










Improving academic learning time effectiveness through lesson study in elementary physical education

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ABSTRACT

Background: Academic Learning Time in Physical Education (ALT-PE) is a key indicator of instructional effectiveness, reflecting the time students spend actively engaged in meaningful learning activities. However, PE lessons often involve excessive Management and waiting time, reducing opportunities for active participation. Although Lesson Study (LS) is recognized as a collaborative professional development approach that can improve instructional quality, its impact on ALT-PE remains underexplored. Objective: This study examined the effectiveness of Lesson Study (LS) in improving instructional effectiveness and optimizing ALT-PE among elementary school PE teachers. Methods: A qualitative-dominant mixed-methods action research design was employed involving 10 PE teachers from six public elementary schools. Participants were purposively selected based on their involvement in a school-based LS program. The intervention consisted of three LS cycles, including planning, implementation, observation, and reflection. Quantitative data were collected through video-based observations using the revised ALT-PE system and analyzed with descriptive and inferential statistics. Qualitative data were obtained from interviews, reflection notes, and lesson documents, and were analyzed thematically. Result: Following the LS intervention, Activity time increased from 20.63% to 50.96%, while Waiting time decreased from 23.13% to 0.51%. Management time decreased from 43.49% to 37.26%, whereas Instruction time remained relatively stable. Paired-sample t-tests indicated significant improvements in Activity ($p < .001$), Waiting ($p < .001$), and Management ($p = .012$), but not in Instruction time ($p = .576$). Qualitative findings revealed improved classroom organization, greater teacher awareness of instructional efficiency, and stronger collaborative pedagogical reflection. Conclusion: Lesson Study significantly enhanced ALT-PE effectiveness by increasing meaningful activity time, reducing non-productive instructional time, and strengthening instructional practices, highlighting its potential as a sustainable professional development model for elementary PE teachers.

ARTICLE HISTORY

Received January 19, 2026

Accepted March 22, 2026

Published April 01, 2026

KEYWORDS

Academic learning time;
lesson study; physical
education; teacher
effectiveness; time
management.

Introduction

Through the Merdeka Belajar policy, the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia emphasizes the strategic role of teachers in promoting learner-centered instruction across all subjects, including Physical Education (PE). Within this framework, PE teachers are expected not only to facilitate students' physical development but also to foster cognitive, social, and

emotional growth through meaningful movement experiences (Ginanjari & Anggraeni, 2024; Herniawati, 2023). Consequently, teachers are required to continuously engage in professional learning to deliver high-quality PE instruction that aligns with students' developmental characteristics and contemporary educational demands.

Effective instructional time management has long been recognized as a fundamental component of teaching quality and student learning outcomes (Cereda, 2023). Research on instructional effectiveness consistently demonstrates that the quantity and quality of students' engagement in learning tasks strongly influences academic achievement and skill acquisition (Berliner, 1990; Carroll, 1963; Nesbitt et al., 2021). In PE, where learning primarily occurs through active participation and repeated motor practice, efficient time use is particularly critical. Excessive time devoted to transitions, organization, or non-learning activities reduces practice opportunities and diminishes the effectiveness of instruction.

The concept of Academic Learning Time in Physical Education (ALT-PE) emerged from broader time-on-task theory, which posits that students learn most effectively when they spend substantial time actively engaged in appropriate learning activities with a high rate of success (Fisher et al., 1980; Siedentop et al., 1982). ALT-PE specifically refers to the proportion of lesson time during which students are appropriately engaged in motor tasks related to lesson objectives at a level that promotes successful learning. Unlike general instructional time, ALT-PE emphasizes not only participation but also meaningful engagement, task appropriateness, and learning relevance. Previous studies have shown that higher ALT-PE is positively associated with motor skill development, student motivation, physical activity participation, and instructional effectiveness in PE settings (Benes et al., 2016; Nesbitt et al., 2021; Zhou et al., 2021).

