

Fostering Inductive Reasoning and Learning Experiences About Energy Sources: A Pilot Study of the Picture-Concept Sort Approach in a Rural High School

*Eda Marie Hitalia^{1,2}, Jeriel D. Divino^{1,3}, Ronilo V. Aponte¹

¹Iloilo State University of Fisheries, Science and Technology, Barotac Nuevo, Iloilo, Philippines

²Banate National High School

³Mostro National High School

DOI: <https://doi.org/10.51584/IJRIAS.2026.11080114>

Received: 24 August 2026; Accepted: 29 August 2026; Published: 15 September 2026

ABSTRACT

Science education in rural high schools faces significant barriers due to inadequate resources, limited exposure to innovative practices, and a lack of opportunities for active, participatory learning. To address these challenges, this study investigated the effects of the Picture-Concept Sort-Collaboration (PCSC) approach on the inductive reasoning performance and learning experiences of Grade 7 learners on renewable and nonrenewable energy sources. Employing a mixed-methods design with a quasi-experimental pretest-posttest control group framework, the study involved 60 Grade 7 learners divided into an experimental group (n=30) receiving the PCSC intervention and a control group (n=30) receiving traditional lecture-based instruction. Researchers gathered quantitative data via a validated 40-item test and analyzed it using descriptive statistics and the Mann-Whitney U Test, while qualitative data on learner experiences were analyzed thematically. Results indicated that while both groups improved, the experimental group achieved a significantly higher post-test mean score (M = 33.43, SD = 3.94; pre-test: M = 23.70, SD = 3.31) than the control group (M = 25.17, SD = 5.36; pre-test: M = 20.13, SD = 5.78).

Although baseline pre-test scores showed no significant difference ($p = 0.226$), post-test scores demonstrated a statistically significant difference ($U = 21.000$, $p = 0.000$) in favor of the experimental group. Thematic analysis of learner experiences revealed key themes of active engagement, enhanced collaboration, enjoyable learning, and the development of inductive thinking skills. The study concludes that the PCSC approach is a highly effective alternative to traditional lecture methods, demonstrating that learner-centered, interactive strategies can boost academic performance and engagement in rural science education.

Keywords: Collaboration, Energy Resources, Inductive Thinking, Picture-Concept Sort, Rural Science Education

INTRODUCTION

The Inductive Thinking Model is a learner-centered teaching strategy designed to develop inductive mental operations and foster critical thinking skills (Taba, 1967). This strategy is essential in the science curriculum, as it offers conducive opportunities to harness learners' intellect and cultivate their ability to apply, evaluate, analyze, and construct innovative ideas (Susanto, 2020). Taba's model requires learners to actively process raw data, find underlying patterns, and construct concepts from the bottom up (Porter et al., 2020). In this framework, learning is viewed as an active, dynamic transaction between the learner and the provided information (Button, 2023). Consequently, inductive thinking positively influences learners' performance and motivation (Billing, 2013).

In recent years, educational research has increasingly emphasized collaborative learning practices to enhance cognitive abilities and learner participation in science classes. Collaborative learning enables learners to

actively engage, share ideas, and co-construct knowledge through peer interaction. Evidence shows that collaborative teaching approaches improve critical thinking and academic outcomes (Lagare & Paglinawan, 2024). Additionally, innovative strategies such as cooperative and inquiry-based learning foster deeper conceptual understanding and meaningful learning experiences (Chen & Chen, 2025). Integrating visual-based instructional tools, such as concept mapping and picture-based tasks, further enhances inductive thinking skills by helping learners organize knowledge, recognize relationships, and develop logical reasoning in science (Hu & Hwang, 2024) and in natural science knowledge (Toth et al., 2021).

