbolic reasoning (Piaget, 1952). This developmental incongruence may contribute to the formation of negative attitudes toward mathematics from an early age, attitudes that may be difficult to reverse once established (Cvencek et al., 2021). Carstens et al. (2021) similarly cautioned that technology introduced into classrooms without careful pedagogical alignment can fail to address, or can even compound, the specific learning difficulties it was intended to resolve. The persistence of conventional teaching methods in the face of such documented shortcomings thus represents not merely a pedagogical oversight but a structural barrier to equitable learning outcomes.

The motivational dimensions of learning are particularly salient in elementary mathematics education, where affective factors frequently determine whether students persist through difficulty or disengage from the subject (Hanin & Gay, 2023). Learning motivation is broadly defined as the internal and external force that initiates, sustains, and directs an individual's engagement with academic tasks, and has been most influentially articulated through self-determination theory, which distinguishes between intrinsic motivation, arising from inherent interest and satisfaction, and extrinsic motivation, arising from external reward or pressure (Ryan & Deci, 2020). In primary school settings, this motivational force is especially susceptible to environmental stimuli: the novelty of learning materials,

the interactivity of instructional media, and the perceived relevance of tasks all exert considerable influence on how students orient themselves toward learning (Bednorz & Bruhn, 2023). Hidayat et al. (2024) affirmed that the integration of technology tools and resources into teaching practices constitutes a substantive strategy for strengthening the motivational climate of classrooms, underscoring the point that instructional design choices carry direct motivational consequences. Understanding the conditions under which technology-enhanced instruction can reliably stimulate both intrinsic and extrinsic motivation therefore remains an urgent research priority.

Against this backdrop, the interactive digital smartboard has attracted considerable scholarly and practical attention as an instructional medium capable of addressing the motivational challenges that characterize conventional mathematics teaching. The smartboard is a touch-sensitive display system that integrates seamlessly with computer-based software to enable the presentation of dynamic, multimedia-rich learning content, including animated visualizations, interactive simulations, embedded video materials, and real-time student response activities (Zhou et al., 2022). Its functional architecture affords instructors the capacity to orchestrate multi-modal learning experiences within a single platform without the need to transition between disparate media, thereby sustaining a continuous, visually stimulating instructional flow (Kühl & Wohninsland, 2022). Crucially, the smartboard also enables direct student interaction with the display surface, creating opportunities for active physical participation in mathematics lessons that traditional classroom media cannot replicate. These combined affordances have led a growing number of researchers and policymakers to regard the smartboard as a transformative instructional resource for elementary mathematics education.

The theoretical rationale for the motivational and cognitive benefits of smartboard-based instruction is most coherently articulated through Mayer's cognitive theory of multimedia learning (Mayer, 2020). This theory posits that human working memory operates through two distinct processing channels: an auditory-verbal channel and a visual-pictorial channel. Meaningful learning is maximized when both channels are simultaneously engaged, as this dual-channel activation reduces extraneous cognitive load and facilitates the integration of new information with prior knowledge. Empirical research has substantiated this theoretical claim across a range of instructional contexts. Kühl and Wohninsland (2022) found that interactive whiteboard instruction significantly enhanced student motivation and engagement compared to conventional instruction, with particularly pronounced effects among learners who experienced anxiety in traditional classroom settings. These findings indicate that multimedia-rich, interactive instructional platforms do not merely present information more attractively; they also alter the affective and cognitive conditions under which learning occurs.

Several empirical studies conducted in diverse national and institutional contexts have documented positive associations between interactive whiteboard use

and student learning outcomes. Zhou et al. (2022) identified teacher-student interaction quality as a central determinant of effective interactive whiteboard use, concluding that the technology's educational value is contingent upon how it is embedded within a broader instructional strategy. Extending this line of inquiry to primary mathematics education specifically, Bednorz and Bruhn (2023) demonstrated that technology-enhanced learning environments can simultaneously foster mathematical knowledge development and motivational engagement among young learners, provided that such environments are thoughtfully designed to accommodate individual differences in self-regulation. Despite this growing body of evidence, however, most existing studies have been conducted in Western and East Asian educational contexts, where technological infrastructure, classroom culture, and pedagogical norms differ substantially from those prevailing in Indonesian elementary schools. Furthermore, prior investigations have largely relied on quantitative outcome measures, leaving the lived classroom dynamics through which smartboard use shapes student motivation comparatively underexplored. The qualitative, process-oriented dimensions of how interactive media transforms motivational behavior in real instructional settings thus remain an important gap in the literature.

