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Study Packet: Photo-Based Problem-Solving Worksheets in Force, Motion, and Energy

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Abstract. *Persistent difficulties in translating Physics concepts into systematic problem-solving steps continue to hinder junior high school learners' performance. This study examined the effectiveness of a photo-based, visually scaffolded study packet in improving Grade 9 students' understanding of force, motion, and energy. A quasi-experimental design was employed involving two comparable intact classes assigned to control and experimental conditions. Pretest analysis confirmed no statistically significant difference between groups, $t(50) = 0.95$, $p = .35$, indicating baseline equivalence. Following a four-week implementation of the instructional strategy, the experimental group demonstrated a significant improvement from pretest ($M = 9.69$, $SD = 3.00$) to posttest ($M = 16.85$, $SD = 2.44$), $t(25) = -9.42$, $p < .001$, with a very large effect size (Cohen's $d = 2.62$). The control group, in contrast, attained a posttest mean of 12.04 ($SD = 2.85$). Between-group comparison further revealed a statistically significant difference in posttest performance favoring the experimental group, $t(50) = -6.53$, $p < .001$, with a very large effect size ($d = 1.81$). Qualitative findings indicated that learners perceived the photo-based visuals, real-life contexts, and structured solution guides as instrumental in reducing abstraction and enhancing problem-solving confidence. Overall, the results demonstrate that contextualized, visually supported worksheets significantly improve conceptual understanding and problem-solving proficiency in Physics. The findings highlight the value of low-cost, teacher-developed instructional materials in strengthening science learning outcomes, particularly in resource-limited settings, and contribute to efforts aligned with Sustainable Development Goal 4 (Quality Education).*

Keywords: *Photo-based worksheets; physics education; problem-solving skills; quasi-experimental design; visual scaffolding*

A. Introduction

Physics remains one of the most challenging subjects in the secondary curriculum due to the abstract nature of its concepts and the mathematical reasoning required to apply them. In many classrooms, learners can recall definitions or identify known quantities in a problem, yet struggle to determine which principle, equation, or process is appropriate for solving tasks related to force, motion, and energy. This difficulty is well-documented: high school students often recognize problem elements but fail to execute the necessary steps to arrive at a solution, largely due to challenges in distinguishing equations and interpreting symbolic representations (Qotrunnada, 2022). Learners also find it difficult to visualize abstract ideas, which contributes to poor problem-solving performance in Physics topics that require conceptual–mathematical translation (Badmus & Jita, 2024).

These issues are reflected at the national level, as shown by the Philippines' performance in PISA 2022. Filipino learners scored significantly below the OECD average, with the majority demonstrating only basic proficiency in identifying scientific explanations—equivalent to a learning lag of five to six years (OECD, 2023). Such persistent underperformance suggests deeper gaps in scientific reasoning, numeracy, and the ability to interpret real-world phenomena through scientific principles. Local classroom observations at the junior high school level echo these findings, in which teachers commonly note students' hesitation to analyze multi-step Physics problems, despite students' familiarity with the everyday contexts embedded in these tasks. Research affirms that students frequently struggle to identify key relationships, organize problem components, and reason systematically through solution steps (Franestian et al., 2020).

Literature underscores the need for instructional materials that help learners visualize concepts and reduce cognitive demands in problem-solving. Cognitive Load Theory posits that learning improves when instructional materials are designed to reduce extraneous cognitive load and support efficient processing within learners' limited working memory capacity (Sweller, Ayres, & Kalyuga, 2011). Similarly, the Cognitive Theory of Multimedia Learning emphasizes that students learn more deeply when verbal explanations are paired with relevant visuals (Mayer, 2024). Studies confirm that worksheets enriched with photographs, diagrams, or real-life scenarios enhance comprehension and engagement by helping learners connect abstract Physics concepts with concrete experiences (Anggraeni et al., 2021; Wicaksono et al., 2023). Despite these benefits, many teacher-made modules remain text-heavy and offer limited visual scaffolding, leaving a gap in accessible, context-rich resources tailored to junior high school Physics.

