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Integrating Learning Media for Language and Literacy Development: Educational Impact and Economic Evaluation of Recycled Paper Production

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Abstract

This study investigates the development and integration of literacy tree learning media as an innovative educational tool for enhancing language and literacy development among elementary school students. The research emphasizes the role of literacy tree learning media in promoting reading, writing, and language comprehension within classroom settings. Alongside its pedagogical benefits, the study includes an economic evaluation of producing the literacy tree learning media using recycled paper, highlighting both its cost-effectiveness and environmental sustainability. The economic assessment covers key factors such as production costs, labor, and material expenses, demonstrating that literacy tree learning media offers a practical, affordable, and sustainable solution for educational institutions. By combining educational

innovation with economic feasibility, this study provides valuable insights for schools seeking to improve literacy and language outcomes while contributing to resource conservation and environmental responsibility.

Keywords: Economic evaluation; Feasibility study; Learning media; Literacy tree; Paper recycling.

Introduction

Language and literacy development are foundational elements in early education, shaping students' abilities to communicate, comprehend, and engage critically with the world around them (Condie & Pomerants, 2020). In primary education, fostering reading and writing skills is essential for academic success and lifelong learning (Eryilmaz et al., 2024). One effective approach to enhancing these skills is the use of learning media, tools, and resources designed to support and enrich the educational process (Peña-Ayala, 2021; Wang, 2024; Farida, 2023). Among these, literacy tree media has emerged as an innovative strategy for promoting literacy and language learning, particularly in elementary school classrooms.

Many reports regarding literacy have been well-documented (Zukmadini et al., 2024; Farokhah et al., 2025; Hendrayanto et al., 2022; Millatina et al., 2022; Mulya et al., 2023; Nugraha, 2023). Literacy tree media refers to a visual and interactive display, often designed in the form of a tree, where students can engage in activities related to reading and writing. This medium serves not only as a decorative classroom element but also as a functional tool that encourages active participation, motivation, and engagement in literacy tasks (Suryawati et al., 2020). Studies have shown that incorporating such media into classroom environments can significantly enhance students' literacy experiences by creating a more interactive and stimulating learning atmosphere (Delgadova, 2015; Condie & Pomerantz, 2020; Meldawati et al., 2023).

Beyond its educational benefits, the production of literacy tree media presents an opportunity to align sustainability with educational practices. In recent years, there has been growing concern over environmental sustainability and resource conservation, particularly concerning paper waste (Fatimah et al., 2020). Integrating recycled paper into the production of literacy tree media not only reduces environmental impact but also provides a cost-effective solution for schools. This approach supports green education initiatives, encouraging both environmental awareness and literacy development among students.

Paper waste generates quite a lot, reaching 10% of the total amount of waste (Pasang et al., 2007; Rajput et al., 2012). This is because the need for paper is still high in Indonesia (Fatimah et al., 2020). To reduce this, a paper recycling process can be carried out (Kuo et al., 2021; Susilawati & Kanowski, 2020). Paper recycling involves processing unused paper into new, reusable paper (Kuo et al., 2021; Lei et al., 2019). Depending on the fiber, this process can be repeated five to seven times. However, if the fibers are too short, the recycling process can no longer be carried out (Raut et al., 2012; Villanueva & Wenzel, 2007). In Indonesia, the results of waste recycling can also be used for learning media, including the creation of literacy trees (Fatimah et al., 2020). Teachers can practice reading and writing activities through the literacy tree before learning begins (Delgadova, 2015). Therefore, the literacy tree from waste recycling can be a profitable medium for schools and their environment to reduce paper waste (Villanueva and Wenzel, 2007; Pivnenko et al., 2015; Rahman et al., 2014; Ahmadi and Al-Khaja, 2001). Research on the use of paper recycling has been widely carried out (Pivnenko et al., 2015; Ervasti et al., 2016). The results of the research on techno-economic analysis are explained in elsewhere (Pathak et al., 2021; Aykut & Terzi, 2020; Krishnamoorthy et al., 2022; Syahrudin et al., 2026; Apriliani et al., 2026; Sesrita et al., 2025; Samsuri et al., 2025; Rachmadhani and Priyono, 2024; Maratussolihah et al., 2022;

Elia et al., 2023). While previous research has explored the technoeconomic feasibility of paper recycling, there is limited research on how recycled materials can be effectively integrated into learning media like literacy trees. Furthermore, few studies assess the economic implications of producing such media in the context of educational settings.