Despite its importance, empirical studies consistently report that instructional time in PE is frequently used inefficiently. Large proportions of lesson time are often consumed by management routines, equipment organization, lengthy explanations, and student waiting periods, thereby reducing opportunities for meaningful physical engagement. These inefficiencies are particularly problematic in elementary PE, where limited lesson duration already constrains students' opportunities for active learning. Previous research revealed that PE instructional time at Senior High School 10 Malang was not optimally implemented, as core instructional activities accounted for only 61% of total lesson time, falling short of the recommended 80% standard for effective learning (Putra & Winarno, 2023). In many developing educational contexts, including Indonesia, PE instruction continues to face challenges in classroom organization, teacher preparedness, and instructional quality, which may negatively affect ALT-PE and overall learning effectiveness.

Existing studies on PE instructional time have primarily focused on describing general inefficiencies or on reporting overall time-allocation patterns. However, relatively few studies have systematically examined specific ALT-PE components—such as activity time, management time, instructional time, and waiting time—as interconnected indicators of instructional effectiveness. Moreover, previous research has rarely linked ALT-PE analysis with collaborative professional development interventions capable of producing sustainable pedagogical improvement. As a result, there remains limited empirical evidence on how teachers can practically optimize instructional time in PE through structured, reflective professional learning processes.

One promising approach for improving instructional effectiveness is Lesson Study (LS), a collaborative professional development model originating from Japan. LS involves cycles of collaborative lesson planning, classroom observation, reflection, and lesson revision to improve teaching practices and student learning (Lewis et al., 2019). Unlike conventional teacher training, LS emphasizes reflective inquiry grounded in authentic classroom experiences, enabling teachers to critically analyze instructional decisions, student engagement, and learning processes. Previous

international research has demonstrated that LS contributes to improved pedagogical knowledge, instructional clarity, teacher collaboration, and student engagement across various educational contexts (Dudley, 2013; Fujii, 2016). In PE specifically, collaborative lesson reflection may help teachers redesign learning tasks, streamline transitions, and reduce non-instructional time, thereby increasing ALT-PE effectiveness.

However, research examining the relationship between LS and ALT-PE remains scarce, particularly within elementary school PE contexts in developing countries. Existing LS studies in PE have largely focused on learning outcomes, curriculum implementation, and teacher perceptions, without explicitly examining how LS contributes to optimizing instructional time. Consequently, the potential of LS as a mechanism to improve ALT-PE efficiency remains underexplored, both theoretically and empirically.

The novelty of this study lies in integrating ALT-PE analysis with collaborative lesson study practices to examine how professional development processes influence the effectiveness of instructional time in elementary PE. Unlike previous studies that merely describe inefficient time allocation, this study systematically analyzes changes across ALT-PE components—including activity, management, instructional, and waiting time—through multiple lesson study cycles. In addition, this study contributes to literature by positioning LS not only as a teacher development strategy but also as a practical mechanism for optimizing instructional effectiveness and meaningful student engagement in PE.

Therefore, this study aims to investigate how lesson study enhances ALT-PE effectiveness among elementary school PE teachers in Indonesia. The findings are expected to contribute to theory by strengthening the connection between time-on-task theory, instructional effectiveness, and collaborative professional development in PE. In practice, the study is expected to provide evidence-based insights for teachers, schools, and policymakers on sustainable strategies to improve instructional quality and student-centered learning within the Merdeka Belajar framework.

Method

Research Design

This study employed a qualitative-dominant mixed-methods action research design to examine how Lesson Study (LS) contributes to improving the effectiveness of Academic Learning Time in Physical Education (ALT-PE) among elementary school PE teachers. Action research was selected because the study aimed not only to investigate instructional problems but also to implement collaborative pedagogical improvements through iterative reflection and intervention cycles within authentic classroom settings.

Participants

The study was conducted in six public elementary schools in Plaju District, Palembang, Indonesia, during one academic semester (approximately 16 weeks). Participants consisted of 10 PE teachers (8 males and 2 females) who were actively involved in a school-based LS community. Teachers were selected using purposive sampling based on the following inclusion criteria: (1) currently teaching PE at the elementary school level, (2) willingness to participate in all LS activities, and (3) minimum teaching experience of two years. The participants included both civil servants and contract-based teachers.

