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Improving Critical Thinking in Third-Grade Science through Inquiry Learning Supported by Interactive PowerPoint

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ABSTRACT

This classroom action research examined changes in critical thinking during inquiry learning supported by interactive PowerPoint in a third-grade science (IPAS) class at SDN 127 Sekeloa, Bandung, Indonesia. Twenty-nine students studied the life cycles of humans, animals, and plants across three cycles, with one 70-minute meeting per cycle. The intervention followed the Engage, Explore, Explain, Elaborate, and Evaluate (5E) inquiry phases, supported by PowerPoint presentations with 3D life-cycle models, material explanations, and a song for recalling the concepts. Students worked in progressively smaller groups, targeting six students in Cycle I, four in Cycle II, and two in Cycle III. The research used problem identification, action planning, implementation, observation and data collection, analysis, and reflection, concluding after Cycle III. Critical thinking was assessed through ten essay items (maximum total score 100) across five operational indicators. Class mean scores increased from 35.90 at baseline to 55.00 in Cycle I, 73.70 in Cycle II, and 85.40 in Cycle III. The proportion scoring strictly above 75 increased from 0.00% to 27.59%, 62.07%, and 86.21%, respectively (25 of 29 students in Cycle III). All five indicators mean increased. These descriptive results indicate improvement during the combined instructional implementation, without establishing causality or isolating PowerPoint's contribution.

Keywords
Classroom Action Research
Critical Thinking
Elementary Science
Inquiry Learning
Interactive PowerPoint

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Introduction

The ability to evaluate evidence, explain reasons, and draw defensible conclusions is an important aim of elementary science education. In classroom practice, critical thinking is not simply recalling scientific terms; students also need opportunities to question information, select relevant observations, and explain the basis for an answer. Recent research in primary science shows that guided inquiry and the construction and revision of representations can make these processes visible and open to teacher support [1]. Observational research with science teachers also highlights the importance of attending to students' actual reasoning processes rather than treating a correct final answer as sufficient evidence of critical thinking [2].

A systematic review of critical-thinking approaches in primary classrooms identified dialogic, practical, digital, and text-based forms of instruction, while emphasizing that teaching activities need clear theoretical links to the abilities they intend to develop [3]. For this study, critical thinking is operationalized through students' responses to inquiry questions and an adapted five-indicator essay instrument; it is not assumed to be captured completely by any single test score.

Preliminary classroom observations at SDN 127 Sekeloa identified a specific instructional problem among third-grade students. Some students relied on repeating information from learning materials, struggled when familiar questions were expressed differently, and had difficulty explaining why their answers were appropriate. These classroom observations provided the practical basis for seeking an instructional approach that could move students from reproducing information toward interpreting questions, examining evidence, and communicating reasoned conclusions.

Inquiry learning organizes science learning around questions, evidence-seeking, interpretation, and explanation. A recent review by de Jong et al. [4] argues that inquiry should not be treated as the absence of teacher explanation: learners, particularly novices, benefit when inquiry tasks are paired with timely instruction and scaffolding. An inquiry-focused meta-analysis published in 2025 reported a positive overall association with critical thinking in science while emphasizing substantial heterogeneity across studies [5]. Another meta-analysis found favorable results for higher-order thinking outcomes in science education,

although the size and consistency of effects differed by study characteristics [6]. Such findings support exploring inquiry in a particular classroom but do not guarantee success in every setting.

Evidence also suggests that the amount of learner autonomy should be chosen carefully. A 2024 systematic review of open inquiry warned against treating minimally guided inquiry as invariably preferable, whereas subsequent reviews of guided inquiry described opportunities for cultivating critical thinking through structured investigation [7]–[8]. A 2026 review of inquiry in science education likewise highlights the importance of learner readiness, instructional design, and appropriate guidance [9]. These findings are relevant to Grade III learners who require prompts and concrete representations when interpreting life-cycle stages.

The role of the teacher is especially relevant at elementary level. Research involving Moroccan primary-school science teachers underscores the difficulty of translating general commitments to critical thinking into specific classroom questioning and instructional practices [10]. A systematic review of technology use in inquiry-based elementary science reports that technology frequently supports observation and interpretation during inquiry, while its educational contribution depends on the processes and interactions it enables [11]. A wider K–12 review also found that appropriate digital tools and activity design can help students participate in inquiry and scientific argumentation [12].

