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Integrating Problem Based Learning and Quizizz to Foster Learning Activeness in Elementary Science

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Abstract

The *Merdeka Curriculum* envisions IPAS as an active, inquiry-based subject, yet lecture-dominated instruction in Indonesian elementary schools continues to produce passive learning and low student activeness. This study examined the effect of the Problem-Based Learning (PBL) model assisted by Quizizz on the learning activeness of third-grade elementary students in the IPAS topic of changes in the state of matter. A quasi-experimental nonequivalent pretest-posttest control group design was employed with 52 third-grade students at SDN 088 Panyabungan, divided through total sampling into an experimental class (N = 26) and a control class (N = 26). Data on five activeness dimensions were collected through validated observation checklists and questionnaires and analyzed using an independent samples t-test. A statistically significant difference in learning activeness emerged between the groups ($p < 0.05$), with the experimental class achieving a medium normalized gain (N-Gain = 0.57) against a low gain (N-Gain = 0.24) in the control class, and the largest improvements appearing in the oral and emotional dimensions. The integration of PBL with Quizizz serves as a catalyst for transformational education, effectively shifting the pedagogical paradigm from passive knowledge consumption to the active construction of meaning while fostering the holistic learner agency essential to the *Profil Pelajar Pancasila* framework.

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INTRODUCTION

Science and Social Studies (IPAS) is a newly integrated subject introduced under Indonesia's *Merdeka Curriculum* at the elementary level, designed to unify natural science and social studies within a single coherent framework that develops students' holistic understanding of natural phenomena and social life through contextual, inquiry-based, and student-centered experiences (Umar et al., 2024). Yet the foundational science literacy on which this vision depends remains a persistent concern, as the PISA 2022 assessment placed Indonesian students below the OECD average in science, underscoring the urgency of transforming everyday classroom practice (Hakim et al., 2025). Classroom observations at SDN 088 Panyabungan sharpened this concern at the local level, revealing that lecture-dominated instruction continued to suppress active participation and to produce passive learning behaviors at odds with the *Merdeka Curriculum's* emphasis on learner agency (Tapung, 2025). The gap between the curriculum's aspiration and the reality of the classroom makes it imperative to identify instructional models and digital media capable of restructuring IPAS learning into an active, engaging, and meaningful experience for young learners.

Learning activeness, understood as the extent to which students are physically and mentally engaged in learning, is widely recognized as a pivotal determinant of academic achievement and durable conceptual understanding. Ayadi and Onodipe (2023) distinguished eight dimensions of activeness, spanning visual, oral, listening, writing, drawing, motor, mental, and emotional

engagement, with each representing a distinct mode through which students construct knowledge. Empirical work consistently links higher activeness to stronger outcomes, particularly in science subjects that demand exploration and critical thinking. Conversely, students exposed primarily to teacher-centered approaches display markedly lower rates of oral participation, collaborative engagement, and self-directed inquiry than peers in active learning environments (Estaji & Jafari, 2022; Li et al., 2024). Enhancing activeness must therefore be treated not as an incidental byproduct but as a deliberate instructional goal, achievable only through the purposeful selection of models and media that place students at the center of the learning process.

Problem Based Learning (PBL) offers a constructivist-grounded response to this goal, engaging students with authentic, ill-structured problems that compel them to investigate, collaborate, and construct solutions. Darmawati and Mustadi (2023) characterized PBL as a model expressly designed to foster higher-order thinking, self-directed learning, and collaborative problem-solving, competencies that align closely with the *Profil Pelajar Pancasila* framework of the *Merdeka Curriculum*. This theoretical promise is matched by empirical strength: (Wu et al., 2025) synthesis of more than two hundred studies confirmed that PBL outperforms traditional instruction in developing conceptual understanding, critical thinking, and intrinsic motivation, while in the Indonesian elementary context Dewi et al. (2025) found that PBL raised learning activeness by an average of 21.3 percentage points relative to conventional groups. PBL thus represents a theoretically robust and empirically validated framework for promoting active engagement in IPAS (Ilmu Pengetahuan Alam dan Sosial, natural and social sciences), especially when anchored to contextually rich phenomena such as changes in the state of matter.