This study aims to examine the educational impact of literacy tree media on language and literacy development in elementary schools while also conducting an economic evaluation of producing these media using recycled paper. The study provides a dual perspective, highlighting both the pedagogical effectiveness and the cost-efficiency of literacy tree media production. By combining educational innovation with sustainable practices, this research contributes to the advancement of resource-efficient teaching tools. It offers practical insights for school administrators, educators, and policymakers seeking to enhance literacy outcomes while promoting environmental responsibility. The research aims to analyze the results of technical and economic analysis of paper waste production used for the manufacture of literacy tree media. The novelty in this study not only illustrates the existence of renewable technology in converting paper waste into value-added products, but it can also provide an overview of the potential economic impact of this research process.

Literature review

Language and literacy development in primary education

Language acquisition and literacy development are central to primary education, forming the basis for students' academic growth and social participation. Literacy encompasses not only the ability to read and write but also the development of critical thinking, comprehension, and communication skills (Delgadova, 2015; Suprayogi et al., 2024). Language skills, including listening, speaking, reading, and writing, are interconnected, and their development during the early years of schooling significantly influences future academic success. Educational researchers emphasize that interactive and engaging learning environments play a critical role in promoting literacy skills (Condie & Pomerantz, 2020). Tools such as learning media help foster student motivation and active participation, which are essential in supporting language learning and literacy acquisition (Daryanes et al., 2023; Ramdani et al., 2024).

Literacy in elementary school can help develop students' language skills because it can attract attention and create an active and fun learning atmosphere (Winarni et al., 2020; Feiyue, 2022; Sinaga et al., 2020; Kurniawan et al., 2024; Matteo, 2025). The elementary school curriculum emphasizes that before learning begins, students can read books for 15 minutes and present the results of the reading to develop children's language skills from an early age (Marmoah & Poerwanti, 2022).

The role of literacy tree media

Literacy Tree Media has emerged as a creative and effective approach to enhancing literacy skills. Designed as a visual representation (typically a tree where students can display their reading achievements, writing tasks, or vocabulary), this medium encourages student engagement in literacy activities. Such interactive tools stimulate interest and provide a sense of ownership over learning, fostering both intrinsic motivation and collaborative learning.

While several studies have highlighted the benefits of interactive media in literacy education, limited research focuses specifically on literacy tree media. However, the concept aligns with broader findings that visual and kinesthetic learning tools enhance students' reading and

writing abilities. These tools not only support cognitive engagement but also create positive emotional connections to learning activities, improving literacy outcomes.

Literacy tree learning media can help increase reading interest in elementary school (Saputri & Wiranti, 2024) because students are invited to be creative and actively develop reading materials according to their imagination in carrying out learning in the classroom.

Sustainable practices in educational media

In addition to its pedagogical value, literacy tree media can contribute to environmental sustainability through the use of recycled materials. Paper waste remains a significant environmental challenge, especially in countries like Indonesia, where it constitutes approximately 10% of total waste (Fatimah et al., 2020; Pasang et al., 2007; Cardoso et al., 2023). Recycling paper into educational media presents an opportunity to reduce waste while fostering green awareness among students.

Studies on paper recycling have primarily focused on its industrial applications and economic feasibility. For instance, developed a circular economy model for recycling paper packaging, highlighting the potential for resource conservation and cost reduction. However, limited attention has been given to applying these practices in the education sector, specifically in the production of learning media such as literacy tree displays.

Economic evaluation of educational tools

Evaluating the economic feasibility of producing educational tools is essential for ensuring their scalability and sustainability. Technoeconomic analyses in other industries (Krishnamoorthy et al., 2022) offer frameworks for assessing production costs, labor requirements, and investment returns. Applying similar models to literacy media production enables schools to balance educational innovation with budgetary constraints.