Addressing these challenges aligns with Sustainable Development Goal 4, which calls for equitable access to quality learning opportunities supported by inclusive and engaging instructional resources (Adipat & Chotikapanich, 2022). In response, the researchers developed the Study Packet: Photo-Based Problem-Solving Worksheets for Grade 9 Physics. Anchored on the 7E Instructional Model, the packet integrates real-life photographs, guided examples, and structured problem-solving activities intended to make abstract concepts more accessible and to scaffold learners through systematic reasoning. Through its contextualized and visually rich design, the study packet aims to strengthen learners' conceptual understanding while encouraging independent analysis and meaningful engagement with Physics problems.

This study examined the effectiveness of the photo-based study packet in improving Grade 9 learners' problem-solving performance and explored their perceptions of the material. By employing both quantitative and qualitative methods, the research provides evidence on how contextualized, visually supported learning tools can enhance comprehension, engagement, and problem-solving proficiency in secondary Science classrooms.

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B. Methodology

This study utilized a quasi-experimental design with pre-test and post-test assessments to determine the effectiveness of the Study Packet: Photo-Based Problem-Solving Worksheets in improving Grade 9 learners' performance in Physics. Quasi-experimental designs are appropriate for school-based research in which intact classes must be used, and random assignment is not feasible (Thomas, 2024). To complement the quantitative findings, qualitative data were gathered through semi-structured interviews, following recommendations to integrate qualitative insights for deeper contextual interpretation of instructional interventions (Oranga & Matere, 2023).

Two intact Grade 9 sections from a public secondary school in Candaba, Pampanga, were selected through purposive sampling. This sampling approach is suitable when groups must meet predetermined criteria, such as comparable academic performance and similar learning environments (Nikolopoulou, 2022). Each class consisted of 26 learners. One section served as the experimental group, while the other functioned as the control group. Approval to conduct the study was granted by the school principal, and informed consent was obtained from parents and learners prior to data collection.

The instructional strategy consisted of implementing the Study Packet: Photo-Based Problem-Solving Worksheets in the experimental group for four weeks. The material was designed following the 7E Instructional Model, which emphasizes sequential engagement, exploration, and conceptual consolidation to promote deeper learning. The packet incorporated real-life photographs, guided examples, and structured problem-solving tasks. Visual and contextual scaffolds were intentionally embedded in the material, consistent with research demonstrating that image-supported and context-rich learning resources improve students' comprehension and problem-solving ability in Physics (Anggraeni et al., 2021; Wicaksono et al., 2023). Excerpts from the study packet are presented in Figure 1 to illustrate the photo-based design and problem-solving scaffolds used in the strategy.

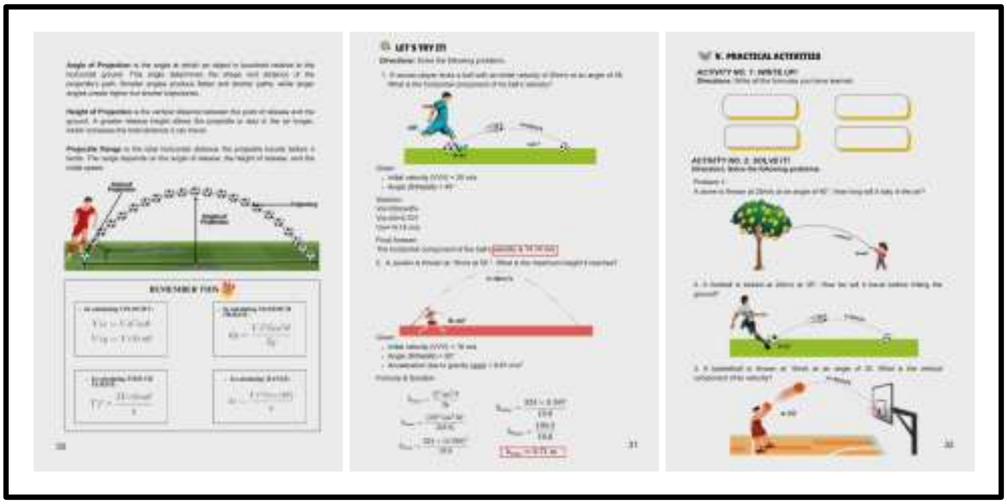

Figure 1. Selected Excerpts from the Photo-Based Study Packet

The packet was reviewed by a Physics teacher, a science coordinator, and an instructional materials specialist, who assessed the accuracy of concepts, clarity of instructions, appropriateness of visuals, and overall alignment with curriculum competencies. Refinements were made in response to their feedback. A cooperating teacher monitored the implementation to ensure fidelity in pacing and instructional flow. Meanwhile, the control group received traditional instruction consisting of teacher-led explanations and textbook-based activities.