As a fundamental domain in science education, energy concepts relate to daily life, influencing domestic activities, communication, and transportation. Global challenges such as climate change, resource depletion, and rising energy demands underscore the necessity for a thorough understanding of renewable and nonrenewable energy resources. Teaching these critical topics requires a broad understanding of how energy sources are evaluated and applied within communities. Consequently, science education must prioritize both content mastery and higher-order cognitive skills, particularly inductive thinking, which empowers learners to recognize patterns, categorize information, and form generalizations (Vo & Csapo, 2023). Despite these educational imperatives, rural high schools often rely on traditional lecture-based instruction, constraining learner participation in the learning process. Rural learners routinely meet systemic challenges, including inadequate instructional resources, minimal exposure to innovative teaching practices, and limited opportunities for active, participatory learning take part in the active learning process (Adebola, 2024).

The Picture-Concept Sort-Collaboration (PCSC) approach addresses these constraints by integrating visual learning with peer collaboration to enhance cognitive growth. By requiring learners to categorize, analyze, and discuss visual representations, this strategy promotes active participation and strengthens inductive reasoning. However, empirical evidence evaluating its effectiveness is still limited, particularly within rural secondary school contexts.

To address this empirical gap, this study investigates the impact of the Picture-Concept Sort-Collaboration Approach on the inductive thinking skills of Grade 7 learners in a rural high school setting. Specifically, it compares the effectiveness of the PCSC approach with traditional lecture-based instruction in enhancing learners' inductive thinking performance during a unit on renewable and nonrenewable energy sources. The findings may inform educators, school administrators, and curriculum designers in selecting evidence-based strategies that foster active learning engagement, cultivate critical thinking, and refine science learning in resource-constrained environments.

THEORETICAL FRAMEWORK

This study is based on currently accepted learning theories that explain how learners improve inductive thinking skills through active, visual, and collaborative learning experiences.

First, the study is based on Constructivist Learning Theory, which was developed by Jean Piaget. This idea explains how learners actively develop their own understanding by linking current information to past knowledge. Instead of just receiving knowledge, kids learn best when they engage in meaningful tasks such as seeing, categorizing, and analyzing concepts. In this study, the use of visuals and concept sorting enables learners to actively build their understanding of renewable energy resources.

Furthermore, Lev Vygotsky's Social Constructivism lends credence to the study. This idea emphasizes the role of social interaction in learning. According to Vygotsky, pupils learn better when they cooperate, exchange ideas, and accept guidance from peers or teachers. The collaboration part of the Picture-Concept Sort-Collaboration Approach reflects this concept. As learners collaborate to examine and classify information, they improve their reasoning and thinking skills.

The study also used Bruner's Discovery Learning Theory. Bruner thought that the most effective learning occurred when pupils discovered things for themselves via exploration and problem solving. This strategy taught learners to recognize patterns and generalize, both of which were essential components of inductive

thinking. By including learners in visual analysis and sorting exercises, the method encouraged discovery and deeper comprehension.

The study is further backed by Dual Coding Theory, which was introduced by Allan Paivio. According to this hypothesis, learning is better when information is delivered in both verbal and visual formats. The use of visuals in teaching improves knowledge processing and retention, particularly when dealing with abstract scientific subjects.

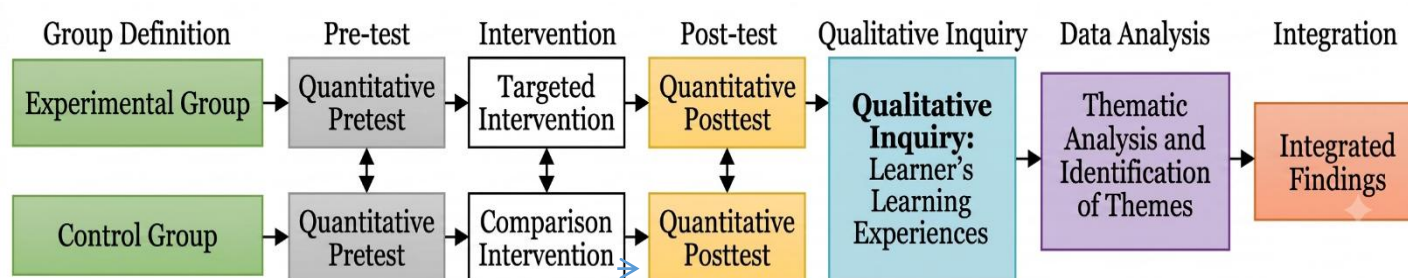
Finally, Collaborative Learning Theory, which is backed by scholars such as David W. Johnson and Roger T. Johnson, emphasizes that learning increases when learners work together to achieve a common goal. Collaboration allows learners to discuss ideas, question one another's thinking, and co-create knowledge, which improves both critical and inductive thinking skills.