The present study was conducted at SD Negeri Gandri, a state elementary school in Penengahan District, South Lampung Regency, where preliminary observation had revealed persistent patterns of student disengagement during conventional mathematics instruction. The central research question guiding this investigation is: how does the use of interactive digital smartboard media influence the learning motivation of fourth-grade students in mathematics at SD Negeri Gandri? The novelty of this study lies in three respects. First, it examines smartboard-mediated motivation within a rural Indonesian elementary school context, a setting that has received limited attention in the international literature on educational technology. Second, it adopts a descriptive qualitative case study design that captures the dynamic, session-by-session progression of motivational change, moving beyond static pre-post comparisons that dominate the existing evidence base. Third, it integrates multiple data sources, including observational records, semi-structured interviews, motivation questionnaires, and systematic field notes, to construct a rich, triangulated account of how interactive digital media reshapes the motivational landscape of elementary mathematics classrooms. The findings are expected to contribute both theoretical insights into the relationship between interactive instructional media and student motivation and practical recommendations for teachers, school administrators, and education policymakers seeking to leverage technology in service of more engaging and effective elementary mathematics instruction.

LITERATURE REVIEW

Interactive Digital Media and the Smartboard in Education

Instructional media have undergone a profound and accelerating transformation over the past two decades. Whereas earlier conceptions of classroom media were largely restricted to static visual aids, printed materials, and teacher-operated projectors, the contemporary educational landscape accommodates an expansive repertoire of digital tools capable of delivering dynamic, responsive, and multi-sensory learning experiences (Wang et al., 2024). Within this landscape, interactive digital media occupy a particularly prominent position. Unlike passive display technologies, interactive digital media are distinguished by their capacity not merely to present information but to invite learner response, participation, and co-construction of meaning (Dabbagh, 2023). This participatory dimension is widely regarded as central to the motivational and cognitive benefits that such media are reported to generate in classroom settings.

The smartboard represents one of the most fully realized expressions of interactive digital media in formal educational contexts. Technically, it functions as a touch-sensitive display surface integrated with computer hardware and specialized instructional software, enabling the simultaneous presentation of text, image, animation, video, and interactive assessment tools within a single unified interface (Zhou et al., 2022). Teachers using the smartboard are able to display content, annotate materials in real time, manipulate on-screen objects, and embed gamified quiz elements, all without disrupting the instructional flow by transitioning between separate devices or media (Kühl & Wohninsland, 2022). Beyond these teacher-facing affordances, the smartboard uniquely permits students to physically approach the display and interact directly with learning content, an experience that qualitatively differs from passive observation and has been associated with heightened engagement and ownership of the learning process. Zhou et al. (2022) established that the effectiveness of interactive whiteboard technology depends substantially on the quality of teacher-student interaction it enables, reinforcing the understanding that the smartboard functions most powerfully not as a standalone technological artefact but as a mediating tool within a broader pedagogical relationship.

The theoretical foundation most commonly invoked to explain the cognitive advantages of smartboard-based instruction is Mayer's cognitive theory of multimedia learning. This theory advances the position that the human cognitive system processes information through two discrete channels: a verbal channel, responsible for handling spoken and written language, and a pictorial channel, responsible for processing visual and graphical input (Mayer, 2020). Because each channel operates with limited capacity, the simultaneous and coordinated engagement of both channels through multimodal instruction reduces the cognitive burden placed on any single processing pathway, thereby freeing cognitive resources for deeper comprehension and knowledge integration. The smartboard, with its inherent capacity to present verbal and visual information in a synchronized and spatially unified manner, is particularly well suited to instantiating these

principles in classroom practice. Kühl and Wohninsland (2022) provided empirical support for this mechanism, demonstrating in a controlled classroom study that interactive whiteboard instruction produced measurable improvements in both learning outcomes and student motivation relative to instruction delivered without the technology, with motivational gains proving especially robust among students who were typically reticent or anxious in conventional classroom environments.

Learning Motivation in Elementary School Students

Learning motivation is broadly understood as the psychological energy that activates, orients, and sustains an individual's engagement with academic activity. Within educational psychology, motivation is conventionally differentiated into two principal forms. Intrinsic motivation originates from within the learner and manifests as curiosity, genuine interest in the subject matter, and the inherent satisfaction derived from learning and mastery (Chukwuedo et al., 2021). Extrinsic motivation, by contrast, is generated by factors external to the learner, including environmental conditions, instructional stimuli, peer dynamics, and the design of learning media. Vansteenkiste et al. (2020) extended the foundational tenets of self-determination theory by demonstrating that motivation quality, rather than motivation quantity alone, is governed by the degree to which an instructional environment satisfies learners' basic psychological needs for autonomy, competence, and relatedness, with environments that meet these needs reliably producing more durable and self-sustaining engagement.