The intervention was implemented through three consecutive LS cycles, each lasting approximately 4 weeks and consisting of one collaborative planning session, one open lesson, one classroom observation session, and one structured reflection meeting. In total, the study involved three open lessons and six collaborative reflection meetings. Fifth-grade students participated indirectly as part of the instructional setting observed during lesson implementation; however, students were not treated as primary research participants.

The LS process followed the classical Plan–Do–See model. During the planning stage, teachers collaboratively designed lesson plans emphasizing ALT optimization through improved task

organization, efficient transitions, and increased student engagement in meaningful motor activities. In the implementation stage (open lesson), one teacher led the collaboratively designed lesson, while other teachers and researchers observed the instructional process and student engagement. During the reflection stage, teachers critically discussed lesson strengths, instructional challenges, classroom management issues, and possible revisions for subsequent cycles.

Ethical Approval Statement

Ethical approval was obtained prior to data collection from the Research Ethics Committee of Universitas Negeri Malang under Permit Number 7.5.17/UN32.14/PB/2026 dated May 7, 2026. All research procedures complied with ethical principles for human participant research, including voluntary participation, confidentiality, anonymity, and data protection. All participating teachers received detailed information regarding the study objectives, procedures, benefits, and potential risks before providing written informed consent. Participants' identities were anonymized using coded identifiers, and all collected data were used exclusively for academic purposes. Participants were informed of their right to withdraw from the study at any stage without consequence. The students observed during lesson implementation were not treated as direct research participants because the study focused on teacher instructional practices and classroom time allocation. Observational data were analyzed collectively without identifying individual students.

Research Instruments

Data was collected using multiple instruments to ensure methodological triangulation. Classroom observations were conducted using the revised ALT-PE observation system developed by [Siedentop et al. \(1982\)](#). The instrument categorized lesson time into four components: activity time, instructional time, management time, and waiting time. Observations were conducted through systematic interval coding of video-recorded PE lessons. All open lessons were video recorded using digital cameras positioned to capture teacher instruction, student movement patterns, and classroom organization. Video data enabled repeated observation and more accurate coding verification.

Semi-structured interviews were conducted at the end of each LS cycle to explore teachers' perceptions regarding instructional changes, time management strategies, collaborative reflection, and challenges encountered during implementation. Supporting documents, including lesson plans, observation notes, teaching materials, and LS reflection reports, were analyzed to identify patterns of pedagogical improvement across cycles.

To strengthen instrument trustworthiness, two trained observers independently coded the ALT-PE video recordings. Prior to data collection, observers participated in a training session involving coding practice and discussion of ALT operational definitions. Inter-rater reliability was assessed using Cohen's Kappa coefficient, which yielded a value of 0.87, indicating a high level of coding agreement. Content validity was established through expert review by two specialists in PE pedagogy and instructional evaluation, who evaluated the suitability of the observation categories and coding procedures.

Data Analysis

Quantitative ALT-PE data were analyzed descriptively using percentages, means, and percentage change scores across LS cycles. The analysis focused on changes in four ALT-PE components: activity time, instructional time, management time, and waiting time. Pretest and post-test comparisons were conducted to identify shifts in instructional efficiency following LS implementation. Video recordings were analyzed through interval-based coding procedures using the ALT-PE framework. Observation results from the two coders were compared to ensure consistency prior to final data tabulation. Mean percentages for each ALT component were calculated across teachers and cycles to identify trends in instructional improvement.

Qualitative data obtained from interviews, reflection discussions, observation notes, and teaching documents were analyzed thematically using an interactive model consisting of data reduction, data display, and conclusion drawing. Coding focused on recurring themes related to teacher collaboration, instructional effectiveness, classroom management, reflective practice, and strategies for reducing non-instructional time.