Together, these theories support the notion that learning is most effective when pupils are actively engaged, visually stimulated, and socially involved. These ideas are the foundation of the Picture-Concept Sort-Collaboration Approach employed in this study.

CONCEPTUAL FRAMEWORK

Figure 1 depicts the study's explanatory sequential mixed methods conceptual framework, guiding the evaluation of the Picture-Concept Sort Approach. It visualizes a preceding quantitative quasi-experimental phase where pre-test and post-test scores measuring learners' inductive thinking performance are compared between experimental and control groups. Subsequently, a qualitative inquiry strand follows, exclusively exploring the experimental group's learning experiences using thematic analysis. The framework culminates in the integration stage, combining quantitative results and qualitative themes to generate meta-inferences about the intervention's effectiveness in fostering inductive reasoning and learning experiences about energy sources.

Figure 1. Explanatory Sequential Conceptual Framework for Evaluating the Picture-Concept Sort-Collaboration Approach.



Statement of the Problem

This study aimed to evaluate the effects of the Picture-Concept Sort-Collaboration (PCSC) approach on the inductive thinking performance of Grade 7 learners in a rural high school during a unit on renewable and nonrenewable energy resources.

Specifically, this study sought to answer the following questions:

- What is the level of inductive thinking performance of Grade 7 learners before and after exposure to the Picture-Concept Sort-Collaboration approach?
- Is there a significant difference in the inductive thinking performance of Grade 7 learners before and after exposure to the Picture-Concept Sort-Collaboration approach?
- What learning experiences gained by the learners exposed to the Picture-Concept Sort-Collaboration approach?

Hypothesis

There is no significant difference in the inductive thinking performance of Grade 7 learners before and after exposure to the Picture-Concept Sort-Collaboration approach.

METHODOLOGY

Research Design

This study employed an explanatory sequential mixed-methods research design to evaluate the efficacy of the Picture-Concept Sort-Collaboration (PCSC) approach in enhancing learners' inductive thinking performance about renewable and non-renewable resources in a pilot study. Following this explanatory sequential framework, the research progressed systematically through a primary quantitative phase followed by a secondary qualitative phase to provide a comprehensive, contextualized interpretation of the intervention's impact.

The quantitative phase used a quasi-experimental pretest-posttest non-equivalent control group design involving two intact learner groups. At baseline, both the experimental and control groups were administered an identical pretest to gauge initial conceptual understanding and show baseline equivalence. Following the pretest, the experimental group was exposed to the PCSC approach, while the control group received traditional lecture-based instruction. To isolate the effect of the instructional intervention, both groups covered an identical curriculum on energy resources over the same instructional duration. Upon completing the unit, a post-test was administered to both groups to compare performance gains statistically using the Mann-Whitney U test, allowing the researchers to statistically compare performance gains using a Mann-Whitney U test.

Immediately following the quantitative data collection, the study transitioned to its qualitative phase to explain and elaborate upon the statistical findings. As illustrated in the conceptual framework, a distant qualitative branch extended from the experimental group's pathway to capture learners' learning experiences. This phase gathered reflective feedback and narrative accounts specifically from participants in the experimental group, documenting their attitudes, peer interactions, and impressions of the collaborative sorting activity. By sequencing the design in this manner, the qualitative data served to contextualize and enrich the quantitative performance results, yielding a cohesive, multi-dimensional understanding of how the strategy influenced learner learning.