Indonesian primary-school studies provide more directly comparable settings. Prasanti and Suniasih examined inquiry and critical thinking in Grade V science [13]; Ianah et al. studied inquiry-based IPAS through classroom action research in Grade IV [14]; and Mulyani et al. investigated an inquiry approach combined with Educaplay in Grade V IPAS [15]. Fahyuni and Anggraini considered inquiry with value-integrated science activities in Grade IV [16]. Although these studies differ in grade, medium, assessment, and design, they point to the practical importance of opportunities for questioning, collaborative exploration, and explanation. A 2026 comparative study also examined guided inquiry against problem-based learning for Grade V science, reinforcing that instructional approaches should be evaluated in context rather than treated as interchangeable [17].

Interactive PowerPoint was selected as a supporting medium for the classroom intervention. Research with Indonesian elementary students has examined interactive PowerPoint for science and critical thinking [18], while a 2025 study combined scientific inquiry and interactive technology in elementary science [19]. Related classroom action research in 2026 documented changes in critical thinking during guided discovery supported by PowerPoint [20]. These studies provide relevant contextual comparisons, but none establishes that PowerPoint, used independently of pedagogy, automatically produces deeper

reasoning. Accordingly, the present study interprets the medium as one element of the inquiry-based teaching package, rather than as an isolated treatment.

Recent elementary science studies also examine other forms of visual and interactive media, including multimedia for IPAS concepts [21], augmented-reality representations [22], and web-based interactive media [23]. These works offer a rationale for making otherwise abstract or sequential scientific phenomena more visible; they do not demonstrate that the PowerPoint features in the present classroom had the same effects as media tested in different designs. In this study, the 3D life-cycle models were used as representations for learner discussion rather than as proof of conceptual understanding on their own. The purpose was to address the observed classroom problem and document the improvement process across three cycles, without claiming an experimental causal effect.

Methods

A. Research Design and Participants

The study employed classroom action research informed by John Elliott's reflective approach. The participants were 29 Grade III students at SDN 127 Sekeloa, Bandung, Indonesia. Preliminary observation found difficulties in interpreting questions, explaining answers, and supporting explanations with relevant information. The IPAS topic was the life cycles of humans, animals, and plants. The intervention comprised three meetings in total: one meeting in each of Cycles I, II, and III, lasting 70 minutes per meeting. Each cycle included problem identification or review, action planning, implementation, observation and data collection, analysis, and reflection. Reflection informed whether another cycle was needed. This was a single-class improvement study without random assignment or a comparison group.

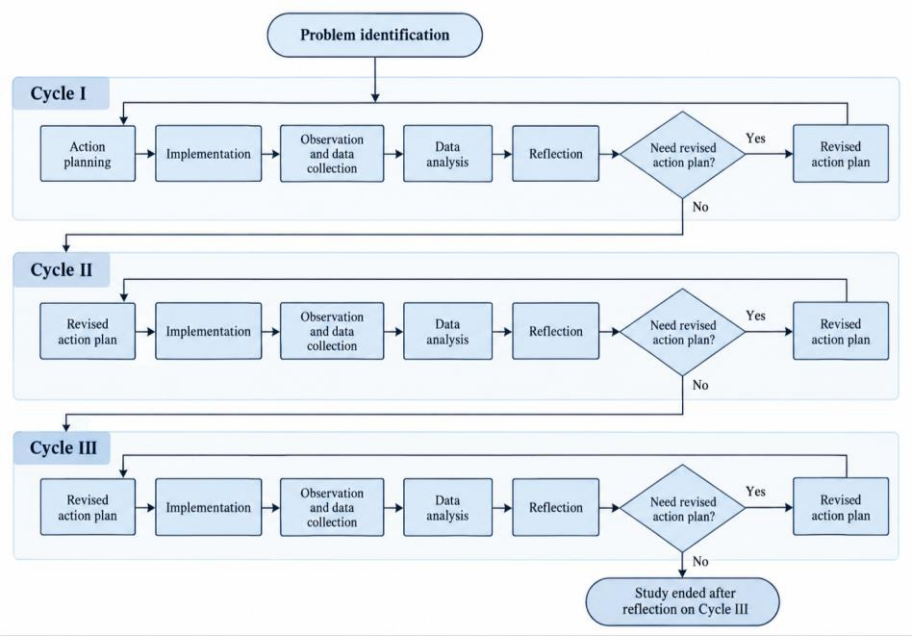

Fig. 1. Classroom Action Research Procedure Across Three Cycles

B. Research Instrument

The research instrument was a summative assessment test used to measure students' critical reasoning after the instructional intervention in each cycle. The test was developed based on the critical reasoning indicators that served as the focus of the study and was aligned with the science learning materials taught during the intervention.