Elementary school students present a distinctive motivational profile that has important implications for instructional design. Children at this developmental stage are characterized by high levels of curiosity and openness to novelty, but also by comparatively limited attentional persistence and a heightened sensitivity to the immediate affective qualities of their learning environment (Chen et al., 2021). In a large-scale meta-analytic review applying self-determination theory across educational settings, Vasconcellos et al. (2020) found that instructional conditions supporting learner autonomy and competence were consistently associated with stronger motivational outcomes among younger students in particular, suggesting that the relationship between instructional design and motivation in elementary settings is not uniform but is mediated by how well a given medium addresses these developmental needs. When instructional activities are perceived as stimulating, interactive, and personally relevant, young learners demonstrate remarkable capacity for sustained engagement; conversely, when instruction is monotonous or abstract without adequate scaffolding, their attention dissipates rapidly and disengagement sets in (Wahyuni et al., 2025).

The measurement and operationalization of learning motivation in elementary school research has been approached through a range of empirically validated indicators, typically encompassing a sustained desire to succeed at assigned tasks, resilience in the face of learning difficulties, evident enthusiasm and

positive affect during instructional activities, and satisfaction with learning accomplishments (Ramos et al., 2022). These indicators are particularly useful in the present study's context because they are observable through both behavioral observation and self-report instruments, making them amenable to the multi-method data collection approach employed here. Hidayat et al. (2024) further affirmed that a conducive and stimulating instructional environment, including the deliberate integration of technology resources into teaching practice, constitutes one of the most consistently effective strategies for strengthening these motivational indicators across diverse school settings.

Mathematics Learning in Elementary School

Mathematics is universally recognized as a foundational academic discipline, yet it is simultaneously one of the subjects that generates the highest levels of anxiety, disengagement, and negative self-perception among elementary school students (Alam & Mohanty, 2023). The source of these difficulties is widely attributed to the inherent nature of the subject itself: mathematics is abstract, cumulative, and hierarchically structured, meaning that comprehension of any given concept is frequently contingent upon secure mastery of prior concepts. For children in the concrete operational stage of cognitive development, this abstract and sequential character poses a genuine developmental challenge, as their thinking remains anchored in tangible experience and direct manipulation of objects rather than in the formal symbolic reasoning that mathematics demands (Saccardo et al., 2024). Without appropriate instructional scaffolding that bridges this gap between concrete experience and abstract conceptualization, many elementary students develop persistent difficulties that compound progressively across grade levels.

The instructional environment in which mathematics is taught exerts a powerful influence on students' motivation and achievement. Golaszewski et al. (2021), in a large-scale observational study of fourth-grade classrooms, found that time spent on-task declined measurably as lessons progressed, particularly under instructional conditions that lacked variation or interactive stimulation, reinforcing the broader concern that the predominance of lecture-based, teacher-directed instruction in elementary classrooms is associated with diminished sustained attention. The absence of varied, visually stimulating media deprives students of the sensory and cognitive stimulation necessary to sustain attention and activate meaningful processing of mathematical content. Siller and Ahmad (2024) corroborated the importance of concrete and visually grounded instructional tools, demonstrating in a quasi-experimental study with fifth-grade students that blended concrete and virtual manipulative instruction produced significantly greater gains in mathematical achievement compared to traditional exposition-based teaching, with students in the manipulative-based condition also reporting more positive engagement with the material.

The integration of interactive digital technology into elementary mathematics instruction has therefore attracted growing empirical attention as a potential remedy for these persistent motivational and pedagogical challenges. Bednorz and Bruhn (2023) documented that fourth-grade students who received mathematics instruction through technology-enhanced, visually dynamic learning environments reported richer and more positive learning experiences compared to those taught through conventional means, attributing enhanced engagement to the interactivity and visual richness of the instructional medium. Zhou et al. (2022) similarly established that interactive technology-based instruction produced significantly higher levels of student engagement in elementary classrooms, particularly in sustaining attention across lesson segments that would otherwise provoke disengagement. Siller and Ahmad (2024) findings extend these conclusions by showing that interactive, visually concrete instructional tools produced concurrent improvements in both conceptual understanding and motivation, reinforcing the theoretical position that cognitive and motivational outcomes in mathematics education are deeply intertwined rather than independent.