Participants and Sampling Method

The participants in this study included Grade 7 learners enrolled at a public high school in a rural district of the Philippines during the Academic Year 2025–2026. Since this is a pilot study, two intact classrooms were selected for the study: one served as the experimental group, instructed using the Picture-Concept Sort-Collaboration (PCSC) approach, while the other served as the control group, taught through traditional lecture-based instruction. Each group consisted of 30 learners, reflecting standard class sizes in the Philippine public secondary schools, excluding learners who did not voluntarily participate and withdrew during the implementation of the intervention.

A purposive sampling technique was employed, using the intact classes rather than randomly assigning individual learners to treatment conditions. This method was appropriate for a classroom-based pilot implementation of the intervention in a quasi-experimental design, as random assignment of individual learners was not feasible within the established school structure. Working with intact classes enabled the researchers to execute the intervention while preserving the natural instructional environment.

Participation in the study was voluntary. Before data collection, learners were briefed on the research goals and procedures. Informed consent was obtained from parents or legal guardians, and written assent was secured from the participating learners before their inclusion in the study.

Research Instruments

The primary quantitative instrument was a researcher-developed 40-item multiple-choice test designed to measure the inductive reasoning performance of Grade 7 learners in a unit on renewable and nonrenewable energy sources. The same items used in the instrument were administered but shuffled in the pre-test and post-test to avoid bias. Test items were designed to evaluate four key dimensions of inductive reasoning: pattern recognition, resource classification, comparison of similarities and differences, and logical generalization, all aligned with the Department of Education Grade 7 Science curriculum competencies.

To establish face validity and content validity, the test was reviewed by a panel of subject matter experts, including master teachers and science curriculum specialists, who evaluated item clarity, alignment, and content accuracy. Recommendations from the panel were integrated to refine the test items.

Reliability was evaluated by pilot-testing the instrument on a non-participating cohort of Grade 7 learners with similar characteristics. Internal consistency was calculated using the Kuder-Richardson Formula 20 (KR 20), yielding a coefficient value of .82 threshold and confirms instrument reliability.

To gather qualitative data, open-ended learner reflection logs were administered to the experimental group following the intervention. These logs captured qualitative data regarding learners' perceptions, peer interactions, and learning experiences during the implementation of the PCSC approach.

Intervention Procedures

Intervention

The Picture-Concept Sort-Collaboration (PCSC) approach served as the experimental intervention to enhance learners' inductive reasoning performance over two weeks, making up six instructional sessions.

In the experimental group ($n = 30$), learners engaged in structured, small-group collaborative activities using picture cards representing diverse energy resources, including solar, wind, hydropower, coal, petroleum, geothermal, and biomass. To promote inductive discovery, no predefined categories were initially provided. Learners systematically observed, contrasted, and, through peer collaboration, negotiated conceptual groupings and categorized the resources into renewable and non-renewable sources. Each session concluded with learner presentations, followed by a teacher-guided synthesis to resolve misconceptions and reinforce accurate conceptual generalizations.

The control group ($n = 30$) received traditional lecture-based instruction covering the same curriculum through direct teacher delivery, textbook readings, and standard question-and-answer routines. To control for extraneous variables, both groups received identical learning objectives, core content, and instructional time. Immediately following the two-week intervention, the posttest was administered to both groups to measure differences in inductive thinking performance.

Data Gathering

The data collection process commenced with securing administrative approval from the school principal and the science subject teacher. Following institutional approval, informed consent was obtained from the parents or legal guardians, and written assent was secured from the learner participants. Upon obtaining all ethical clearances, the 40-item multiple-choice pretest was administered to both the experimental and control groups to establish baseline inductive reasoning performance regarding renewable and non-renewable energy sources.