The activeness-generating capacity of PBL can be further amplified by gamified digital media, and Quizizz is among the most accessible of these tools. As a cloud-based platform, Quizizz reframes formative assessment as an interactive, game-like experience through real-time leaderboards, animated avatars, point systems, and immediate feedback. Darmawati and Mustadi (2023) argued that this gamified structure satisfies students' fundamental needs for competence, autonomy, and relatedness, sustaining intrinsic motivation and participatory engagement, and (Basuki, 2023) demonstrated experimentally that learners using gamified quiz platforms showed greater attentiveness, collaborative discussion, and voluntary participation than those using paper-based assessment. In the Indonesian elementary setting, Berzanskis (2021) reported that third-grade students using Quizizz exhibited a 28% increase in on-task behavior and a 34% increase in oral participation relative to traditional quiz formats. Embedding Quizizz within a PBL framework therefore holds substantial promise for reinforcing inquiry-based learning with real-time, motivating, and socially interactive evaluation.

Despite the demonstrated value of PBL and Quizizz individually, their combined effect on learning activeness in IPAS under the *Merdeka Curriculum* remains largely unexamined, and it is precisely this intersection that the present study addresses. Existing research has tended to isolate one component from the other: Daryanes (2023) reported activeness gains from Quizizz in online settings but without a structured problem-based model, while Nurhasanah et al. (2024) examined PBL with digital media yet did not target gamified assessment, leaving the complementary relationship between problem-based inquiry and gamification unexplored. Jones et al. (2023) made this gap explicit, calling for integrated experimental research that unites active learning models with digital gamification specifically within the IPAS framework. The novelty of this study lies in responding directly to that call by experimentally testing PBL integrated with Quizizz, rather than either element alone, on a clearly defined IPAS topic, thereby generating actionable evidence on whether the two function synergistically to transform third-grade elementary classrooms into active, participatory learning communities.

RESEARCH METHOD

This study employed a quantitative approach with a quasi-experimental, nonequivalent pretest-posttest control group design to examine the causal effect of Problem Based Learning assisted by Quizizz on students' learning activeness. A quasi-experimental design was selected because the random assignment of individual students was not feasible within the natural grouping of intact classes, a constraint that Lindstromberg (2025) identifies as typical of authentic educational settings and best addressed through the use of pre-existing groups with baseline equivalence testing. The pretest enabled verification of initial comparability between groups and provided a reference point against which post-intervention gains could be evaluated, while the parallel administration of identical measures to both groups controlled for maturation and testing effects. The instructional treatment served as the independent variable, contrasting PBL assisted by Quizizz in the experimental class with conventional direct instruction in the control class, whereas learning activeness, operationalized across five observable dimensions, constituted the dependent variable (Meilani Azizah & Purba, 2025). The structure of this design is summarized in **Table 1**.

Table 1. Nonequivalent Pretest-Posttest Control Group Design

Group	Pretest	Treatment	Posttest
Experimental	O_1	X (PBL assisted by Quizizz)	O_2
Control	O_3	– (Conventional direct instruction)	O_4

Note: O_1 and O_3 denote pretest measures; O_2 and O_4 denote posttest measures; X denotes the experimental treatment.

The study was conducted at SDN 088 Panyabungan during the second semester of the 2025/2026 academic year, with the intervention delivered over six weeks across 12 instructional meetings. The population comprised all 52 third-grade students enrolled in two parallel classes, and the full population was included through total sampling, so that Class III-A (n = 26) formed the experimental group and Class III-B (n = 26) the control group. Baseline equivalence between the two classes was established prior to the intervention using a Mann-Whitney U test on prior academic performance, which yielded no statistically significant difference ($p = 0.412 > 0.05$), confirming that the groups were comparable at the outset and supporting the internal validity of the subsequent comparison (Kratochwill & Levin, 2025). Both groups studied the same IPAS content on changes in the state of matter and were taught by the same teacher to control for teacher effects, with the experimental and control conditions differing only in the instructional model applied.