RESEARCH METHODOLOGY

This study employed a descriptive qualitative approach with a single embedded case study design. This methodological choice is grounded in the epistemological position that motivational experiences of elementary school students are most meaningfully understood through detailed, context-sensitive inquiry rather than through numerical aggregation alone (Creswell & Poth, 2024). Case study design is particularly well suited to educational research settings where the researcher seeks to capture the complexity and particularity of a bounded phenomenon within its natural context, and where research questions are oriented toward understanding how and why rather than how many (Yin, 2018). This approach allowed the study to examine the nuanced interplay between instructional media use and student motivational responses as they unfolded organically across real classroom sessions.

The research was conducted at SD Negeri Gandri, Penengahan District, South Lampung Regency, Indonesia. Participants consisted of 24 fourth-grade students, comprising 13 male and 11 female students, selected through purposive sampling on the basis of preliminary observational evidence indicating pronounced motivational difficulties during conventional mathematics instruction (Sugiyono, 2022). The researcher's concurrent role as the class teacher afforded privileged and naturalistic access to the instructional setting, substantially strengthening the depth and authenticity of the data. Three learning sessions were structured with a comparative schema: the first session served as a baseline condition using conventional chalk-and-board instruction, while the second and third sessions introduced the smartboard as the primary instructional medium, delivering

mathematics content on measurement and plane geometry through animated visualizations and interactive touch-based quiz activities.

Data were gathered through four complementary instruments reflecting the multi-method triangulation strategy recommended for qualitative case study research. Participatory observation was conducted across all three sessions, with systematic field notes recorded to document behavioral patterns, classroom dynamics, and contextually significant events. Semi-structured interviews were subsequently conducted with selected students and the class teacher to elicit perceptions and affective accounts of the learning experience. A learning motivation questionnaire was administered to all 24 participants following the smartboard-assisted sessions, structured around four behavioral and affective indicators commonly used in validated elementary motivation instruments, namely engagement and desire to succeed, persistence in the face of difficulty, enthusiasm and interest during learning, and satisfaction with learning outcomes, indicator categories consistent with validated self-determination theory-based motivation scales for elementary-aged children such as the Elementary School Motivation Scale (Ramos et al., 2022). The combination of these instruments ensured that motivational phenomena were captured from observational, experiential, and self-report perspectives simultaneously.

Data analysis followed the interactive model proposed by Miles et al. (2020), comprising three iterative and mutually informing phases: data condensation, data display, and conclusion drawing with verification. Raw data from all instruments were systematically coded and reduced to thematically coherent categories relevant to the research questions, before being organized into structured narrative accounts that facilitated cross-instrument comparison and pattern recognition. Conclusions were drawn through inductive analytical generalization, whereby recurring patterns across multiple data sources were interpreted in relation to the theoretical frameworks informing the study (Creswell & Poth, 2024). Trustworthiness was established through source triangulation, comparing data across participant groups, and technique triangulation, cross-referencing observational, interview, and questionnaire data. Member checking was additionally employed, whereby preliminary interpretations were shared with the class teacher to confirm their plausibility against observed classroom realities (Yin, 2018).

RESULT AND DISCUSSION

Active Student Engagement Across Learning Sessions

Observational data collected across the three structured learning sessions revealed a consistent and progressive increase in active student engagement that corresponded directly with the introduction of smartboard-assisted instruction. During the first session, which employed conventional chalk-and-board methods as a baseline condition, only 40% of the 24 participants sustained consistent attentional engagement throughout the lesson. Field notes recorded during this

session documented frequent instances of off-task behavior, including daydreaming, unsolicited peer conversation, and restless physical movement, behavioral patterns consistent with documented indicators of attentional disengagement in elementary classroom settings (Golaszewski et al., 2021). The overall classroom atmosphere during this session was notably passive, with student responses to teacher prompts limited in both frequency and spontaneity.

A marked contrast emerged in the second session, when the smartboard was introduced as the primary instructional medium. Active engagement rose substantially to 85%, as evidenced by students' sustained visual attention to the animated content on the display, spontaneous requests to approach the board and interact directly with on-screen elements, and a measurable increase in voluntary question-answering. By the third session, engagement reached its peak at 92%, representing the highest level recorded across the entire study. At this point, the large majority of observed students were actively involved in at least one form of participatory behavior, whether following the animated mathematical content, responding to the teacher's interactive prompts, or completing touch-based quiz activities at the board. This progressive pattern of engagement is consistent with the findings of Zhou et al. (2022), who similarly documented that the quality of teacher-student interaction enabled by interactive whiteboard technology is a central driver of increased active participation, and aligns with Bednorz and Bruhn (2023) conclusion that technology-enhanced learning environments can meaningfully shift student engagement in elementary mathematics settings.