By integrating recycled paper into the production of literacy tree media, schools can achieve both educational and economic benefits, making the initiative cost-effective and sustainable. This dual focus aligns with Sustainable Development Goals (SDGs) and promotes environmental responsibility within educational settings (Ragadhita et al., 2025; Maryanti et al., 2022).

Synthesis

Existing literature highlights the importance of interactive learning tools for literacy development and the potential of recycling practices for environmental sustainability. However, limited studies have combined these two perspectives, particularly regarding the design, implementation, and economic evaluation of literacy tree media. This study addresses this gap by exploring how literacy tree media, produced using recycled paper, can enhance language and literacy skills while ensuring cost-effectiveness and sustainability.

The process of making paper recycling into literacy trees can be done by remaking paper waste into useful paper. Paper recycling is done through (i) paper collection, (ii) paper sorting, (iii) Enumeration and pulping (Slurry Process), (iv) paper formation, and (v) drying. Furthermore, to produce new paper from waste paper, a dilution process is carried out (dispensing dissolved water to waste paper), grinding (grinding paper that has been soaked in water until it becomes pulp), extraction (mixing vinegar and dyestuff into a pulp mixture), Filtration (filtering pulp using wood molds, drying (drying the printed paper. Thus, it is ready for production. Figure 1 explains the paper recycling production process.

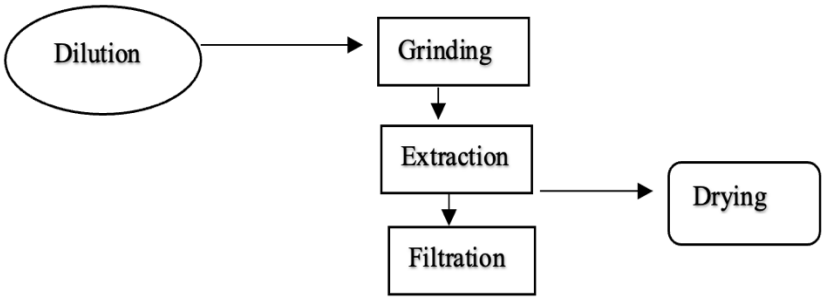

Figure 1. Paper recycling production process.

Method

Research design

This study employed a descriptive research design combining qualitative and quantitative approaches to examine the educational impact of literacy tree media and assess the economic feasibility of its production using recycled paper. The research was conducted in two phases:

- Educational Implementation: Focused on the design, integration, and observation of literacy tree media in elementary school classrooms to evaluate its role in enhancing language and literacy skills.
- Economic Evaluation: Conducted an economic assessment of producing literacy tree media, focusing on cost analysis related to raw materials, labor, and production capacity. Detailed information regarding this analysis is reported elsewhere (Fiandini and Nandiyanto, 2024).

Participants

The study involved elementary school teachers and students in selected primary schools who participated in the implementation of literacy tree media within their classrooms. Teachers provided feedback on the effectiveness of the media in supporting reading and writing activities, while students' engagement and responses were observed throughout the process.

For the economic evaluation, data were gathered from production estimates, including material suppliers and labor cost standards relevant to recycled paper production.

Development of literacy tree media

The literacy tree media was designed using recycled paper materials, following environmentally conscious practices. The process involved:

- Collection of paper waste.
- Paper recycling procedures, including pulping, sheet formation, and drying.
- Design and assembly of literacy tree structures (e.g., tree displays with branches for reading materials, writing tasks, or vocabulary words).

This media was then integrated into classroom activities, supporting reading comprehension, writing exercises, and language enrichment.

Data collection

Educational Impact is in the following:

- Observations: Classroom observations were conducted to assess student engagement with the literacy tree media.
- Teacher feedback: Collected through informal interviews and questionnaires focusing on the perceived effectiveness of the media in enhancing literacy skills.

Economic vvaluation

An economic feasibility analysis was performed to estimate the cost of production for Literacy Tree Media using recycled paper. The analysis included:

- Material Costs: Calculated based on the market price of recycled paper and other materials required for constructing the literacy tree.
- Labor Costs: Estimated using standard wage rates for the production process, including collection, processing, and assembly.
- Production Capacity: Assumed production cycles and quantities over twenty years to evaluate long-term feasibility.