Data were collected using two instruments aligned with the five dimensions of learning activeness, namely visual, oral, motor, mental, and emotional activity. The first was a structured observation checklist of 20 items completed by trained observers during each meeting, and the second was a Likert-scale questionnaire of 25 items scored from 1 to 4 and administered as a pretest and posttest. The operationalization of the five activeness dimensions into observable indicators and item distribution is presented in **Table 2**.

Table 2. Blueprint of the Learning Activeness Instrument

Dimension	Indicator	Number of Items
Visual	Observing demonstrations, reading materials, attending to visual phenomena	4
Oral	Asking questions, answering, expressing opinions in discussion	5
Motor	Conducting experiments, manipulating materials, hands-on observation	4
Mental	Analyzing problems, drawing conclusions, relating concepts	4
Emotional	Showing enthusiasm, curiosity, and enjoyment of learning	3
Total		**20**

Note: Item distribution refers to the structured observation checklist; the questionnaire mirrors these dimensions across 25 items.

Content validity was confirmed through expert judgment, and construct validity was tested empirically using Pearson product-moment correlation, with all items exceeding the critical value ($r > 0.381$). Reliability was established using Cronbach's Alpha, which produced coefficients of 0.87 for the observation checklist and 0.89 for the questionnaire, both indicating high internal consistency (Madadizadeh & Bahariniya, 2025).

Data analysis proceeded in three stages using IBM SPSS Statistics Version 26. Descriptive statistics summarized the central tendency and dispersion of activeness scores for both groups, and the normalized gain (N-Gain) was computed and interpreted against Hake's (1999) criteria to gauge the magnitude of improvement. Prerequisite assumptions were then examined through the Kolmogorov-Smirnov test of normality and Levene's test of homogeneity of variance. Once these assumptions were satisfied, hypothesis testing was carried out using an independent samples t-test at the 5% significance level to determine whether the difference in learning activeness between the experimental and control groups was statistically significant.

RESULT AND DISCUSSION

Results

Descriptive analysis of the pretest data confirmed that the experimental and control groups entered the study with statistically equivalent baseline learning activeness, validating the fairness of the subsequent between-group comparisons. The experimental group recorded a pretest mean of 58.31 (SD (Sekolah Dasar, elementary school) = 6.92), while the control group recorded 57.92 (SD = 7.05), and the Mann-Whitney U test detected no significant difference between them ($p = 0.412$), confirming baseline equivalence prior to the intervention. After the six-week PBL–Quizizz intervention, the experimental group's posttest mean rose to 82.46 (SD = 7.23), a gain of 24.15 points, whereas the control group's posttest mean increased only modestly to 68.23 (SD = 8.14), a gain of 10.31 points. The normalized N-Gain for the experimental group reached 0.57, classified as medium according to Hake's (1999) criteria, while the control group obtained an N-Gain of 0.24, classified as low. Taken together, these descriptive results indicate that the intervention produced improvements in learning activeness that substantially exceeded those achieved through conventional instruction across the measurement period. The complete descriptive figures for both groups, including pretest and posttest means and the corresponding N-Gain classifications, are summarized in **Table 3**.