To ensure consistency in implementation and minimize instructional bias, both the experimental and control groups were taught by the same cooperating teacher and followed the same class schedule and instructional time allotment throughout the four-week period. Core lesson objectives, content coverage, and problem sets were aligned across groups, with the primary difference being the use of the photo-based study packet in the experimental group and textbook-based materials in the control group. The teacher followed a standardized lesson flow to maintain consistency in pacing and instructional delivery. Implementation was monitored through regular coordination with the cooperating teacher and periodic classroom observations to ensure adherence to the planned procedures.

A teacher-developed 30-item test was used as both a pre-test and a post-test to assess learners' understanding of force, motion, and energy. The instrument underwent content validation by three subject-matter experts, who assessed its clarity, relevance, and alignment with Grade 9 Science competencies. Consistent with established practices for test development, the instrument was pilot tested with another class of 30 learners, and item analysis was conducted to refine difficulty and discrimination indices (Pascual, 2024).

Semi-structured interview questions were prepared and validated to gather qualitative feedback from selected learners in the experimental group regarding their experiences with the instructional strategy. Content analysis was used to code and categorize responses into themes, following established procedures for qualitative interpretation (Columbia University, 2023).

Before performing inferential analyses, the normality of pre-test and post-test distributions was assessed using the Kolmogorov–Smirnov test. Since the data met parametric assumptions, paired samples t-tests were used to assess significant changes within the experimental group, while independent samples t-tests were used to compare post-test results between the control and experimental groups. Descriptive statistics, including mean, standard deviation, and frequency distribution, were used to summarize learners' performance levels.

Ethical standards were strictly observed throughout the study. Participation was voluntary, and learners were assured of confidentiality and the right to withdraw at any point. Parental consent and school approval were secured prior to implementation, and all data collected were used solely for research purposes and handled in accordance with data privacy guidelines.

C. Results and Discussion

1. Result

Table 1
Learners' Scores in the Pre-Test of the Control and Experimental Groups

	Control Group		Experimental Group	
Range	**Frequency**	**Percentage**	**Frequency**	**Percentage**
25-30	0	0	0	0
19-24	0	0	0	0
13-18	4	15.38	7	26.92
7-12	21	80.77	14	53.85
0-6	1	3.85	5	19.23
Standard Deviation	2.55		3.00	
Mean	10.42		9.69	
Interpretation	Fairly Satisfactory		Fairly Satisfactory	

Outstanding (25-30) Very Satisfactory (19-24) Satisfactory (13-18) Fairly Satisfactory (7-12) Did Not Meet Expectations (0-6)

As shown in Table 1, both groups demonstrated comparable performance levels prior to the implementation of the strategy. The control group attained a mean score of 10.42 (*SD* = 2.55), while the experimental group obtained a slightly lower mean of 9.69 (*SD* = 3.00). Both means fall within the "*Fairly Satisfactory*" range, indicating that both groups were struggling with problem-solving tasks at baseline.

Frequencies also show that more than half of the students in the experimental group and more than 80% of the students in the control group scored in this range. Only a small number of students dropped into the "*Did Not Meet Expectations*" category. No students reached the "*Satisfactory*" or higher performance levels.

Table 2
Test of Difference Between the Pre-test Scores

	Mean	*SD*	*t(50)*	*p*	Decision	Remarks
Control Group	10.42	2.55	0.95	0.35	Fail to reject H_0	NS
Experimental Group	9.69	3.00				

Note. *The level of significance was set at a = .05 (two-tailed). Results were considered statistically significant when p < .05.*

The independent samples t-test indicates that the pre-test scores were not statistically different between the two groups ($t(50) = 0.95$, $p = .35$; Table 2). These results clearly depict that the two groups had a similar performance before implementation of the strategy.