The economic indicators analyzed included:

- Total Production Cost
- Gross Profit Margin
- Break-Even Point (BEP)
- Internal Rate of Return (IRR)
- Net Present Value (NPV).

These indicators provided insights into the cost-effectiveness and financial viability of producing literacy tree media for elementary schools. Data Analysis is in the following:

- Qualitative data (from observations and teacher feedback) were analyzed thematically to identify patterns in student engagement and literacy development.
- Quantitative data (from the economic evaluation) were analyzed using standard financial models to assess profitability and sustainability.

This research method calculates a technoeconomic analysis to obtain information on the feasibility of the paper recycling business into a literacy tree medium. Technoeconomic feasibility analysis includes analysis of raw materials and their price components, production capacity, selection of technological tools, required labor structure, and financial feasibility analysis such as cumulative net value (CNPV), break-even point (BEP), and internal rate of return (IRR).

Results and discussion

Educational impact of literacy tree media

The implementation of literacy tree media in elementary school classrooms led to increased student engagement and improved literacy and language skills. Teachers observed that the interactive display motivated students to participate actively in reading and writing tasks. The literacy tree served as a central visual feature, where students proudly showcased their written work, including vocabulary, summaries, and creative stories.

These observations align with previous research highlighting the benefits of visual learning aids in promoting language comprehension and literacy development (Delgadova, 2015). The interactive nature of the literacy tree fostered collaborative learning and student ownership, contributing to a supportive classroom environment.

Economic Evaluation of Literacy Tree Media Production

The economic feasibility of producing literacy tree media using recycled paper was analyzed based on production assumptions and cost structures over twenty years.

Production process overview

The paper recycling process used to create the literacy tree media involved five main stages:

- Collection and sorting of paper waste
- Pulping through enumeration and slurry processing
- Sheet formation and molding
- Drying of recycled paper
- Assembly into literacy tree media structures

To ensure the analysis of the economic feasibility of paper recycling production as a literacy tree medium, several assumptions are used, namely: analyzing and predicting several possibilities that will occur in the implementation of production. The assumptions used are: (i) all financing uses USD with a value of 1 USD = IDR 15,949, (ii) the composition of the main raw materials for production is paper recycling which is based on the commercial price on the website and commerce which is USD 0.46/kg, (iii) the price of equipment and actual conditions are determined based on the commercial value listed, (iv) The assumption used is that one paper recycling production cycle using a machine takes 8 hours, (v) the assumption of employee costs is USD 13748.31/year with the number of employees as many as 4 people consisting of 1 supervisor, 1 finance person and 2 staff, (vi) the production project lasts for 20 years (Monte et al., 2009). The study results stated that with two workers, it will produce 20kg of paper recycling. So in one year, a total of 4,800 paper recycling will be made with a total production cost of 655,92 USD.

The company will experience losses for one to five years based on the total production calculation. Meanwhile, in the sixth year, the company will start to make a profit, with a curve that increases its profit in the twentieth year. Table 1 shows a curve with economic evaluation parameters under ideal conditions.

Table 1. Production cost assumption factor.

Component	Parameter	Cost (IDR)
Fixed Cost	Loan Interest	0
	Capital Related Cost	68.668.543,74
	Fixed cost+Depresiasi	0
	Depreciation	4.630.859,10
	Fixed Cost less depreciation	0
	Total Fixed Cost	73.299.402,84
Variable Cost	Raw material	26.250.000,00
	Utilities	2.048.000,00
	Operating Labor (OL)	216.000.000,00
	Labor Related Cost	144.720.000,00
	Sales Related Cost	36.960.000,00
	Total Variable Cost	425.978.000,00
	Sales	528.000.000,00

% Estimated	Profit	Manufacturing Cost	494.646.543,74
		Investment	49.636.461,00
		Profit	0,06
BEP		Profit to Sales	0,67
		Unit	4800
		Fixed Cost	73.299.402,84
		Variable cost	425.978.000,00
		Variable cost	0
		Sales	528.000.000,00
		Sales	0
		BEP	3448,639839
		Percent Profit on Sales	0,063169425
		Return on Investment	0,720243383
		Pay Out Time	1,21915034

In economic evaluation, ideal conditions are needed. Thus, they can be used as a benchmark for a project. Figure 2 shows ideal conditions by analyzing the relationship between CNPV/TIC and age (years).