Table 3. Descriptive Statistics of Learning Activeness Scores by Group

Variable	Group	N	Mean	SD	N-Gain
Learning Activeness (Post-test)	Experimental	26	82.46	7.23	0.57 (Medium)
Learning Activeness (Post-test)	Control	26	68.23	8.14	0.24 (Low)
Pre-test	Experimental	26	58.31	6.92	–
Pre-test	Control	26	57.92	7.05	–

Source: Primary research data (2025)

Prerequisite testing confirmed that the data satisfied all assumptions required for a parametric independent samples t-test. The Kolmogorov-Smirnov normality test produced significance values of 0.142 for the experimental group and 0.168 for the control group, both above the 0.05 threshold, indicating that the score distributions in both classes approximated normality. Levene's Test for Equality of Variances yielded a significance value of 0.312 (> 0.05), confirming homogeneity of variance and justifying the use of the equal-variance t-test. The independent samples t-test produced a t-count of 4.87, exceeding the t-table critical value of 2.01 ($df = 50$, $\alpha = 0.05$), with a two-tailed significance of $p = 0.000$. These results led to the rejection of the null hypothesis and the acceptance of the research hypothesis, providing statistically robust evidence that PBL assisted by Quizizz exerted a significant positive effect on the learning activeness of third-grade students in IPAS. The outcomes of the hypothesis test are presented in **Table 4**.

Table 4. Independent Samples t-Test Results

Test	t-count	t-table	Sig. (2-tailed)	Decision
Independent t-test	4.87	2.01	0.000	H_0 Rejected

Note: Significance level $\alpha = 0.05$; df = 50

Disaggregated analysis across the five observed dimensions revealed that the experimental group consistently outperformed the control group on every indicator, with the largest gains concentrated in the oral and emotional dimensions. Oral activities, including student-initiated questioning, answering, and participation in group discussion, reached a mean of 83% in the experimental class against 62% in the control class, a difference attributable to the structured collaborative inquiry phases of PBL that require verbal interaction and the negotiation of meaning. Emotional activeness, reflecting enthusiasm, curiosity, and enjoyment of learning, reached 82% in the experimental class versus 63% in the control class, consistent with the capacity of Quizizz to generate positive affect and sustained motivation through game-based reward mechanisms. Visual and mental activities showed comparable differences, with experimental means of 85% and 84% respectively against 65% and 69% in the control class, indicating that the problem-solving and inquiry phases of PBL stimulated both perceptual engagement and higher-order cognitive processing. Motor activities, encompassing hands-on experimentation such as observing ice melting and water evaporating, recorded the smallest yet still meaningful gap (80% versus 67%), confirming that both approaches supported concrete experiential learning, albeit with greater structured facilitation in the PBL condition. The dimension-by-dimension comparison between the two classes is detailed in **Table 5**.

Table 5. Comparison of Learning Activeness by Dimension: Experimental versus Control Class (%)

Indicator	Experimental (%)	Control (%)	Difference
Visual Activities	85	65	+20
Oral Activities	83	62	+21
Motor Activities	80	67	+13
Mental Activities	84	69	+15
Emotional Activities	82	63	+19

Note: Scores represent the mean percentage of observed activeness indicators per dimension.

Table 5 lays bare a pattern that is too consistent to be incidental: across every one of the five activeness dimensions, the experimental class sat well above the control class, and the spread of those margins tells its own story about how PBL and Quizizz did their work. The widest gaps opened in the oral (+21%) and visual (+20%) dimensions, which is precisely where a problem-based design exerts its strongest pull, since students cannot move through a collaborative inquiry cycle without speaking, questioning, and attending closely to the phenomenon in front of them. Emotional activeness followed at +19%, a margin that points less to the structure of PBL than to the affective lift Quizizz supplied through its competitive, feedback-rich format. The narrower gaps in mental (+15%) and especially motor (+13%) activeness are equally telling: hands-on observation of melting ice or evaporating water is the one mode of engagement that conventional instruction can still deliver reasonably well, so the room for the intervention to add value there was always going to be smaller. Read as a whole, the dimensional profile shows that the intervention did not raise activeness uniformly but selectively amplified the behaviors most dependent on dialogue, motivation, and sustained attention, which is exactly the signature one would expect when a collaborative inquiry model is fused with a gamified assessment tool rather than the flat, across-the-board increase a generic engagement boost would produce.