After pretesting, the intervention phase was implemented. The experimental group was instructed using the Picture-Concept Sort-Collaboration (PCSC) approach, whereas the control group received traditional lecture-based instruction during regular class sessions. To preserve internal validity, both groups covered identical curriculum content over equal instructional time. At the conclusion of the intervention, the same 40-item test was administered as a posttest to measure performance gains; however, items were shuffled to eliminate bias.

Following posttest administration, qualitative data were gathered from the experimental group via reflection logs to capture learners' perspectives and learning experiences. All test instruments and reflection responses were collected, scored, and tabulated for statistical and thematic analyses. Throughout the study, participant data were kept strictly confidential, anonymized, and stored securely for research purposes only.

Data Analysis

Quantitative data from the pretest and posttest were scored, organized, and analyzed using descriptive and inferential statistical procedures. Descriptive statistics, including mean (M) and standard deviation (SD), were calculated to describe the inductive reasoning performance of both the experimental and control groups. Performance gains, derived from the difference between posttest and pretest scores, were evaluated to measure changes in learner achievement. Because the data violated the assumption of normal distribution, non-parametric tests were employed. The Mann-Whitney U test was conducted to evaluate between-group differences in the pre-test (as baseline) and post-test scores (as performance gains) and the effect size. All statistical tests were evaluated at a .05 level of significance using Jamovi.

Learners' reflection comments about their learning experiences during the intervention were further examined. Braun and Clarke's six-phase reflexive thematic analysis framework guides researchers through a systematic process of qualitative data interpretation, beginning with deep dataset immersion through repeated reading and initial note-taking. Researchers then generate concise initial codes that tag meaningful features across the dataset before synthesizing these codes into broader, candidate themes centered on shared patterns of meaning. These potential themes undergo a rigorous review process against both the extracted codes and the full dataset to ensure coherence and validity across the data map. Finally, the researcher refines each theme by defining its core conceptual boundaries, assigning clear descriptive names, and producing a structured final report that weaves illustrative data excerpts into a compelling analytic narrative. In generating a deeper understanding of how the Picture-Concept Sort-Collaboration approach affected learners' engagement, comprehension, and critical thinking abilities was provided by the qualitative findings, which were utilized to complement and explain the quantitative results (Braun & Clarke, 2021). The thematic analysis that resulted in the generation of themes was validated by the identified experts to secure the accuracy of the findings.

Ethical Considerations

Throughout the study, the researchers made sure that all ethical guidelines were adhered to. The principal of the school and the subject teacher were the first to grant permission to conduct the study. The learners and their parents or guardians gave their informed consent after being fully informed about the study's objectives, its methods, and their voluntary involvement. The learners were told that they could avoid any unfavorable outcomes. In all documents and reports, codes were used in place of learners' names to ensure strict confidentiality and anonymity.

All collected data, including test scores and reflection responses, were kept secure and used only for research purposes. The activities conducted during the intervention were aligned with regular classroom instruction and did not pose any harm to the participants. Both the experimental and control groups were treated fairly by providing the same learning content and equal instructional time.

After the study, the researcher ensured that the control group was also given access to the instructional materials used in the experimental group so that no learner was disadvantaged. Throughout the study, honesty, objectivity, and respect for the participants were strictly reinforced. The researchers disclosed the use of Gemini.ai in the refinement of the figure in the conceptual framework.

RESULTS

Level of inductive thinking performance of Grade 7 learners before and after exposure to the Picture-Concept Sort-Collaboration approach

The results of the study showed that both the traditional and experimental groups improved their performance from pre-test to post-test. For the traditional group, the mean score increased from 20.13 in the pre-test to

25.17 in the post-test, showing a noticeable improvement in learners' understanding of renewable and nonrenewable energy resources. Similarly, the experimental group also showed improvement, with the mean score increasing from 23.70 in the pre-test to 33.43 in the post-test, which reflects a higher level of learning gain compared to the traditional group.

