DOI: doi.org/10.58797/cser.040102

Designing L-FEA Worksheets for Alternative Energy Physics: A Teacher Needs Analysis to Support Team-Based Project Learning and Design Thinking

Devi Yulianty Surya Atmaja*, Achmad Samsudin, Duden Saepuzaman

Department of Physics Education, University of Education, Jl. Dr. Setiabudhi No. 229, Bandung 40154, Indonesia

*Corresponding Author Email: deviyulianty.0715@upi.edu

Abstract

This study aims to identify physics teachers' needs for developing Physics Worksheets on Alternative Energy (L-FEA) integrated with Team-Based Project Learning and a Design Thinking approach. The study employed a quantitative descriptive research design using a survey approach. Data were collected through an online questionnaire distributed via Google Forms to 40 physics teachers from eight cities/regencies across Java Island using purposive sampling. The adapted questionnaire consisted of eight closed- and open-ended questions. The findings revealed that 68% of the teachers considered the development of Physics Worksheets on Alternative Energy to be very necessary, while 27% considered them necessary for classroom learning. Furthermore, 41% of the teachers expected the worksheets to include systematic experimental activities, and 32% emphasized the importance of contextual tasks related to social and environmental issues. Teachers also recommended incorporating authentic projects, contextual problem-solving, and hands-on activities to foster collaboration, creativity, and critical thinking. The findings provide an empirical foundation for developing L-FEA that aligns with teachers' needs and supports the implementation of Team-Based Project Learning integrated with a Design Thinking approach. The proposed worksheets are expected to facilitate meaningful physics learning while contributing to the development of interdisciplinary STEAM-oriented instructional materials.

Keywords: alternative energy, design thinking, needs analysis , physics worksheets, team-based projects

Received: 19 January 2026
Revised: 20 February 2026
Accepted: 18 March 2026
Published: 3 April 2026
Issued: 30 April 2026

Current Steam and Education Research
e-ISSN: 3025-8529

INTRODUCTION

Physics education at the Senior High School level has a very important role in helping students build mastery of concepts, creative thinking skills, and an understanding of science and critical thinking skills that are important in the future (Khaeruddin et al., 2023; Muhammad et al., 2025; Razak et al., 2022; Rehmat & Hartley, 2020). One of the relevant topics to be developed is Alternative Energy material, because it has a direct connection to current issues and the context of everyday life (Malina et al., 2021; Saeed & Siraj, 2024). Alternative energy is also seen as a solution to reduce dependence on fossil fuels, which are increasingly limited and have an impact. bad for the environment (Zamri et al., 2022).

In line with the National Curriculum's directives that encourage project-based learning, teaching tools are needed that can bridge the gap between curriculum objectives and real-world classroom conditions. One solution is the development of Physics Worksheets for Alternative Energy (L-FEA), designed to support Team-Based Project with a Design Thinking approach. This learning model emphasizes teamwork and systematic problem-solving through the stages of empathy, problem definition, solution design, prototyping, and evaluation (Auernhammer & Roth, 2023; Brown, 2008; Guo et al., 2024).

Team-Based Project learning model encourages students to collaborate in groups to complete projects relevant to the learning topic (Zhang et al., 2024), so that they not only learn conceptually, but also train collaboration, communication, and problem-solving skills (Dias-Oliveira et al., 2024; Iserte et al., 2023; Kumar, 2021; Tramonti et al., 2024). Meanwhile, Design Thinking emphasizes the creation of innovative solutions that center on user needs, which makes this approach very relevant to the topic of alternative energy (Przybilla et al., 2022; Rylander Eklund et al., 2022). This approach is also able to improve students' creative thinking skills (Liu et al., 2024), which are very necessary in facing future challenges such as the energy crisis that requires smarter and more environmentally friendly solutions, for example in research on perovskite solar cells (Sen et al., 2023) and the development of electrocatalysts (Kim et al., 2023). Through learning Team-Based Project with the approach Design Thinking, students are not only required to solve problems, but also to design innovative, applicable, and sustainable solutions. by working in teams. This process encourages them to think creatively and integrate physics concepts to produce solutions.