The similarity in pre-test means and variability between groups further supports baseline equivalence, strengthening internal validity and increasing confidence that subsequent differences may be attributed to the instructional strategy rather than pre-existing academic disparities.

Table 3
Post-Test Results of Control and Experimental Group

	Control Group		Experimental Group	
Range	**Frequency**	**Percentage**	**Frequency**	**Percentage**
25-30	0	0	0	0
19-24	1	3.85	6	23.08
13-18	7	26.92	20	76.92
7-12	18	69.23	0	0
0-6	0	0	0	0
Standard Deviation	2.85		2.44	
Mean	12.04		16.85	
Interpretation	Fairly Satisfactory		Satisfactory	

Outstanding (25-30) Very Satisfactory (19-24) Satisfactory (13-18) Fairly Satisfactory (7-12) Did Not Meet Expectations (0-6)

After the implementation of the instructional strategy, the experimental group demonstrated a significant improvement compared to the control group. As shown in Table 3, the control group achieved a post-test mean of 12.04 (*SD* = 2.85), which falls under "*Fairly Satisfactory*" indicating a slight improvement from their pre-test results. Moreover, the experimental group attained a mean score of 16.85 (*SD* = 2.44), which is classified as "*Satisfactory*" performance. The increase of more than seven points reflects a notable difference in post-test performance between groups.

This improvement is further reflected in the overall distribution of scores, where learners in the experimental group shifted toward higher performance categories, while the majority of the control group remained within the "Fairly Satisfactory" range. Such movement indicates a broader elevation in student achievement within the experimental group.

Table 4
Test of Difference on the Pre- and Post-test of the Experimental Group

	Mean	*SD*	*t(25)*	*p*	Decision	Remarks
Pre-test	9.69	3.00	-9.42	<0.001	Reject $\boldsymbol{H_o}$	Significant
Post-test	16.85	2.44				

Note. *The level of significance was set at a = .05 (two-tailed). Results were considered statistically significant when p < .05.*

A paired-samples t-test was used to compare the experimental group's performance before and after exposure to the study packet (Table 4). The results showed a significant difference between the pre-test (*M* = 9.69, *SD* = 3.00) and post-test (*M* = 16.85, *SD* = 2.44). The mean difference was 7.16 points, with $t(25) = -9.42$, $p < .001$. The results indicate an improvement in performance from "Fairly Satisfactory" to "Satisfactory". The magnitude of the difference suggests that the observed change was substantial.

To evaluate the magnitude of this improvement, Cohen's *d* was computed using the pooled standard deviation. The resulting effect size of *d*

= 2.62 represents a large effect, suggesting that the learning gains were not only statistically significant but also highly meaningful in practical terms.

Table 5

Test of Difference Between the Post-test Scores

	N	Mean	*SD*	*t(50)*	*p*	Decision	Remarks
Control Group	26	12.04	2.85	-6.53	<0.001	Reject H_o	Significant
Experimental Group	26	16.85	2.44				

Note. *The level of significance was set at a = .05 (two-tailed). Results were considered statistically significant when p < .05.*

An independent samples *t*-test revealed a significant difference in post-test scores between the experimental group (*M* = 16.85, *SD* = 2.44) and the control group (*M* = 12.04, *SD* = 2.85), *t(50)* = −6.53, *p* < .001 (Table 5). The experimental group obtained significantly higher post-test scores than the control group.

Cohen's *d* was also computed to determine the practical significance of this difference. The resulting value of *d* = 1.81 indicates a very large effect, indicating that the difference between groups was substantial. This finding highlights the practical significance of the observed post-test score differences.

Table 6

Insights of Learners on the Study Packet

Code / Meaning Unit	Selected Student Comments
Helpful Pictures	"*The pictures helped me better understand the lessons and made problem-solving easier"* (respondent no. 10).
Clear Formulas	"*The formulas showed me exactly what to do, making it easier to solve problems"* (respondent no. 17).
Real-Life Scenarios	"*It's enjoyable to apply the activities in real life, such as throwing a ball"* (respondent no. 15).
Engaging Design	"*The content is colorful, making it fun to answer questions"* (respondent no. 20).