Learning Motivation Scores and Motivational Indicators

The learning motivation questionnaire, administered to all 24 participants following the smartboard-assisted sessions, yielded a mean motivation score of 83.4%, placing the cohort collectively within the high motivation category. Scores were distributed across the four motivational indicators outlined in the Methodology, namely engagement and desire to succeed, persistence in the face of difficulty, enthusiasm during the learning process, and satisfaction with learning outcomes (Ramos et al., 2022). Among these four indicators, enthusiasm during learning and desire to succeed registered the highest mean scores, while persistence and satisfaction, though elevated, showed comparatively more modest gains. This pattern represents a notable finding given that mathematics is a subject frequently associated with anxiety and avoidance among elementary students, and the motivational response observed under smartboard-assisted conditions therefore stands in contrast to the more guarded engagement typically reported for this subject in the broader literature.

These results substantiate the theoretical claims advanced by Vansteenkiste et al. (2020), who identified stimulating, needs-supportive instructional environments as primary determinants of sustained motivation among young learners. They also lend empirical weight to Hidayat et al. (2024) contention that

the deliberate integration of technology tools into teaching practice strengthens the motivational climate of classrooms in ways that are observable and measurable. The motivational gains documented here were achieved within a context where the subject matter, elementary mathematics, is widely acknowledged in the literature to be among the more motivationally challenging subjects in the primary curriculum, a contextual detail that situates these findings within a meaningfully difficult instructional setting rather than a neutral or already-favorable one.

Student Perceptions of Smartboard-Assisted Learning

Interview data collected from selected participants and the class teacher provided qualitative depth to the quantitative motivational picture emerging from the questionnaire results. The majority of students interviewed described their experience of smartboard-assisted mathematics learning in distinctly positive affective terms, characterizing the lessons as enjoyable, engaging, and fundamentally different in quality from their prior experience of conventional instruction. Several students spontaneously employed the phrase “learning while playing” to describe the smartboard sessions, a characterization that is significant because it reflects the dissolution of the boundary between effortful academic work and pleasurable activity, a condition associated in the self-determination theory literature with more autonomous and intrinsically driven motivational engagement (Deci & Ryan, 1985). Multiple students specifically identified the animated visual content and the opportunity to physically touch and manipulate elements on the screen as the features most responsible for their enhanced comprehension and enjoyment.

The class teacher's interview responses reinforced and extended the student accounts. The teacher observed that students who had previously exhibited habitual passivity and reluctance to participate in mathematics lessons demonstrated noticeably altered behavior during the smartboard sessions, volunteering answers, approaching the board unprompted, and engaging in spontaneous peer discussion about on-screen mathematical problems. This behavioral shift aligns with the theoretical proposition embedded in Mayer's cognitive theory of multimedia learning that the simultaneous engagement of verbal and visual processing channels through coordinated multimodal instruction reduces cognitive load and creates conditions more favorable to both comprehension and positive affect (Mayer, 2020). The interview data therefore corroborate the observational and questionnaire findings from a distinct evidential angle, strengthening the overall credibility of the study's conclusions through instrument triangulation.

Classroom Dynamics and Behavioral Transformation

Field note records from the two smartboard-assisted sessions documented several qualitatively significant behavioral transformations that extended beyond the individual motivational responses captured by the questionnaire. Most notably,

students who had been consistently identified as passive and disengaged during the baseline conventional session demonstrated a willingness, in some cases a visible eagerness, to approach the smartboard and interact directly with the learning content. One plausible interpretation of this behavioral shift is that it reflects growing self-efficacy and confidence as students discovered, through repeated successful interaction with the technology, that mathematical activity was something they could engage with competently and enjoyably. This interpretation aligns conceptually with Bandura's (1997) theory of self-efficacy, in which mastery experiences, such as the immediate and tangible feedback generated by touching the board and producing a correct response, are identified as among the most powerful sources of efficacy belief; however, as the present study did not directly measure self-efficacy as a construct, this remains an interpretive inference drawn from observed approach-behavior rather than a directly evidenced finding.