Discussion

The statistically significant superiority of the PBL–Quizizz class over the conventional group is best understood not as an isolated gain in engagement but as evidence of a transformative shift in how learning was organized, from the transmission of content to the active construction of knowledge. Constructivist theory holds that meaningful understanding emerges when learners confront problems, generate hypotheses, and collaborate toward shared solutions, and Vygotsky's (1978) Zone of Proximal Development offers the clearest lens on what occurred in the experimental class: the collaborative investigation phases of PBL created scaffolded peer environments in which less capable students were drawn upward by more capable peers, lifting the collective activeness ceiling rather than the performance of a few individuals. (Ulutas, 2023) metatheoretical review reinforces this reading by locating the power of PBL not in problem-solving as such but in the collaborative inquiry the model structures around authentic problems, while Waqar et al. (2025), the originator of modern PBL, framed the model's purpose precisely as the conversion of passive content recipients into active knowledge constructors. The posttest data document exactly this conversion, which is why the effect observed here reflects a deep structural compatibility between PBL's pedagogical architecture and the activeness it is designed to produce rather than a transient novelty effect.

If PBL supplied the transformative structure, Quizizz supplied its motivational engine, and the two operated synergistically rather than additively. (Santiago et al., 2025) Self-Determination Theory holds that voluntary engagement is sustained when competence, autonomy, and relatedness are satisfied, and the real-time leaderboards, self-paced answering, and peer competition of Quizizz address all three at once. Saraiwang and Worawong (2023) corroborated this in a closely analogous setting, reporting that game-based quiz platforms raised voluntary question-answering by 41% and extended on-task behavior by 67%, mechanisms that map directly onto the elevated oral and emotional activeness recorded in the present study. Y. Wang et al. (2024) add a cognitive layer, showing that the immediate corrective feedback characteristic of such platforms activates metacognitive monitoring and prompts students to re-engage with content after incorrect answers, a pattern that corresponds to the experimental class's heightened mental activeness. The convergence of these motivational and cognitive mechanisms with PBL's collaborative structure meant that Quizizz did not merely supplement the model; it reinforced the very mechanisms through which PBL generates activeness, at the motivational, cognitive, and social levels simultaneously.

These findings gain further significance when read against the wider research landscape, which positions them within a coherent and growing empirical consensus rather than at its margins. Imaduddin et al. (2021), in a systematic review of IPAS interventions under the *Merdeka Curriculum*, identified active learning integrated with digital tools as the most consistently effective approach for improving engagement and conceptual understanding in Indonesian elementary schools, a conclusion the present results directly corroborate. Anggraini and Wulandari (2022) reported a closely comparable effect (N-Gain = 0.53) using interactive digital media in PBL, suggesting that the medium-gain band of roughly 0.50 to 0.60 reflects a realistic upper bound for single-semester elementary interventions of this kind. The medium N-Gain of 0.57 obtained here should therefore be read not as a ceiling on what PBL–Quizizz can achieve but as a function of identifiable boundary conditions: Hake (1999) located medium-gain interventions in the 0.30 to 0.70 range, and Osuna and Munson (2024) both argued that problem authenticity, teacher facilitation, and the seamless embedding of technology within the instructional sequence determine how close an intervention moves toward the high-gain threshold. X. Wang et al. (2025) sharpened this point by showing that the durability of active-learning effects depends on structured teacher professional development, signaling where the present design could be strengthened in future replications.