Sufficient Samples	*"There were quite a lot of problem-solving tasks, but there were also many pictures, which made it somewhat easier"* (respondent no. 25).

The study's qualitative phase generated insightful information about how students used the study packet. Five recurring codes were identified through content analysis of interview responses (Table 6): helpful pictures, clear formulas, real-life scenarios, engaging design, and sufficient practice problems. Students often highlighted how pictures help explain abstract ideas, claiming that they made lessons simpler to understand. Students were able to relate concepts to their everyday lives through real-world scenarios, such as throwing a ball in projectile motion, which was described as entertaining and relatable.

Several students praised the packet's clean and colorful design, describing it as inspiring and interesting. They also stressed how formulas were easy to understand and offered structured direction when solving problems. However, a few respondents said that the number of practice problems could sometimes feel overwhelming, even though the supportive visuals made the tasks easier.

2. Discussion

Improvement in Problem-Solving Performance

The results of this study indicate that the photo-based problem-solving study packet has improved learners' ability to solve Physics problems, enhancing their academic achievement in science. The performance of the experimental group shows substantial progress, as evidenced by the pre- and post-tests, clearly exceeding the control group's test results. This suggests effectiveness in helping learners with their Physics problem-solving activities, consistent with earlier studies that highlight the persistent difficulties of Filipino learners in applying scientific reasoning (Bernardo et al., 2023; Cabural, 2024).

The findings highlighted in this study align with the 7E Instructional Model, allowing for flexibility in engagement and exploration. Moreover, the study packet was guided by constructivist learning principles, emphasizing self-directed learning and meaningful interactions, which aligned well with the purpose of this study: building effective problem-solving strategies rather than relying on textbooks. Franestian et al. (2020) also observed comparable outcomes, thereby demonstrating that the use of systematic scaffolding significantly improved middle school students' problem identification and solving.

The substantial effect sizes provide strong support for the study packet's impact, demonstrating that the improvement was not merely statistically significant but also meaningful in practical terms. This aligns with the principles of the 7E Instructional Model, in which guided exploration and structured engagement promote deeper understanding and improved problem-solving performance.

Role of Visual and Contextual Learning

The quantitative results were reinforced by qualitative findings, suggesting the importance of illustrations and experiential learning. This is reflected in Dual Coding Theory, which argues that learning deepens when information is processed through both verbal and visual channels (Paivio, as cited in Christiansen, 2022). Making physics concepts less abstract through visual scaffolding demonstrates how visual engagement enhances cognition, as noted by Balas (2024).

The qualitative findings further clarify how visual supports function across specific physics concepts. Learner comments categorized under *"Helpful Pictures"* were most frequently associated with topics involving motion and force, where students reported difficulty visualizing trajectories, directions, and interactions in text-based problems. The inclusion of real-life photographs helped learners form mental representations of these abstract situations, thereby reducing cognitive demands during problem interpretation and solution planning. In addition, responses coded as *"Clear Formulas"* and *"Sufficient Samples"* suggest that guided visual cues supported learners in organizing given information and selecting appropriate equations, particularly in multi-step problems involving energy and motion.

These findings can be further explained through Cognitive Load Theory, which posits that learning is hindered when instructional materials impose unnecessary extraneous cognitive load on learners' limited working memory. In traditional text-based Physics problems, students must simultaneously visualize abstract situations, interpret symbolic representations, and perform mathematical calculations, often overwhelming cognitive resources. The photo-based worksheets mitigated this challenge by providing concrete visual references that served as mental models of physical situations, such as force interactions and motion trajectories. By externalizing key visual information, the photographs reduced the need for learners to mentally construct scenarios from text alone, thereby freeing working memory for equation selection, manipulation, and calculation. This suggests that the instructional value of the photos lies not merely in increased engagement, but in their role in managing extraneous cognitive load during problem-solving.

Furthermore, real-life contexts also played a crucial role in learning, as students enjoyed applying concepts such as analyzing motion in familiar situations. This aligns with Ajani's (2023) findings that experiential learning heightens motivation and strengthens comprehension by embedding abstract knowledge in tangible situations. With these visuals and contextual tasks, the study packet functioned as an interactive learning resource rather than a traditional worksheet.