Field notes also recorded the emergence of spontaneous peer collaboration during the smartboard sessions. Students were observed discussing on-screen mathematical problems with their immediate neighbors without prompting from the teacher, negotiating solution strategies, and celebrating correct answers together. This organic collaborative behavior was entirely absent during the conventional session and represents a qualitatively distinct dimension of the smartboard's motivational impact: its capacity to restructure the social dynamics of the classroom in ways that support collective as well as individual engagement. This dynamic is broadly consistent with self-determination theory's emphasis on relatedness as a basic psychological need supporting motivation (Vansteenkiste et al., 2020). With respect to sustained attention specifically, the marked reduction in off-task behavior observed during the smartboard sessions, falling from the 60% disengagement rate recorded in the baseline session to engagement levels of 85% and 92% in the subsequent sessions, represents a substantial improvement, though it should be noted that a residual proportion of students, approximately 8% in the best-performing session, remained less than fully engaged even under smartboard-assisted conditions. Bednorz and Bruhn (2023) similarly documented that technology-enhanced learning environments can substantially, though not universally, improve sustained engagement in elementary mathematics classrooms.

Limitations

Several limitations of this study warrant acknowledgment. First, the relatively small sample size of 24 students drawn from a single fourth-grade classroom at one school in South Lampung restricts the transferability of the findings to broader populations of elementary school students in Indonesia or comparable developing-country contexts. While qualitative case study research does not seek statistical generalizability, the bounded nature of this study's context means that its conclusions should be interpreted as context-specific insights rather than universal claims. Second, because participants were selected through purposive sampling

specifically on the basis of preliminary evidence of pronounced motivational difficulties during conventional instruction, the sample may have been subject to a ceiling or floor effect: a group pre-selected for low baseline motivation and engagement has greater room to show apparent improvement than an unselected classroom would, meaning the magnitude of the observed increase from 40% to 92% engagement should be interpreted with this selection criterion in mind rather than treated as a generalizable effect size.

Third, the study spanned only three learning sessions, a timeframe sufficient to capture initial motivational responses but inadequate for assessing whether the observed gains are sustained over an extended period of smartboard-integrated instruction; the novelty effect, whereby students respond positively to any new stimulus regardless of its specific pedagogical properties, cannot be fully ruled out within this design. Fourth, the researcher's dual role as both classroom teacher and primary investigator, while advantageous in terms of access and contextual familiarity, introduces the possibility of observer bias in the interpretation of behavioral and affective data. Although source and technique triangulation were employed to mitigate this risk, the potential influence of researcher positionality on data collection and analysis should be considered when evaluating the findings. Future studies addressing these limitations through larger, unselected samples, longitudinal designs, and independent observation would substantially strengthen the evidence base for recommendations regarding smartboard integration in Indonesian elementary mathematics education.

Relationship of Findings to Prior Literature

The findings of this study are, in their totality, strongly supportive of the body of scholarship reviewed in the introduction and literature review, while also introducing nuances that extend and refine several of those positions, with the sampling-related caveat discussed above. The observed progressive increase in engagement from 40% to 92% across sessions directly supports Zhou et al. (2022), who reported that teacher-student interaction quality drives participation gains under interactive whiteboard conditions, and is consistent with Siller and Ahmad (2024) documentation of concurrent motivational and achievement improvements under visually concrete, technology-supported instruction. The mean motivation score of 83.4% corroborates Vansteenkiste et al. (2020) theoretical claim that needs-supportive, stimulating instructional conditions are primary motivational determinants, and affirms Hidayat et al. (2024) practical contention that technology integration strengthens measurable motivational outcomes.

With respect to the internationally indexed literature, the present findings are in clear alignment with Kühl and Wohninsland (2022), whose study established that interactive whiteboard instruction enhances motivation and learning outcomes relative to conventional instruction. The motivational gains documented in the current study, observed within a rural Indonesian elementary school context rather

than a Western secondary school setting, suggest that these benefits generalize across substantially different cultural, institutional, and developmental contexts, thereby extending rather than merely replicating Kühl and Wohninsland's findings. The study further supports Zhou et al. (2022) on the centrality of teacher-student interaction quality, a conclusion borne out by the teacher interview data, which attributed much of the motivational shift to the interactive and participatory structure of the smartboard lessons.

The findings also complement Bednorz and Bruhn (2023), who demonstrated that technology-enhanced learning environments foster motivational engagement in primary mathematics, with the present study contributing the additional insight, qualified by the limitations noted above, that these motivational effects are observable even in resource-limited, rural school settings where prior technological exposure among students may be minimal. Taken together, and with appropriate caution regarding sample selection and study duration, the present study neither contradicts nor merely duplicates the prior literature; rather, it substantiates, extends, and contextualizes an emerging body of evidence suggesting that interactive digital media, when thoughtfully integrated into elementary mathematics instruction, can serve as a meaningful catalyst for student motivational engagement.