When comparing the two groups, although the experimental group started with a slightly higher pre-test mean, their post-test mean increased more significantly than that of the traditional group. This suggests that the learners exposed to the Picture-concept Sort Collaboration Approach showed greater improvement in their inductive thinking skills.

Furthermore, the analysis of gain scores using the Mann-Whitney U test revealed a statistically significant difference between the two groups ($U=131.000$, $p<0.05$). This shows that the improvement saw in the experimental group was significantly higher than that of the traditional group.

Overall, the results suggest that while both teaching methods contributed to learners' learning, the Picture-Concept Sort-Collaboration Approach was more effective in enhancing learners' performance and developing their inductive thinking skills.

Table 1: Descriptive Statistics of Pretest and Posttest Scores

Group	Assess	N	Mean	Std. Deviation
Control	Pretest	30	20.13	5.78
Experimental	Pretest	30	23.70	3.31
Control	Posttest	30	25.17	5.36
Experimental	Posttest	30	33.43	3.94

Table 1 shows that both groups improved from pre-test to post-test. However, the experimental group obtained a higher mean gain compared to the traditional group, showing greater improvement in performance. The lower standard deviation in the experimental group also suggests more consistent scores among learners. Overall, the results show that the Picture-Concept Sort-Collaboration approach led to better and more consistent learning outcomes.

Significant difference in the inductive thinking performance of Grade 7 learners before and after exposure to the PCSC approach and lecture-based method

Since the study used non-equivalent groups and assumed a non-normal distribution, the Mann-Whitney U Test was used. The two groups were comparable before the intervention, as seen by the pre-test results, which reveal no significant change between them ($p=0.226$). The experimental group received a higher mean rank, according to the post-test data, which show a significant difference ($p=0.000$).

The effect sizes suggest meaningful data comparison. In the pre-test comparison, the effect size ($d = 0.999$) indicates that the no significant difference is due to comparable performance between the two groups before the implementation of the intervention. While the effect size between post-test comparisons ($d = 0.496$) indicates a moderate effect size. The difference can be attributed to the improvement of learners inductive reasoning skills performance is due to the effect of the intervention even at a small intact group of participants of the study.

Table 2: Mann-Whitney U Test for Pretest Scores

Assess	Mann-Whitney U	Z	p-value	Decision	Effect Size
Pretest x Pretest	370.500	-1.21	0.226	Not significant	0.999
Posttest x Posttest	21.000	-6.85	0.000	Significant	0.496

The pretest scores did not change significantly ($p>0.05$). Posttest results, however, showed a substantial difference ($p<0.05$) in favor of the experimental group.

This suggests that the Picture-Concept Sort-Collaborative Approach was more successful than the conventional approach because the experimental group fared noticeably better following the intervention.

Learning experiences gained by the learners exposed to the Picture-Concept Sort-Collaborative approach.

Table 3: Main Themes from Learners' Learning Experiences of the PCSC approach

Main Themes	Description	Learner Response
Active Engagement	Learners became more involved and took part during the activity. The activity is fun and interesting.	"I enjoyed sorting the pictures because it made me active in class." "The activity was fun and not boring like usual lectures."
Improved Inductive Thinking Performance	The strategy through the activity helped learners improve their ability to classify and analyze concepts.	"I understood the topic more because I could see and group the ideas." "It helped me think and identify the correct groups."
Collaboration	Learners learned to collaborate with their classmates and share ideas	"We worked together and helped each other understand the lesson."

The themes show that learners perceived the Picture-Concept Sort Collaboration approach as engaging and supportive. Peer discussion helped clarify concepts, encouraged participation, and boosted learners' confidence in expressing their ideas.