Learner Engagement and Motivation

Learner engagement was strongly shaped by the aesthetics and organization of instructional materials. Students remarked that the study packet's vivid colors and systematic arrangement heightened both enjoyment and accessibility in problem-solving tasks. This observation reflects the argument of Pals et al. (2023), who maintain that formative assessment must simultaneously monitor skill development and cultivate motivation. Hence, instructional resources that are thoughtfully designed advance cognitive growth while also supporting affective outcomes, underscoring the indispensable role of design in effective teaching practice.

Learners were also able to persist through demanding problem sets because supportive visuals reduced the sense of difficulty. While a number of students expressed concern about the quantity of practice tasks, their overall evaluation of the materials was favorable. Such results suggest that engagement is strengthened when instructional design maintains equilibrium between rigor and accessibility.

The research transcends its immediate results, yielding implications for addressing long-standing concerns in Philippine Science education. As stated by PISA (OECD, 2023), persistent low scores by Filipino learners on global assessments reveal gaps in content knowledge and limitations in analytical and problem-solving skills. The study shows that affordable, locally made study packets can improve learners' performance, highlighting the importance of using visuals and real-life examples in teaching Science.

In schools with limited laboratories and digital tools, photo-based problem-solving packets can be a practical and inclusive option. These materials aim to enhance traditional teaching methods by promoting fairness and quality in education. Additionally, evidence shows that Science learning is more meaningful and engaging when teaching approaches are based on constructivist principles, supported by visuals, and closely connected to real-life experiences.

D. Conclusion

This study examined the effectiveness of a photo-based problem-solving packet in enhancing the performance of Grade 9 students in Science.

Results showed that while both groups began at an equivalent baseline, the experimental group demonstrated significant improvement after using the instructional material, progressing from a "Fairly Satisfactory" to a "Satisfactory" performance level. Between-group comparisons further confirmed that learners exposed to the packet significantly outperformed those taught through conventional instruction. Qualitative findings supported these results, as students expressed that the visuals, real-life contexts, and clear step-by-step formulas made problem-solving more understandable and engaging.

The findings contribute to the growing body of evidence supporting the integration of constructivism, visual, and contextualized strategies in Science education. They highlight that low-cost, teacher-developed instructional materials can produce measurable gains in problem-solving ability, even in resource-limited settings. For practice, Science teachers may consider adopting similar approaches to supplement textbook instruction, particularly in topics where learners struggle with abstraction. For policy, curriculum planners may encourage the development of instructional materials that contextualize content and integrate visual supports, especially in Physics, where Filipino students consistently underperform.

Future research may extend this work by examining long-term retention of learning through delayed posttests administered several weeks after the instructional strategy implementation, testing the strategy across different grade levels, or comparing it with digital alternatives. Employing placebo-controlled designs using worksheets identical in structure but without photographic elements may further clarify the specific contribution of visual scaffolding beyond novelty effects. Studies involving larger and more diverse samples across multiple schools, districts, or regions may also help establish the broader applicability of photo-based problem-solving packets. Finally, future investigations may refine the balance between instructional rigor and learner motivation to sustain engagement without overwhelming students.

This study adds to the limited body of research on the use of contextualized, photo-based problem-solving materials in junior high school Physics. Its demonstrated effectiveness provides evidence that low-cost, visually supported instructional tools can serve as viable alternatives to technology-heavy approaches, especially in resource-constrained contexts.

In conclusion, the study packet proved to be an effective, practical, and student-centered strategy that improved learners' problem-solving skills while fostering engagement. Its success demonstrates that innovative, yet accessible instructional strategies can play a vital role in addressing persistent gaps in science education.

Limitations of the study

This study was limited to two intact classes from a single public secondary school with relatively small group sizes, which may restrict the generalizability of the findings. Although significant results were obtained, the modest sample and non-random assignment limit broader conclusions. Future studies with larger, randomly selected samples across multiple schools are recommended to strengthen external validity.