Although previous studies have demonstrated the effectiveness of Team-Based Project Learning, Design Thinking, and alternative energy learning in improving students' conceptual understanding, creativity, and collaboration, most studies have primarily focused on learning implementation and outcomes. Limited attention has been given to conducting a needs analysis prior to developing integrated physics worksheets that combine Team-Based Project Learning and Design Thinking for alternative energy topics. Furthermore, teachers' perspectives on the characteristics of such worksheets remain underexplored. Therefore, a needs analysis is essential to ensure that the developed worksheets address actual classroom needs and support interdisciplinary STEAM-oriented learning.

https://doi.org/10.58797/cser.040102

However, before developing a Physics Worksheet for Alternative Energy (L-FEA) material, it is important to first conduct a needs analysis as a strategic initial step (Afifulloh & Cahyanto, 2021). This needs analysis aims to identify and understand the gap between ideal conditions and actual learning conditions from the perspective of teachers as implementers in the classroom. Based on this, this study aims to analyze physics teachers' needs for developing Physics Worksheets on Alternative Energy (L-FEA) integrated with Team-Based Project Learning and a Design Thinking approach. The findings are expected to provide an empirical foundation for developing STEAM-oriented instructional materials that support students' conceptual understanding, creativity, collaboration, and authentic problem-solving skills.

METHOD

Research Design

This study employed a quantitative descriptive research design using a survey approach to identify physics teachers' needs for developing Physics Worksheets on Alternative Energy (L-FEA) integrated with Team-Based Project Learning and a Design Thinking approach.

Research Subjects

Participants were selected using a purposive sampling technique because the study specifically targeted physics teachers who were considered capable of providing relevant information regarding the development of Physics Worksheets on Alternative Energy (L-FEA). The questionnaire was distributed online via Google Forms through several WhatsApp communities, including the Guru Belajar Community, Physics Teacher Professional Education (PPG), and Physics Teachers' Subject Teacher Forum (MGMP). A total of 40 physics teachers from eight cities and regencies across Java Island, Indonesia, participated in this study by completing the online questionnaire. The participants represented Sumedang Regency, Subang Regency, Bekasi City, Bekasi Regency, Garut Regency, Tasikmalaya Regency, Pandeglang Regency, and Lebak Regency, as illustrated in Figure 1.

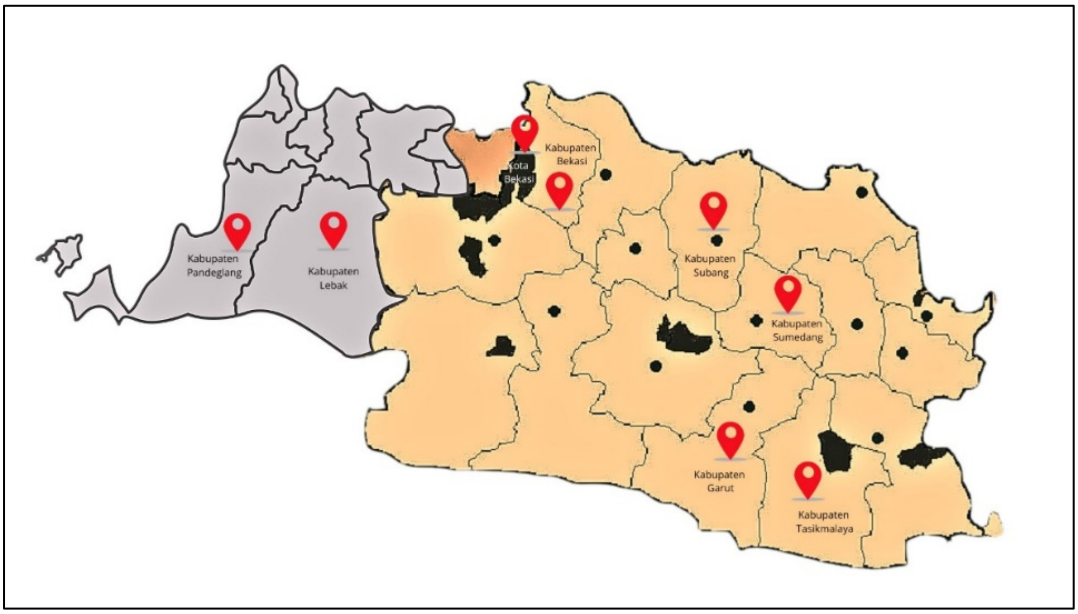

Figure 1. Geographic Distribution of the Participating Physics Teachers

After visualizing the distribution of physics teachers' locations using a map, the teacher data were then classified by gender, education level, and length of teaching. The following presents the teacher data profiles.