Methodological triangulation was conducted by comparing findings from classroom observations, interview responses, video analysis, and reflection documents. Data integration at the interpretation stage enabled a comprehensive understanding of how LS contributed to improvements in ALT-PE effectiveness and instructional quality.

Results and Discussion

Results

Academic Learning Time in Physical Education (ALT-PE) was categorized into four components: Activity (A), Management (M), Instruction (I), and Waiting (W). Activity time represents students' direct engagement in movement tasks; management time refers to organizational activities; instructional time includes teacher explanations and demonstrations; and waiting time refers to periods during which students are inactive while awaiting participation opportunities.

Before conducting inferential analyses, assumptions were tested. The Shapiro–Wilk test indicated that pretest and post-test scores were normally distributed ($p > .05$). In contrast, Levene's test confirmed homogeneity of variance ($p > .05$). Therefore, paired-sample t-tests were used to examine differences between pretest and post-test scores, with Wilcoxon signed-rank tests conducted as non-parametric confirmation.

Table 1. Descriptive Statistics of ALT-PE Components

| Component | Pretest Mean \pm SD | Post-test Mean \pm SD | Mean Difference | Percentage Change |
|-----------------|-----------------------|-------------------------|-----------------|-------------------|
| Activity (A) | 20.63 \pm 16.74 | 50.96 \pm 4.08 | 30.33 | 147.0% |
| Management (M) | 43.49 \pm 13.21 | 37.26 \pm 3.01 | -6.23 | -14.3% |
| Instruction (I) | 12.26 \pm 7.88 | 11.26 \pm 3.80 | -1.00 | -8.2% |
| Waiting (W) | 23.13 \pm 22.12 | 0.51 \pm 1.61 | -22.62 | -97.8% |

Based on [Table 1](#), the descriptive findings indicate substantial improvements in instructional time allocation following the LS intervention. Activity time increased markedly from 20.63% to 50.96%, representing a 147.0% increase. This result suggests that students spent considerably more time actively engaged in meaningful physical activities after teachers participated in collaborative LS cycles.

Conversely, waiting time decreased dramatically from 23.13% to 0.51%, reflecting a reduction of 97.8%. This finding indicates that inactive periods during PE lessons were nearly eliminated after the intervention. Management time also decreased from 43.49% to 37.26%, suggesting improved classroom organization and smoother lesson transitions. Meanwhile, Instruction time decreased only slightly, indicating that teachers could provide more concise and efficient explanations without reducing instructional clarity. To determine whether the observed differences were statistically significant, paired-sample t-tests were conducted. The results are presented in [Table 2](#).

Table 2. Paired-Sample t-Test Results for ALT-PE Components

| Component | t | p | Interpretation |
|-----------------|-------|--------|----------------------|
| Activity (A) | -7.84 | < .001 | Significant increase |
| Management (M) | 3.12 | .012 | Significant decrease |
| Instruction (I) | 0.58 | .576 | Not significant |
| Waiting (W) | 5.97 | < .001 | Significant decrease |

Based on Table 2, the paired-sample t-test results revealed a statistically significant increase in Activity time ($t = -7.84, p < .001$). Waiting time also showed a highly significant reduction ($t = 5.97, p < .001$), demonstrating that LS effectively minimized inactive instructional periods. Management time decreased significantly ($t = 3.12, p = .012$), suggesting improvements in classroom organization, transition management, and equipment preparation. However, no statistically significant difference was found in Instruction time ($p = .576$). The Wilcoxon signed-rank test further confirmed the significance of changes in the Activity and Waiting components ($p < .01$), indicating consistency between the parametric and nonparametric analyses. To assess the practical significance of the intervention, Cohen’s d was used to calculate effect sizes. The results are presented in Table 3.