DISCUSSION

The significant difference in the comparison of the posttests between the experimental group and the control group suggests that PCSC is effective in improving the inductive thinking performance of learners in classifying energy sources among learners at a pilot-tested rural high school where teaching resources are limited. These findings are also supported by learners' reflections on their learning experiences. Learners' reflections said that the Picture-Concept Sort-Collaborative Approach produced a more dynamic and interesting learning environment for them. Furthermore, they reported that they were more engaged in the session, which improved their comprehension of the material (Al-Barakat & Alali, 2024). Since learners learn better and faster if they can organize and visualize knowledge through the use of visuals (Al-Barakat & Alali, 2024; Bismala et al., 2024), captured their attention, and stimulate creative thinking (Perry, 2006), which made it simpler for them to categorize and evaluate concepts. According to Vo and Csapó (2020), inductive reasoning strategies can improve learners' thinking skills.

Thus, through the PCSC approach, learners could exchange ideas and gain knowledge from one another, and this is called teamwork which significantly improved learning (Perry, 2006). When learners are allowed to collaborate, their comprehension of the lessons is enhanced and strengthen their collaboration and communication abilities. This is supported by the learners' statement saying that the PCSC approach boosted their drive and enthusiasm for studying.

Overall, the qualitative results support the quantitative findings, proving that the Picture-Concept Sort-Collaboration Approach is a successful method for enhancing learners' educational experiences and capacity for inductive thinking.

CONCLUSION

Quantitative analysis revealed no baseline differences between the groups on the pre-test but proved a statistically significant higher performance in the experimental group on the post-test. These findings show that the Picture-Concept Sort-Collaboration (PCSC) approach enhances learners' inductive reasoning and overall academic performance compared to traditional lecture methods. Qualitative results corroborated the empirical data; participant feedback highlighted elevated classroom active engagement, improve performance, and stronger inductive reasoning skills driven by visual sorting and collaborative interaction. Consequently, integrating this approach into instructional practice serves as an effective pedagogical strategy to cultivate active, meaningful learner learning experience.

RECOMMENDATIONS

The following recommendations are put forward:

- Integrate the Picture-Concept Sort-Collaboration Approach into routine lesson plans, particularly for complex or abstract science topics, to enhance learner engagement, conceptual mastery, and academic performance.
- Support learner-centered instruction by providing teachers with professional development, pedagogical resources, and structural support to implement interactive and collaborative strategies.
- Actively participate in peer-based cooperative learning activities to cultivate critical thinking, communication skills, and collaborative problem-solving.
- Conduct longitudinal studies with larger sample sizes across diverse subject areas to validate these findings and examine secondary variables, such as long-term retention, motivation, and learning attitudes.
- Adopt low-cost, high-impact strategies like picture-sorting to improve educational equity, learner engagement, and subject comprehension in rural or under-resourced settings.

REFERENCES

1. Al-Barakat, A. & Alali, R. (2024). The Impact of Pictures-Based Activities in Enhancing Reading Comprehension Skills Among Young Children. *XLinguae*. 17. 176-194. 10.18355/XL.2024.17.04.11.
2. Adebola, O.O. (2024). Challenges and opportunities in rural science education: Implications for teaching and learning. *Journal of Rural Education and Development*,9(2),45-60.
3. Basister, M.P., Petersson, J., & Baconguis, R.D.T (2025). Educational innovations for an inclusive learning environment: Insights from teachers' collaboration through lesson study. *Frontiers in Education*, 10,1610749. <https://doi.org/10.3389/feduc.2025.1610749>
4. Basmala, Kaharuddin, & Suardi (2024). The Impact of the Picture and Picture Learning Model on Learner Activity and Social Studies Outcomes (A Case Study of 4th Grade Learners in Gowa District). *Jurnal Stud Guru dan Pembelajaran*, Vol. 7, No. 3, September – December 2024 <https://doi.org/10.30605/jsdp.7.3.2024.48171383>
5. Billing, H. (2013). Effect of Inductive Thinking Model on Achievement Motivation of Learners in Relation to their Learning Approach. *International Journal of Education and Psychological Research (IJEPR)* ISSN: 2279-0179 Volume 2, Issue 4, pp: 49-59. https://www.researchgate.net/profile/Harneet-Billing/publication/364806110_Effect_of_Inductive_Thinking_Model_on_Achievement_Motivation_of_Learners_in_Relation_to_their_Learning_Approach/links/635a9b3312cbac6a3e00026c/Effect-of-Inductive-Thinking-Model-on-Achievement-Motivation-of-Learners-in-Relation-to-their-Learning-Approach.pdf
6. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
7. Braun, V., & Clarke, V. (2021). *Thematic Analysis: A Practical Guide*. SAGE Publications.
8. Chen, F., & Chen, G. (2025). Technology-enhanced collaborative inquiry in K-12 classrooms: A systematic review of empirical studies. *Science & Education*,34,1731-1773.
9. Jalop, A.J.B., & Paglinawan, J.L. (2025). The role of collaborative learning environments in digital pedagogies of experienced teachers. *International Journal of Research and Innovation in Social*