Table 1. Teacher Profile

	Frequency	Percentage (%)
Gender		
Woman	25	62.5
Man	15	37.5
Education Level		
S1	26	65
S2	14	35
Length of Teaching "LT" (Years)		
$0 < LT \leq 5$	8	20
$5 < LT \leq 10$	6	15
$10 < LT \leq 15$	6	15
$15 < LT \leq 20$	10	25
$LT > 20$	10	25

Research Instruments

The questionnaire used in this study was adapted from several previous studies on needs analysis and instructional material development (Aulia et al., 2022; Kurnisar et al., 2025; Nikmatin Mabsutsah & Yushardi, 2022). Several items were modified to align with the objectives of this study, which focused on developing Physics Worksheets on Alternative Energy (L-FEA) integrated with

Team-Based Project Learning and a Design Thinking approach. The final questionnaire consisted of eight closed- and open-ended questions. The closed-ended questions explored teachers' perceptions and experiences regarding the use of Physics Worksheets on Alternative Energy (L-FEA), Team-Based Project Learning, and Design Thinking in physics instruction. Meanwhile, the open-ended questions were designed to gather teachers' expectations and suggestions for the development of L-FEA. Specifically, the questionnaire covered the perceived urgency of using Physics Worksheets on Alternative Energy in classroom learning, teachers' expectations for the worksheets, preferred learning activities, teachers' experience and understanding of Team-Based Project Learning, their interest in implementing the model, their familiarity with the Design Thinking approach, and suggestions for developing L-FEA integrated with Team-Based Project Learning and Design Thinking.

The questionnaire was administered online using Google Forms and distributed through several WhatsApp communities. Quantitative data obtained from the closed-ended questions were analyzed descriptively using percentages, while responses to the open-ended questions were summarized to complement the quantitative findings by providing additional insights into teachers' expectations and suggestions. To ensure participants' privacy, no personal identifying information was collected or reported in this study.

Data Analysis Techniques

The quantitative data obtained from the closed-ended questions were analyzed descriptively using percentages to identify teachers' responses to each questionnaire item. The formula used to calculate the percentage results was derived from Rahmawati et al., (2022) as follows:

$$P = \frac{\Sigma x}{\Sigma x_m} x100\% \quad (1)$$

Information :

P = Percentage of Achievement

Σx = Total score obtained

Σx_m = Total possible score

Responses from the open-ended questions were summarized and used to support the interpretation of the quantitative findings by identifying common suggestions and expectations expressed by the participants regarding the development of L-FEA.

RESULTS AND DISCUSSION

The Urgency of Using Physics Student Worksheets on Alternative Energy Material in Classroom Learning

To determine the importance of the role of physics worksheets in alternative energy material, the following are the results of a questionnaire regarding teachers' perceptions regarding the urgency of their use in physics learning in the classroom. The questionnaire results show that the majority of physics teachers consider worksheets for alternative energy material to be very necessary in learning, with 68% of teachers choosing the " Very Necessary " category. In addition, 27% of teachers stated that the worksheets were "Necessary", while 2% chose the "Quite Necessary " category. No teachers chose " Not Necessary at All ". These findings emphasize the importance of developing worksheets as an important learning aid for alternative energy material during classroom learning. Well-designed worksheets can enhance the feasibility, practicality, and effectiveness of classroom instruction by providing structured learning activities that actively engage students in the learning process (Nikmatin Mabsutsah & Yushardi, 2022).