References

Adipat, S., & Chotikapanich, R. (2022). Sustainable development goal 4: An education goal to achieve equitable quality education. *Academic Journal of Interdisciplinary Studies*, *11*(6), 174. https://doi.org/10.36941/ajis-2022-0159

Ajani, O.A. (2023). Experiential learning approaches in secondary education: Practical applications for student engagement. *National Educational Policy Review*, 32(3), 145–162. https://doi.org/10.5430/jct.v12n4p143

Anggraeni, F. K. A., Maryani, M., & Yuliana, Y. (2021). Physics event photo analysis module based on the STEM approach: An effort to enhance critical thinking. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni, 10*(2), 251–264. https://doi.org/10.24042/jipfalbiruni.v10i2.8626

Badmus, O. T., & Jita, L. C. (2024). Physics difficulty and problem-solving: Exploring the role of mathematics and mathematical symbols. *Interdisciplinary Journal of Education Research,* *6*, 1–14. https://doi.org/10.38140/ijer-2024.vol6.08

Balas, B. (2024). *Practical vision science: Learning through experimentation* (1st ed.). Routledge. https://doi.org/10.4324/9781032691169

Bernardo, A. B. I., Cordel, M. O., Calleja, M. O., Teves, J. M. M., Yap, S. A.,& Chua, U. C. (2023). Profiling low-proficiency science students in the Philippines using machine learning. *Humanities and Social Sciences Communications*, *10*(1), Article 1705. https://doi.org/10.1057/s41599-023

Cabural, A. (2024). Beyond benchmarking: A diagnostic inquiry into the underlying determinants of low performance in Philippine PISA science. *Journal of Tertiary Education and Learning, 2*(3), 46–57. https://doi.org/10.54536/jtel.v2i3.3063

Christiansen, J. (2022). *Building science graphics: An illustrated guide to communicating science through diagrams and visualizations* (1st ed.).*AKPeters/CRC Press*. https://doi.org/10.1201/9781003217817

Columbia University (2023). *Content analysis method and examples.* Mailman School of Public Health. https://www.publichealth.columbia.edu/

Franestian, I. D., Suyanta, N., & Wiyono, A. (2020). Analysis problem solving skills of student in junior high school. *Journal of Physics Conference Series*, *1440*(1), 012089.https://doi.org/10.1088/1742-

6596/1440/1/012089

Mayer, R.E. (2024). The past, present, and future of the cognitive theory of multimedia learning. *Educational Psychology Review 36*(8). https://doi.org/10.1007/s10648-023-09842-1

Nikolopoulou, K. (2022). Purposive Sampling: Definition & Examples. Scribbr.

OECD. (2023). *PISA 2022 Results (Volume II) Learning during – and from – disruption*. OECD Publishing.

Oranga, J., & Matere, A. (2023). Qualitative research: Essence, types and advantages.*OALib*,*10*(12),1–9.https://doi.org/10.4236/oalib.1111001

Pals, F. F., Tolboom, J. L. & Suhre, C. J. (2023). Formative assessment strategies by monitoring science students' problem-solving skill development. *Canadian Journal of Science, Mathematics and Technology Education*,*23*(4),644-663. https://doi.org/10.1007/s42330-023-00296-9

Pascual, M. N. G. (2024). Effectiveness of strategy using scoring scales. *International Journal of Academic and Applied Research, 4*(12), 1–10. http://ijeais.org/wp-content/uploads/2024/4/IJAAR240412.pdf

Qotrunnada, N. A. (2022). Analysis of the difficulties of high school students in improving problem solving ability in physics learning. *International Journal of Current Educational Research*, *1*(1), 84–101.https://doi.org/10.53621/ijocer.v1i1.141

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory*. Springer. https://doi.org/10.1007/978-1-4419-8126-4

Thomas, L. (2024). Quasi-experimental design: Definition, types & examples. Scribbr.

Wicaksono, I., Sutarto, S. H., Hariani, S. A., Siswati, B. H., & Indrawati. (2023). Validity of real picture analysis (RPA)-based student worksheet to improve junior high school students' critical thinking skills. *Journal of Education, Society and Behavioural Science, 36*(10), 102–108. https://doi.org/10.9734/JESBS/2023/v36i101272