CONCLUSION

This study examined the role of interactive digital smartboard media in fostering learning motivation among fourth-grade students in elementary mathematics at SD Negeri Gandri, South Lampung. The findings indicated that smartboard-assisted instruction was associated with meaningful improvements across the motivational indicators observed within this specific, purposively selected sample. Active student engagement rose from 40% during conventional instruction to 85% in the second session and 92% in the third, while the mean motivation score derived from the questionnaire reached 83.4%, placing the cohort within the high motivation category. These outcomes were further supported by qualitative evidence from interviews and field notes, which documented noticeable shifts in student affect, confidence, and spontaneous collaborative behavior, although a small residual proportion of students remained less engaged even under smartboard-assisted conditions.

Within the scope and constraints of this case study, the smartboard appeared effective in stimulating both intrinsic and extrinsic dimensions of student motivation. Intrinsically, its animated and visually dynamic content appeared to arouse curiosity and sustained interest in mathematical material that students had previously found difficult and unengaging. Extrinsically, the novelty of the medium, the participatory structure it enabled, and the immediate feedback afforded by its interactive features appeared to shift the overall affective climate of the

classroom toward one that students associated more closely with enjoyment than with obligation. These patterns should, however, be interpreted as context-specific observations rather than generalizable claims, given the small sample, the purposive selection criteria, and the limited number of sessions involved.

Based on these findings, three recommendations are offered. Teachers are encouraged to continuously develop varied and contextually appropriate smartboard-based activities to sustain the novelty and challenge that drive motivational engagement over time. School administrators are urged to prioritize both the provision of adequate smartboard infrastructure and structured professional development programs that equip teachers with the pedagogical competencies necessary to use the technology effectively. Future researchers are recommended to extend this line of inquiry through larger and more diverse samples, longer instructional periods, and unselected comparison groups, in order to determine whether the motivational gains observed here hold under conditions less susceptible to ceiling or novelty effects.

REFERENCES

Alam, A., & Mohanty, A. (2023). Cultural beliefs and equity in educational institutions: exploring the social and philosophical notions of ability groupings in teaching and learning of mathematics. *International Journal of Adolescence and Youth*, *28*(1). https://doi.org/10.1080/02673843.2023.2270662

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Worth Publishers.

Bednorz, D., & Bruhn, S. (2023). Influence of primary students' self-regulated learning profiles on their rating of a technology-enhanced learning environment for mathematics. *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1074371

Carstens, K. J., Mallon, J. M., Bataineh, M., & Al-Bataineh, A. (2021). Effects of Technology on Student Learning. *TOJET: The Turkish Online Journal of Educational Technology*, *20*(1).

Chen, X., Twomey, K. E., & Westermann, G. (2021). *Curiosity Enhances Incidental Object Encoding in 8-month-old Infants*. https://doi.org/10.31234/osf.io/6bwfm

Chukwuedo, S. O., Mbagwu, F. O., & Ogbuanya, T. C. (2021). Motivating academic engagement and lifelong learning among vocational and adult education students via self-direction in learning. *Learning and Motivation*, *74*, 101729. https://doi.org/10.1016/j.lmot.2021.101729

Creswell, J. W., & Poth, C. N. (2024). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. SAGE Publications Ltd. https://uk.sagepub.com/en-gb/eur/qualitative-inquiry-and-research-design/book266033#main-content

Cvencek, D., Brečić, R., Gaćeša, D., & Meltzoff, A. N. (2021). Development of Math Attitudes and Math Self-Concepts: Gender Differences, Implicit–Explicit Dissociations, and Relations to Math Achievement. *Child Development*, *92*(5), e940–e956. https://doi.org/10.1111/cdev.13523

Dabbagh, N. (2023). The Pedagogical Ecology of Learning Technologies: A Learning Design Framework for Meaningful Online Learning. In *Higher Education in the Arab World* (pp. 25–51). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-33568-6_3

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. Springer US. https://doi.org/10.1007/978-1-4899-2271-7

Golaszewski, N., Bartholomew, J., Errisuriz, V., Korinek, E., & Jowers, E. (2021). Predictors of on-task Behaviors: Evaluating Student-level Characteristics. *Health Behavior and Policy Review*, *8*(2), 159–167. https://doi.org/10.14485/HBPR.8.2.6

Hanin, V., & Gay, P. (2023). Comparative analysis of students' emotional and motivational profiles in mathematics in grades 1–6. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1117676

Hidayat, A., Setyaningsih, P. D. S., & Wulandari, D. D. (2024). Improving Job Performance By Strengthening Work Motivation, Organizational Climate, Transformational Leadership, and Growth Mindset. *SUJANA (Education and Learning Review)*, 35–49. https://doi.org/10.56943/sujana.v3i1.496