Teachers' Expectations for Physics Student Worksheets on Alternative Energy Material

The following are teachers' expectations regarding the features and content of Physics Worksheets on Alternative Energy (L-FEA) that can support the learning process. The results of a questionnaire involving 40 physics teachers revealed diverse expectations regarding the content of the worksheets. The majority of teachers (41%) expected the worksheets to include clear and systematic procedures that guide students in applying alternative energy concepts through experimental activities. This finding indicates teachers' preference for practical and experiential learning experiences that enable students to construct conceptual understanding through direct engagement. In addition, 32% of the teachers expected the worksheets to include assignments that connect alternative energy topics with social and environmental issues, making learning more contextual and relevant to students' everyday lives. These expectations reflect the importance of integrating authentic contexts into physics instruction to enhance students' awareness and engagement with real-world problems. Furthermore, 15% of the teachers emphasized the need for practice questions that not only strengthen conceptual understanding but also foster students' creative thinking skills in addressing increasingly complex challenges. Meanwhile, approximately 7% highlighted the importance of providing clear and easy-to-understand theoretical explanations as a foundation for learning. These findings are consistent with previous studies reporting that well-developed student worksheets facilitate effective learning by helping students discover and construct knowledge within meaningful contexts in which the concepts are presented (Astiwi & Siswanto, 2024). Therefore, the development of L-FEA should prioritize contextual, inquiry-based, and application-oriented learning activities that enable students to connect physics concepts with real-life situations. Such characteristics are expected to support more meaningful learning while promoting creativity, problem-solving, and the implementation of Team-Based Project Learning integrated with a Design Thinking approach. Moreover, these characteristics are closely aligned with the principles of STEAM education, which emphasize interdisciplinary learning, authentic problem-solving, engineering design, creativity, and collaboration in addressing real-world challenges (Utami et al., 2020).

Types of Activities That Need to be Included in the Alternative Energy Worksheets

The following data demonstrates the types of activities teachers consider important to include in alternative energy worksheets to enhance effective learning. A questionnaire survey of 40 physics teachers revealed preferences for the types of activities that should be included in the worksheets. 33% of teachers proposed case studies that highlight real-world situations related to alternative energy as the primary activity, providing relevant context and strengthening student understanding. Experimental activities directly related to alternative energy concepts also received significant attention from 33% of teachers, who considered practical involvement in experiments essential for enhancing conceptual understanding. Furthermore, 19% of teachers suggested that the worksheets include group discussions as a means of solving problems related to alternative energy, demonstrating the importance of collaboration and communication in learning. Finally, 17% of teachers proposed questions and assignments that not only hone conceptual mastery but also develop students' creative thinking skills. These findings indicate that effective worksheets need to incorporate a variety of contextual, practical, and interactive activities to support the successful learning of alternative energy.

Teacher Experience in Using the Team-Based Project Learning Model

To understand the extent to which the Team-Based Project learning model has been used, the following data is available on teachers' experiences in implementing it. Based on the results of a questionnaire with 40 physics teachers, 55% of them stated that they had used the Team-Based Project learning model in their teaching process. Meanwhile, 45% of the other teachers reported that they had never used the learning model. This data indicates that more than half of the teachers are familiar with and have implemented the team-based project-based learning approach, although almost half have not yet adopted this method in their teaching practices.

The Team-Based Project Learning Model

The following data shows the level of teachers' understanding of the concept and practice of Team-Based Project learning. The questionnaire shows that the majority of physics teachers, namely 83%, understand that in the Team-Based Project learning model, students will carry out various activities such as exploration, collaboration, analysis, synthesis, assessment, problem solving, and produce group work as a form of learning outcomes. Conversely, 18% of teachers stated that they did not fully understand the concept. This finding indicates a fairly high level of understanding among teachers regarding the characteristics of team-based project learning, although there is still a small portion that needs to be improved in their understanding.

Teachers' Interest in Implementing the Team-Based Project Learning Model on Alternative Energy Material

The following data presents data on teachers' interest in adopting the Team-Based Project learning model in teaching alternative energy. The questionnaire results revealed that the vast majority of physics teachers, 95%, were interested in implementing the Team-Based Project learning model in teaching alternative energy. Only 5% of teachers stated they were not interested in using this learning model. This indicates a high level of interest among teachers in using the Team-Based Project learning model on alternative energy materials.

Teachers' Introduction to the Concept of Design Thinking in Learning

The following data indicates the extent to which teachers are familiar with and understand the concept of Design Thinking as applied in their learning. Based on the questionnaire, 70% of physics teachers stated they were familiar with the concept of Design Thinking as applied in their learning. Conversely, 30% of teachers admitted they were unfamiliar with the method. These findings indicate that the majority of teachers are familiar with Design Thinking as a learning approach, although there are still several aspects that need to be explored regarding this concept.