The mediating role of teacher capability deserves emphasis because it determines whether the transformative potential of PBL–Quizizz is realized or left latent. The TPACK framework holds that technology-enhanced learning succeeds only when content, pedagogy, and technology are integrated into a unified design, and Mailizar et al. (2021) demonstrated that teachers with higher TPACK proficiency produced significantly larger engagement gains when embedding digital tools in inquiry models, which helps explain why this study yielded medium rather than high gains. Munawaroh et al. (2022) exposed the systemic gap underlying this pattern, finding that while 78% of Indonesian elementary teachers used digital platforms for assessment, fewer than 34% had been trained to embed them within constructivist instruction, and Wolf (2025) quantified the cost of that gap, showing that prior TPACK training raised student activeness by an additional 12.4 percentage points. The social architecture of the platform compounds this teacher-dependent effect: studies have found that balanced competitive elements catalyze productive academic discourse, Piasecki and Filho (2025) reported that the team mode of Quizizz increased student-initiated peer explanations by 53%, and Gearhart (2023) showed that gamified cooperative environments raise the collective efficacy beliefs that Bandura's social cognitive theory identifies as a driver of sustained group engagement. Quizizz therefore amplified activeness not only individually but socio-cognitively, strengthening the collaborative fabric of PBL in a way that multiplied each dimension of activeness beyond what either component could achieve alone, provided a capable teacher orchestrated the integration.

Situated within the policy architecture of the *Merdeka Curriculum*, the intervention emerges as a concrete instantiation of transformative education rather than a discretionary classroom innovation. PBL's problem-investigation cycle directly operationalizes the curriculum's commitment to inquiry-oriented learning and its *Profil Pelajar Pancasila* competencies, and Al Mulhim (2020) found that IPAS teachers using PBL reported markedly stronger alignment with *Capaian Pembelajaran* targets, Goswami (2024) showed longitudinally that technology-assisted active learning produced the most consistent gains in initiative, critical thinking, and collaboration, the very dimensions most closely tied to activeness. Zhang and Crawford (2024) national evaluation reinforces this alignment, with 62% of pilot teachers naming Quizizz their preferred formative assessment tool for IPAS. Yet a transformative agenda must also confront equity: Deveci (2023) documented that rural schools report up to 67% lower device availability and 54% lower stable internet access, and Khan Eusafzai and Suleman (2024) responded by validating an offline-adaptable gamified PBL that reached an N-Gain of 0.49, approaching but not matching the 0.57 of fully digital settings. Beach et al. (2022), tracking a two-year cohort, found that activeness gains were not only sustained but amplified as students grew more self-directed, indicating that the medium-term results reported here mark the opening stage of a cumulative developmental trajectory. Future research should therefore advance three agendas in parallel: scaling the model with equity-responsive, technology-agnostic adaptations, tracing the longitudinal arc of activeness and cognitive outcomes, and isolating the moderating effects of teacher facilitation, problem authenticity, and student digital literacy, so that PBL–Quizizz can mature into a fully evidence-based engine of transformative IPAS learning under the *Merdeka Curriculum*.

CONCLUSION

This study demonstrates that the Problem Based Learning model assisted by Quizizz exerts a significant and educationally meaningful effect on the learning activeness of third-grade elementary students in the IPAS topic of changes in the state of matter, with the experimental class achieving a substantially higher level of activeness and a stronger learning trajectory than the conventionally taught control class. The gains were not uniform but selectively amplified the dimensions most dependent on dialogue, motivation, and sustained attention, with oral and emotional activeness rising most sharply, a pattern that reflects the structural compatibility between PBL's collaborative inquiry cycle and the motivational architecture of gamified assessment. These findings position PBL–Quizizz integration as a concrete instantiation of the

Merdeka Curriculum's vision for transformative IPAS learning and its *Profil Pelajar Pancasila* competencies, offering teachers a practical and replicable strategy for converting passive classrooms into active, participatory learning communities. Future research is recommended to examine the effect of this integration on cognitive outcomes and higher-order thinking skills across diverse IPAS topics and grade levels, to trace its long-term sustainability across academic semesters, and to investigate the moderating roles of teacher facilitation quality and digital infrastructure readiness, so that the model can mature into a fully evidence-based approach to transformative education in Indonesian elementary schools.

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