Kühl, T., & Wohninsland, P. (2022). Learning with the interactive whiteboard in the classroom: Its impact on vocabulary acquisition, motivation and the role of foreign language anxiety. *Education and Information Technologies*, *27*(7), 10387–10404. https://doi.org/10.1007/s10639-022-11004-9

Larkin, K., & Lowrie, T. (2022). *STEM Education in the Early Years*. Springer Nature Singapore. https://doi.org/10.1007/978-981-19-2810-9

Mayer, R. E. (2020). Multimedia Learning. In *Multimedia Learning*. Cambridge University Press. https://doi.org/10.1017/9781316941355

McCarthy, A. M., Maor, D., McConney, A., & Cavanaugh, C. (2023). Digital transformation in education: Critical components for leaders of system change. *Social Sciences & Humanities Open*, *8*(1), 100479. https://doi.org/10.1016/j.ssaho.2023.100479

Miles, M. B., Huberman, M. A., & Saldana, J. (2020). *Qualitative Data Analysis : A Methods Sourcebook*. SAGE.

Paradise, D. R., & Prak, D. P. (2024). IMPACT OF LEADERSHIP IN CAMBODIAN HIGHER EDUCATION THROUGH DIGITALIZATION. *SUJANA (Education and Learning Review)*, 1–14. https://doi.org/10.56943/sujana.v3i2.569

Piaget, J. (1952). The Origins of Intelligence in Children. In *When Thinking* . International University Press. https://www.bxscience.edu/ourpages/auto/2014/11/16/50007779/Piaget When Thinking Begins10272012_0000.pdf

Rahimi, R. A., & Oh, G. S. (2024). Rethinking the role of educators in the 21st century: navigating globalization, technology, and pandemics. *Journal of Marketing Analytics*, *12*(2), 182–197. https://doi.org/10.1057/s41270-024-00303-4

Ramos, M., De Sixte, R., Jáñez, Á., & Rosales, J. (2022). Academic motivation at early ages: Spanish validation of the Elementary School Motivation Scale (ESMS-E). *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.980434

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-

determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, *61*, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Saccardo, F., Decarli, G., Missagia, V. I., Andrao, M., Gini, F., Zancanaro, M., & Franchin, L. (2024). Emotions and interactive tangible tools for math achievement in primary schools. *Frontiers in Psychology*, *15*. https://doi.org/10.3389/fpsyg.2024.1440981

Siller, H.-S., & Ahmad, S. (2024). The Effect of Concrete and Virtual Manipulative Blended Instruction on Mathematical Achievement for Elementary School Students. *Canadian Journal of Science, Mathematics and Technology Education*, *24*(2), 229–266. https://doi.org/10.1007/s42330-024-00336-y

Sugiyono. (2022). *Metode Penelitian Kualitatif: (Untuk penenelitian yang bersifat: eksploratif, enterpretif, interaktif dan konstruktif)*. Bandung : Penerbit Alfabeta.

Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. *Motivation and Emotion*, *44*(1), 1–31. https://doi.org/10.1007/s11031-019-09818-1

Vasconcellos, D., Parker, P. D., Hilland, T., Cinelli, R., Owen, K. B., Kapsal, N., Lee, J., Antczak, D., Ntoumanis, N., Ryan, R. M., & Lonsdale, C. (2020). Self-determination theory applied to physical education: A systematic review and meta-analysis. *Journal of Educational Psychology*, *112*(7), 1444–1469. https://doi.org/10.1037/edu0000420

Wahyuni, N. T., Mulyanah, A., Winahyu, S. K., Darmawati, B., Widiastuti, R., Sariah, Parwati, S. A. P. E., Ratnawati, Izzak, A., & Nurhuda, P. (2025). Leveraging Situational Interest to Enhance Motivation and Engagement in Indonesian Primary EFL Classrooms. *Theory and Practice in Language Studies*, *15*(6), 1975–1986. https://doi.org/10.17507/tpls.1506.26

Wang, C., Chen, X., Yu, T., Liu, Y., & Jing, Y. (2024). Education reform and change driven by digital technology: a bibliometric study from a global perspective. *Humanities and Social Sciences Communications*, *11*(1), 256. https://doi.org/10.1057/s41599-024-02717-y

Yin, R. K. (2018). *Case study research and applications: Design and methods* (Sixth Edition). SAGE Publishing.

Zhou, Y., Li, X., & Wijaya, T. T. (2022). Determinants of Behavioral Intention and Use of Interactive Whiteboard by K-12 Teachers in Remote and Rural Areas. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.934423