The test results were used to identify changes in students' critical reasoning and to compare students' achievement from one cycle to the next following the implementation of Inquiry Learning Supported by Interactive PowerPoint.

C. Instructional Procedure

The inquiry activities followed the five phases of the 5E learning cycle: Engage, Explore, Explain, Elaborate, and Evaluate. Interactive PowerPoint supported these phases through 3D life-cycle models, explanatory slides, and a song for recalling stages and terminology. A 2025 primary-school study examined critical thinking during a STEAM-5E learning cycle [24], providing an additional contextual rationale for explicitly sequencing engagement, exploration, explanation, application, and evaluation.

1. Engage: The teacher introduced questions about the life cycles of humans, animals, and plants and used the slides to focus students on the topic and activate relevant prior knowledge.
2. Explore: Students examined the life-cycle representations, including the 3D models in PowerPoint, and discussed information and observations in their groups.
3. Explain: Students shared their interpretation of the life-cycle stages and explained their answers. The teacher provided clarification and guiding questions when students needed support.
4. Elaborate: Students revisited and applied their explanations to the human, animal, and plant examples, considering how the stages and sequences could be compared.
5. Evaluate: Students' explanations and critical thinking were examined through questioning, reflection, and the ten-item essay assessment used for the study.

Teaching and reflection were repeated across the three cycles. In Cycle I, students worked in groups targeting six members; in Cycle II, the target was four members per group; and in Cycle III, students worked in pairs where possible. These numbers describe the intended group sizes rather than an exact partition of all 29 students. The progressive reduction in group size was the documented instructional adjustment between cycles. After each lesson, classroom observations and critical thinking assessment results were considered during reflection to inform the following cycle. Cycle III was concluded after reflection indicated that the original classroom problem had been sufficiently addressed. Other cycle-specific changes beyond group size were not documented in the supplied information.

D. Critical thinking instrument and scoring

Critical thinking was assessed using ten essay questions divided evenly across five operational indicators by Ennis: (1) elementary clarification, (2) basic support, (3) inference, (4) advanced clarification, and (5) supposition and integration. Each indicator was represented by two questions. The indicator terminology reflects the framework as adapted in the source manuscript, rather than an unmodified standardized instrument. The choice of an essay format can be appropriate for observing reasoning, but the credibility of score interpretations depend on alignment with the intended skills and evidence for scoring quality [25]. Recent elementary science assessment research likewise illustrates the importance of reporting content review and measurement properties rather than assuming them [26].

Each essay question had a possible score of 0–10. The total individual score was the sum of the ten item scores and therefore ranged from 0 to 100 without an additional conversion formula. The corresponding indicator score was the mean of the two item scores; classroom indicator means retained the 0–10 scale. According to the source manuscript, the instrument was reviewed by a mentor teacher and university lecturer using qualitative judgment, and an assessment rubric was used. No statistical reliability estimate was documented. Accordingly, expert review is not described here as proof of statistical validity or inter-rater reliability.

E. Data Analysis

The data were analyzed using quantitative descriptive analysis. According to Sugiyono, descriptive statistics are used to analyze data by describing or presenting the collected data as they are, without intending to draw conclusions that can be generalized to a broader population.

The data analyzed consisted of the results of the summative assessment of students' critical reasoning obtained in each cycle. The analysis involved calculating each student's score, the class mean score, and the percentage of students achieving the success criterion. The class mean was calculated by dividing the total scores obtained by all students by the total number of students. The percentage of achievement was calculated by comparing the number of students who obtained scores above the predetermined success criterion with the total number of students.

The Indonesian Ministry of Education's 2025 assessment guidance emphasizes that learning achievement criteria should be established based on learning objectives and demonstrated competencies rather than relying solely on numerical scores [27]. In this study, a score above 75 (>75) was used as the individual achievement criterion to evaluate students' critical thinking skills. Students who obtained scores above this threshold were considered to have achieved the expected level of performance. Accordingly, the effectiveness of the classroom improvement process was evaluated by examining changes in students' average

scores and the number and percentage of students meeting the achievement criterion across each cycle. The results from the baseline assessment and Cycles I, II, and III were compared to identify improvements in students' critical thinking skills following the implementation of inquiry learning supported by interactive PowerPoint.

Results

A. Development of Critical Reasoning Indicators

The development of students' critical reasoning was analyzed based on the five main indicator groups proposed by Ennis, namely 'Elementary Clarification', 'Basic Support', 'Inference', 'Advanced Clarification', and 'Supposition and Integration'. Each indicator consisted of two essay questions, with a maximum score of 10 for each question. Therefore, the average scores presented in Table 1 ranged from 0 to 10.