Suggestions for Developing L-FEA in Accordance with the Team-Based Project Learning Model and Design Thinking

The following are suggestions given by 40 teachers for the development of Student Worksheets (L-FEA) that are in accordance with the characteristics of Team-Based Project (TBP) and Design Thinking learning. Teachers emphasized the importance of designing L-FEA to increase students' interest in learning alternative energy topics by engaging them in projects relevant to everyday life. This aims to develop students' creative thinking skills. Experimental activities directly related to alternative energy concepts are also considered important for increasing student engagement in groups, replacing discussions that are limited to passive activities.

Additionally, some teachers suggested that L-FEA include a real-life challenge for students to solve, such as designing an alternative energy system for a remote area. This type of assignment gives students the opportunity to produce output that is not just a report, but also a project that can be applied in a real-life context. It was also suggested that each group focus on a different alternative energy source, allowing team members to share knowledge and gain a deeper understanding of various types of alternative energy.

Teachers also suggested that L-FEA be designed to facilitate students' understanding of alternative energy concepts through activities they can carry out independently, such as simple experiments. This approach aims to not only introduce theory but also provide practical experiences that will enrich students' understanding. To develop higher-order thinking skills, the L-FEA is expected to foster students' science process skills. Students are expected to think critically about the various processes involved in energy formation, recognize alternative energy sources, and understand the interactions of materials and the motion phenomena that produce electrons.

In addition, it is important for students to understand the basics of electron control and distribution, which is an integral part of understanding alternative energy. L-FEA also needs to raise students' awareness of the importance of using alternative energy in everyday life. In-depth contextual learning, as well as the integration of 21st-century technology and skills within L-FEA, will help prepare students for future challenges. Therefore, the developed worksheets should encourage students to think critically and creatively in solving problems related to alternative energy. To be more effective, L-FEA should be equipped with teaching aids that support exploration and analysis, as well as attractive visual designs to increase student motivation.

The use of local case studies relevant to social and environmental issues is also highly recommended to increase the relevance of the material to students' real lives, as well as encourage further exploration of applicable alternative energy sources. By taking these suggestions into account, the development of L-FEA based on the Team-Based Project and Design Thinking approaches is expected to provide maximum benefits, not only in terms of increasing understanding of alternative energy materials but also in developing students' critical and creative thinking skills.

CONCLUSION

The findings also reveal that teachers demonstrate a positive understanding of Team-Based Project Learning and the Design Thinking approach, suggesting that these approaches have strong potential to be integrated into the development of L-FEA. Furthermore, teachers emphasized the importance of incorporating authentic projects, contextual problem-solving, hands-on activities, and collaborative learning experiences, including assigning different alternative energy topics to each group to facilitate knowledge sharing and deeper conceptual understanding. Overall, this needs analysis provides an empirical foundation for developing Physics Worksheets on Alternative Energy (L-FEA) that align with teachers' expectations and current classroom needs. The proposed worksheets are expected to support the implementation of Team-Based Project Learning integrated with a Design Thinking approach while fostering more meaningful and engaging learning experiences. In addition, the findings offer valuable implications for the development of interdisciplinary STEAM-oriented instructional materials that encourage collaboration, creativity, engineering design thinking, and authentic problem-solving in physics education. Future studies are recommended to develop and evaluate the effectiveness of the proposed worksheets in improving students' learning outcomes and higher-order thinking skills.

REFERENCES

Appleton, K. (2007). Elementary science teaching. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 493–535). Lawrence Erlbaum Associates.

Becker, K., & Park, K. (2011). Integrating science, technology, engineering, and mathematics (STEM) education: A meta-analysis. *Journal of STEM Education, 12*(5–6), 23–37.

Bourha, D., Hatzigianni, M., Sidiropoulou, T., & Vitoulis, M. (2026). From blocks to bots: The stem potential of technology-enhanced toys in early childhood education. Behavioral Sciences, 16(1), 161. https://doi.org/10.3390/bs16010161

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Bubiková-Moan, J., Hjetland, H. N., & Wollscheid, S. (2019). ECE teachers' views on play-based learning: A systematic review. *European Early Childhood Education Research Journal, 27*(6), 776–800. https://doi.org/10.1080/1350293X.2019.1678717

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Eshach, H. (2006). *Science literacy in primary schools and pre-schools*. Springer. https://doi.org/10.1007/1-4020-4674-X.