Table 3. Effect Sizes of Changes in ALT-PE Components

| Component | Cohen’s d | Magnitude |
|-----------------|-------------|----------------|
| Activity (A) | 1.77 | Large |
| Management (M) | 0.43 | Small–Moderate |
| Instruction (I) | 0.10 | Trivial |
| Waiting (W) | 0.99 | Large |

Based on Table 3, the effect size analysis indicated that Lesson Study produced substantial practical effects on ALT-PE effectiveness. Activity time demonstrated a large effect size ($d = 1.77$), indicating a considerable increase in students’ active engagement during PE lessons. Waiting time also showed a large effect ($d = 0.99$), reflecting a meaningful reduction in inactive instructional periods. In contrast, Management time exhibited a small-to-moderate effect ($d = 0.43$), while Instruction time showed only a trivial effect ($d = 0.10$). These findings suggest that the primary impact of LS was achieved by increasing student participation and reducing inactive time, rather than by changing the amount of instructional explanation provided by teachers.

Qualitative Findings

Qualitative data obtained from classroom observations, teacher interviews, reflection sessions, and lesson plan documentation revealed three major themes: (1) improved classroom organization, (2) increased teacher awareness of instructional efficiency, and (3) collaborative pedagogical reflection. First, teachers demonstrated improved classroom organization after participating in LS cycles. Reflection discussions identified inefficient routines, including delayed equipment setup, unclear instructions, and prolonged student grouping. Teachers subsequently redesigned lesson flow by preparing equipment before class, simplifying movement instructions, and organizing smaller activity stations to reduce transition delays. Second, teachers became more aware of the importance of maximizing student engagement during PE lessons. Observation data showed that teachers increasingly minimized non-learning activities and focused on maintaining continuous student participation throughout instructional sessions. Third, LS promoted collaborative pedagogical reflection among teachers. Reflection meetings enabled teachers to evaluate lesson implementation, exchange ideas about instructional strategies, and collectively revise lesson plans. Document analysis showed progressive improvements in task sequencing, instructional clarity, and transition management across the three LS cycles.

Integration of Quantitative and Qualitative Findings

The integration of quantitative and qualitative findings provides a comprehensive understanding of how Lesson Study improved ALT-PE effectiveness. Significant increases in Activity time and reductions in Waiting and Management time were supported by qualitative evidence showing improvements in classroom organization, transition management, equipment preparation, and instructional efficiency (Suroto et al., 2023). Teachers progressively redesigned learning activities to maximize participation opportunities and minimize inactive periods.

The convergence of quantitative and qualitative evidence suggests that the observed improvements were not merely the result of changes in time allocation but reflected meaningful enhancements in instructional practices. Collectively, the findings demonstrate that Lesson Study significantly enhanced ALT-PE effectiveness by increasing meaningful activity time, reducing non-productive instructional time, and improving instructional organization in elementary school physical education classes.

Discussion

Beyond improving instructional efficiency, the observed increase in ALT-PE may also be explained by enhanced student engagement resulting from more supportive and well-structured learning environments. Through the iterative cycles of planning, observation, and reflection, teachers designed learning tasks that minimized passive waiting time and maximized opportunities for active participation. As students became more consistently involved in meaningful movement activities, their behavioral engagement during lessons increased. This finding is consistent with previous research indicating that teacher support, clear instructional organization, and active learning opportunities are significant predictors of student engagement in physical education (Guo et al., 2023). Furthermore, instructional approaches that emphasize meaningful participation and appropriately challenging learning tasks have been shown to enhance students' motivation, engagement, and overall learning experiences in PE settings (Simón-Chico et al., 2023). Therefore, the improvement in ALT-PE observed in this study may reflect not only better classroom management but also the creation of learning environments that foster greater student involvement and sustained participation.

The findings further highlight the importance of LS as a reflective professional development model. Through the collaborative Plan-Do-See process, teachers critically examined lesson implementation, student responses, and instructional decisions. This reflective practice enabled teachers to identify ineffective teaching routines and collaboratively redesign lessons to maximize learning opportunities. Previous international research has similarly shown that LS strengthens pedagogical reasoning, instructional decision-making, and teacher collaboration by connecting professional learning directly with classroom practice (Dudley, 2013; Lewis et al., 2019). In the present study, LS encouraged teachers to move beyond routine instructional delivery toward more intentional and student-centered lesson management.