Table 1. Development of Scores Based on Critical Reasoning Indicators

Critical Reasoning Indicator	Initial Condition	Cycle I	Cycle II	Cycle III
Elementary Clarification	4.55	6.97	8.52	9.34
Basic Support	4.69	6.72	8.48	9.03
Inference	3.79	5.41	7.90	8.52
Advanced Clarification	2.83	4.21	6.48	8.17
Supposition and Integration	2.10	4.17	5.48	7.62
Mean	**3.59**	**5.50**	**7.37**	**8.54**

Based on Table 1, all critical reasoning indicators showed improvement from the initial condition to Cycle III. In the initial condition, the overall average critical reasoning score was 3.59. Following the implementation of the instructional intervention in Cycle I, the score increased to 5.50, then to 7.37 in Cycle II, and reached 8.54 in Cycle III. This finding indicates a gradual development of students' critical reasoning throughout the implementation of the intervention.

For the 'Elementary Clarification' indicator, the score increased from 4.55 in the initial condition to 6.97 in Cycle I, 8.52 in Cycle II, and 9.34 in Cycle III. This increase indicates that students became increasingly capable of understanding problems and providing simple explanations based on the available information.

The 'Basic Support' indicator increased from 4.69 in the initial condition to 6.72 in Cycle I, 8.48 in Cycle II, and 9.03 in Cycle III. This development indicates that students became more capable of using available information or sources as a basis for formulating their answers.

For the 'inference' indicator, the score increased from 3.79 to 5.41 in Cycle I, 7.90 in Cycle II, and 8.52 in Cycle III. These results indicate the development of students' ability to draw conclusions based on the information they obtained. Compared with the two preceding indicators, students' ability to draw conclusions was relatively lower in the initial condition but showed consistent improvement across the cycles.

The 'Advanced Clarification' indicator increased from 2.83 in the initial condition to 4.21

in Cycle I, 6.48 in Cycle II, and 8.17 in Cycle III. This increase indicates that students gradually developed their ability to provide more detailed explanations and connect information with relevant reasons.

Meanwhile, 'Supposition and Integration' was the lowest-scoring indicator in the initial condition, with a score of 2.10. The score increased to 4.17 in Cycle I, 5.48 in Cycle II, and 7.62 in Cycle III. Although this indicator showed the largest overall increase, it remained the relatively lowest-scoring aspect in Cycle III. This finding suggests that students' ability to determine strategies, consider various possibilities, and integrate information still requires further reinforcement.

Overall, these findings indicate that the implementation of *self-directed learning* contributed positively to the development of all five critical reasoning indicators. The improvement was evident not only in the overall average score but also across each indicator used as the basis for measuring students' critical reasoning.

B. Achievement of the Critical Reasoning Success Criterion

To determine whether the research success criterion was achieved, the average scores were converted to a 0–100 scale. Students were considered to have achieved the success criterion if they obtained a score above 75.

Table 2. Achievement of the Critical Reasoning Success Criterion

Stage	Average Score	Students Scoring >75	Percentage
Initial Condition	35.90	0 of 29	0.00
Cycle I	55.00	8 of 29	27.59
Cycle II	73.70	18 of 29	62.07
Cycle III	85.40	25 of 29	86.21

Based on Table 2, the average critical reasoning score increased at each stage. In the initial condition, the students' average score was 35.90, and no students obtained a score above 75. This condition indicates that students' critical reasoning abilities before the intervention were still at a low level.

In Cycle I, the average score increased to 55.00, with 8 out of 29 students (27.59%) obtaining scores above 75. Although an improvement was observed compared with the initial condition, most students had not yet achieved the success criterion. Therefore, the intervention implemented in Cycle I still required improvement in the subsequent cycle.

In Cycle II, the average score increased to 73.70. The number of students obtaining scores above 75 also increased to 18 out of 29 students (62.07%). These results indicate greater improvement compared with Cycle I, although the class average remained slightly below the score criterion of 75.

In Cycle III, the average score increased to 85.40, with 25 out of 29 students (86.21%) obtaining scores above 75. These results indicate that the research success criterion was

achieved in Cycle III. The improvement also demonstrates that most students experienced development in their critical reasoning after the intervention was implemented progressively across the three cycles.

Overall, the average score increased from 35.90 in the initial condition to 85.40 in Cycle III, representing an increase of 49.50 points. The percentage of students achieving scores above 75 also increased from 0% to 86.21%. Therefore, the findings indicate that students' critical reasoning developed following the implementation of inquiry learning supported by interactive PowerPoint in science learning.