- Science,9(4),6991-7008. <https://doi.org/10.47772/IJRISS.2025.90400515>
10. Lagare, K.O.B., & Paglinawan, J.L. (2024). Collaborative teaching practices and technology mindset on learners' critical thinking abilities. *International Journal of Research and Innovation in Social Science*, 8(12),595-608. <https://doi.org/10.47772/IJRISS.2024.8120047>
11. Li, L., Huang, C.-W., Morgan, C., Luttgen, K., Chow, E., & Yang, S. (2025). Empowering rural learners through computational thinking and real-world STEM applications. *Frontiers in Education*,9,1452470. <https://doi.org/10.3389/feduc.2024.1452470>
12. Outlaw, J.K., & Grifenhagen, J.F. (2024). Theorizing digital dialogic comprehension pedagogy with rural primary teachers: A relational praxis of knowledge, space, and time. *Journal of Literacy Research*,73(1). <https://doi.org/10.1177/23813377241289994>
13. Perry, B. (2006). Using photographic images as an interactive online teaching strategy. *The Internet and Higher Education*, Volume 9, Issue 3, Pages 229-240, SSN 1096-7516. <https://doi.org/10.1016/j.iheduc.2006.06.008>.
14. Hasni, A., & Riopel, M. (2024). Empowering professional learning communities of secondary science teachers to address learners' misconceptions. *Frontiers in Education*,9,1419714. <https://doi.org/10.3389/feduc.2024.1419714>
15. Ramirez-Montoya, M.S., & Rozo-Garcia, H. (2025). Technologies and strategies in collaborative online international learning: A systematic literature mapping. *Smart Learning Environments*,12,63. <https://doi.org/10.1186/s40561-025-00409-x>
16. Ragudo, J.M.G (2024). Logical thinking skills and problem-solving skills of STEM learners: Basis for instructional improvement. *International Journal of Research Studies in Education*,13(6),1-14.
17. Susanto, I. (2020). Pengaruh model pembelajaran berpikir induktif terhadap hasil belajar siswa kelas X sma Parulian One Medan. This study aims to determine the effect of the Inductive Thinking Learning Model on learner learning outcomes in the material Magnitude and Measurement in Class 3, 1–7.
18. Taba, H. (1967). *Teacher's handbook for elementary social studies*. Reading, MA: Addison-Wesley.
19. Tóth, P.; Horváth, K.; & Kéri, K. (2021). Development Level of Engineering Learners' Inductive Thinking. *Acta Polytechnica Hungarica* Vol. 18, No. 5, 107.https://acta.uni-obuda.hu/Toth_Horvath_Keri_112.pdf
20. Vo, D.V.; & Csapó, B. (2020). Development of inductive reasoning in learners across school grade levels, *Thinking Skills and Creativity*, Volume 37, 100699, ISSN 1871-1871. ScienceDirect. <https://doi.org/10.1016/j.tsc.2020.100699>.