The collaborative nature of Lesson Study may have been particularly influential in supporting teachers' professional growth by situating learning in authentic classroom contexts. Rather than receiving externally prescribed training, teachers engaged in continuous cycles of collective inquiry to improve student learning. This process enabled participants to examine classroom observation evidence, discuss instructional challenges, and collaboratively develop solutions tailored to their students' needs (Hummes & Seckel, 2024; Kager et al., 2024; Tobin et al., 2025). Such findings are consistent with research suggesting that Lesson Study promotes context-specific professional learning, strengthens reflective practice, and enhances teachers' capacity to make informed pedagogical decisions based on classroom evidence (Jones, 2024). Consequently, the improvements in ALT-PE observed in this study may be interpreted as outcomes of both enhanced instructional techniques and deeper professional understanding developed through collaborative reflection.

In addition, the study demonstrates that LS contributed to the development of pedagogical content knowledge in PE. Teachers became more capable of designing structured and purposeful movement activities while maintaining effective classroom control and student engagement. This finding supports previous evidence suggesting that collaborative professional learning improves teachers' pedagogical competence and instructional adaptability (Marques Santinha et al., 2024; Slingerland et al., 2021). The collaborative nature of LS also appeared to promote greater teacher confidence in modifying instructional strategies based on classroom observations and student needs. Collectively, these findings suggest that LS effectiveness extends beyond improving instructional time

allocation and contributes to broader improvements in teaching quality, professional competence, and student learning engagement in physical education settings (Kager et al., 2024; Hummes & Seckel, 2024; Tobin et al., 2025).

Limitations of Study

This study has several limitations. First, the study involved a relatively small sample of 10 physical education teachers from six elementary schools within a single district, which may limit the generalisability of the findings to other educational contexts. Second, the intervention was conducted over three Lesson Study cycles within one academic semester; therefore, the long-term sustainability of the observed improvements in ALT-PE remains unclear. Third, although the mixed-methods design provided a comprehensive understanding of instructional changes, the study focused primarily on instructional time allocation and did not directly examine student learning outcomes such as motor skill development, physical fitness, or motivation. Future research should involve larger, more diverse samples, longitudinal designs, and broader measures of student outcomes to evaluate further the long-term impact of Lesson Study on physical education effectiveness.

Conclusions

This study demonstrates that implementing Lesson Study (LS) improved the effectiveness of Academic Learning Time in Physical Education (ALT-PE) in Indonesian primary schools. Through collaborative planning, observation, and reflection, teachers reduced management and waiting time while increasing instructional and activity time during PE lessons. These improvements contributed to more efficient, structured, and student-centered learning processes.

The findings indicate that LS serves not only as a professional development approach but also as an effective strategy for optimizing instructional quality and student engagement in PE. The study also highlights the potential of LS to support the implementation of student-centered learning within the Merdeka Belajar framework. Future research should investigate the long-term impact of improvements in ALT-PE on students' motor skills, physical fitness, motivation, and academic outcomes, using larger samples and broader educational contexts.

Acknowledgments

The authors would like to thank all participants who volunteered to take part in the present study.

Authors' contributions

NA contributed to the study conception and design, data collection, data analysis and interpretation, critical revision of the manuscript, and final approval of the article. MU contributed to the study conception and design, data analysis and interpretation, manuscript drafting, and final approval of the article. WIB contributed to the study conception and design, data analysis and interpretation, manuscript drafting, critical revision of the manuscript, and final approval of the article. I, HY, AR, AHMH, JN, and JVJG contributed to the drafting, critical revision, and final approval of the manuscript. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Competing interests

The authors declare no competing interests.

AI Disclosure Statement

During the preparation of this manuscript, the authors used DeepL Translate and Grammarly to support translation, grammar checking, and language refinement. All generated outputs were carefully reviewed and edited by the authors to ensure accuracy, clarity, and adherence to academic standards. The authors take full responsibility for the content of this manuscript.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author, R.M. The data are not publicly available due to restrictions containing information that could compromise the privacy of research participants.

Funding

This research received no external funding.

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