Fleer, M. (2009). Supporting scientific conceptual consciousness or learning in "a roundabout way" in play-based contexts. *International Journal of Science Education, 31*(8), 1069–1089. https://doi.org/10.1080/09500690801953161

Fleer, M. (2021). Conceptual PlayWorlds: The role of imagination in play and learning. *Early Years, 41*(4), 353–364. https://doi.org/10.1080/09575146.2018.1549024.

Gangal, M., Çalık, M., & Ozturk, Y. (2026). Effectiveness of early childhood science activities in promoting scientific literacy: A meta-analysis study. Science & Education, 1–27. https://doi.org/10.1007/s11191-026-00748-2

Junaedi, E., Cahyani, A., & Prastika, L. R. (2023). Analysis of Science Activities at the Early Childhood Level: A Case Study of Teachers' Topics and Challenges in Bandung City and Bandung Regency. *KIDDO: Jurnal Pendidikan Islam Anak Usia Dini*, *4*(1), 1–13.

Kesner Baruch, Y., Mevarech, Z., & Spektor-Levy, O. (2025). Preschoolers" scientific curiosity and inquiry capabilities: An ecological research approach. Journal of Research in Science Teaching, 63(1). https://doi.org/10.1002/tea.70019

Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing Research*, *35*(6), 382–385. https://doi.org/10.1097/00006199-198611000-00017.

Mubarok, H., Hwang, G.-J., & Lin, C.-J. (2025). Incorporating spirituality and art factors into interdisciplinary tasks: Project-based STREAM, STEAM, and STEM approaches. Educational Technology Research and Development, 74(1). https://doi.org/10.1007/s11423-025-10571-1

Nirmala, D., & Fitria, N. (2020). Analisis Kemampuan Guru dalam Mengembangkan Pembelajaran Sains AUD Berbasis Pendekatan Saintifik. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *4*(2), 765–776. https://doi.org/10.31004/obsesi.v4i2.469.

Norris, S. P., Guilbert, S. M., Smith, M. L., Hakimelahi, S., & Phillips, L. M. (2005). A theoretical framework for narrative explanation in science. *Science Education*, *89*(4), 535–563. ***https://doi.org/10.1002/sce.20063***

OECD. (2017). *Starting Strong V: Early Childhood Education Framework.*

Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47–61. **https://doi.org/10.1016/j.edurev.2015.02.003**

Putri, E.C., & Sugito. (2021).Pola Pembelajaran Sains di Prasekolah. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *6*(2), 1062–1074. https://doi.org/10.31004/obsesi.v6i2.1571.

Pramling Samuelsson, I., & Fleer, M. (2008). *Play and learning in early childhood: International perspectives.* Springer.

Roehrig, G. H., Dare, E. A., Ring-Whalen, E., & Wieselmann, J. R. (2021). Understanding coherence and integration in integrated STEM education. *International Journal of STEM Education*, *8*(1), 1–22. https://doi.org/10.1186/s40594-020-00259-7.

Santangelo, T., & Tomlinson, C. A. (2012). Teacher educators' perceptions and use of differentiated instruction practices: An exploratory investigation. *Action in Teacher Education*, *34*(4), 309–327. https://doi.org/10.1080/01626620.2012.717032

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1–22. https://doi.org/10.17763/haer.57.1.j463w79r56455411

Tschannen-Moran, M., & Hoy, A. W. (2001). *Teacher efficacy: Capturing an elusive construct. Review of Educational Research*, *68*(2), 202–248. https://doi.org/10.3102/00346543068002202.

Verma, V., & Babu M, S. (2026). Learning, Unlearning, Relearning Strategies for 21st century learners to tackle the digital learning paradox. Journal of Interdisciplinary Studies in Education, 15(3), 179–210. https://doi.org/10.32674/v2j8aa74

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Worth, K., & Grollman, S. (2003). *Worms, shadows, and whirlpools: Science in the early childhood classroom*. Heinemann.

Yoon, S. A., Shim, J., Cottone, A., Miller, K., & Noushad, N. (2026). making the case to improve teachers' stem-integrated content knowledge: an analysis of teachers' adaptive expertise and impacts on student classroom experiences. International Journal of STEM Education, 13(1). https://doi.org/10.1186/s40594-026-00617-y