Discussion

A. Development of Critical Reasoning Indicators

The observed progression is consistent with the educational rationale for guided science inquiry: repeated opportunities to clarify questions, consider information, and justify conclusions may help students demonstrate the critical thinking processes targeted by the classroom assessment [1], [4]. The increasing pattern also accords in direction with recent meta-analytic evidence concerning inquiry-oriented science education and higher-order or critical thinking outcomes [5]–[6]. However, such consistency is not evidence that the present classroom study reproduces the treatment effects estimated by those larger research syntheses. This study describes repeated assessment results in one classroom, with no independent comparator.

The results are also directionally consistent with Indonesian inquiry studies in the upper elementary grades [13]–[15] and with more recent evidence comparing guided inquiry to another student-centered model [17]. However, participants in those studies were not the same age, and their measurement scales and interventions differed. The present observations should therefore be understood as a classroom-specific sequence of changes rather than a directly comparable treatment effect or a confirmation of any general effect size.

Teacher guidance provides a plausible interpretation of the classroom process. In the Engage and Explore phases, the presentation and guiding questions supported attention to the problem and examination of life-cycle representations; Explain and Elaborate then provided opportunities for students to articulate and apply their reasoning. The shift from groups targeting six students to groups of four and then pairs could have increased individual opportunities to participate and receive support. However, the study did not independently test the effect of grouping, teacher prompts, or the 5E phases. The need for responsive instruction is emphasized by de Jong et al. [4], while research on primary teachers suggests that opportunities for critical thinking depend on specific instructional choices [10].

The teaching sequence also provided a clear connection between the topic and the assessment: students first interpreted visual information about life-cycle stages, then

discussed similarities and differences, and finally explained conclusions in writing. The purpose of the 5E structure was to elicit these cognitive activities, while reflection after each 70-minute meeting guided subsequent revisions. Studies of inquiry and STEAM-5E learning provide supportive pedagogical context, but the available data cannot determine which stage made the largest contribution [8], [24].

B. Role of interactive PowerPoint

Interactive PowerPoint supported the 5E instruction by displaying 3D models of life-cycle processes, presenting explanations of the learning material, and providing a song to reinforce students' recall of life-cycle stages. The 3D representations were used in connection with exploration and explanation, while the explanatory slides and song supported access to and retention of the topic. Studies in elementary science have reported promising outcomes for interactive PowerPoint or inquiry-oriented interactive multimedia [18]–[19], and systematic reviews emphasize aligning digital tools with active inquiry tasks [11]–[12]. A 2025 study underlined the importance of learner-centered interaction instead of presentation alone [28]. A related 2026 classroom action study using guided discovery and PowerPoint provides a comparison involving a different learning model and setting [20].

The related multimedia literature is not limited to PowerPoint. For example, Yunita et al. developed interactive IPAS media [21], Najib and Suprihatiningrum investigated augmented-reality media [22], and Saputra et al. examined web-based interactive learning resources [23]. Since the formats and research designs differ, they support the broader principle of aligning media with learner activity but cannot establish the effectiveness of the specific PowerPoint presentation used here. Media design and teacher-mediated interpretation should be considered together.

The particular combination of 3D models, explanations, and a recall song is a contextual description of the medium used in this classroom. The supplied information does not document which elements were clickable, animated, or otherwise technically interactive; therefore, no such features are claimed here. Because no inquiry-without-PowerPoint or PowerPoint-without-inquiry comparison condition was included, the scores cannot establish that any specific PowerPoint component was responsible for the improvement.

Conclusion

Inquiry learning using the 5E phases, supported by interactive PowerPoint, was associated with progressively higher critical thinking assessment scores among 29 Grade III students learning about the life cycles of humans, animals, and plants. The class participated in three 70-minute meetings, one per cycle, with groups progressively reduced from approximately six students to four students and then pairs. Class mean scores rose from 35.90 at baseline to 55.00 in Cycle I, 73.70 in Cycle II, and 85.40 in Cycle III. By the final cycle, 25 of

29 students (86.21%) scored strictly above 75 in the retained data, compared with none at baseline. The five adapted indicator means also increased, although supposition and integration remained the lowest. Reflection at the end of Cycle III led to the conclusion that the classroom improvement aim had been sufficiently achieved, with continuing support needed for students still at or below the reporting threshold. These findings describe a local improvement process, rather than a causal or independent effect of any one teaching component.

Conflict of Interest

The authors declare no conflict of interest.

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