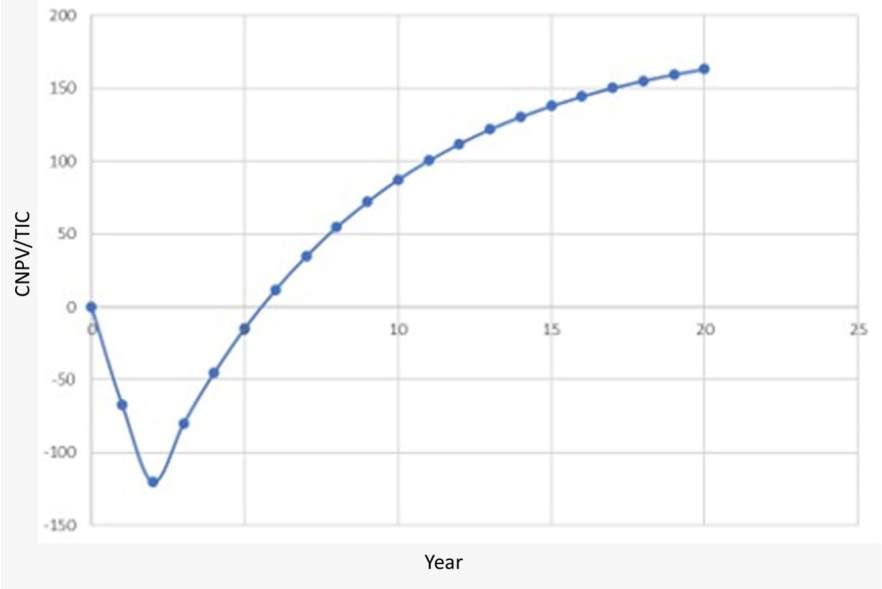

Figure 2. Curve with economic evaluation parameters in ideal conditions.

Discussion

Educational significance of literacy tree media

The integration of literacy tree media into elementary school classrooms demonstrated notable benefits for language acquisition and literacy development. The interactive and visual nature of the media served as a motivational tool, encouraging students to engage more actively in reading and writing activities. Teachers observed improvements in student participation, language comprehension, and writing confidence, aligning with prior studies emphasizing the importance

of interactive learning environments (Delgadova, 2015; Condie & Pomerantz, 2020; Kongsaenkham, 2024).

The literacy tree functioned not only as a display but also as a dynamic learning platform, fostering peer collaboration and ownership of learning tasks. Such engagement is critical in language learning, where social interaction and meaningful contexts enhance literacy outcomes. The findings reinforce the role of learning media in creating stimulating environments that promote critical thinking and communication skills, essential components of language development.

In addition, literacy tree learning media can help improve students' language skills, writing skills, creativity, and cognition because learning is done in an interesting and fun way.

Literacy Tree Media is very effective in increasing reading interest. Thus, it has an impact on the development of students' language skills through innovative, in-depth, fun, and meaningful learning (Saputri & Wiranti, 2024). The use of interactive and contextual learning media can help improve student learning outcomes. Thus, it has an impact on the quality of education following the goals of the fourth SDGs. Thus, a responsive and student-friendly curriculum is needed to help improve students' literacy and language skills to improve the Programme for International Student Assessment (PISA) score.

Economic feasibility and sustainability

In addition to its pedagogical value, the economic evaluation of producing literacy tree media using recycled paper demonstrated that the initiative is financially viable under ideal conditions. The analysis revealed that, despite initial losses in the early years of operation, the project became profitable starting from the sixth year, with sustained positive returns over the twenty-year lifespan.

The return on investment (ROI) of 72.02% and a payback period of approximately 1.22 years indicate that the production model can provide cost-effective educational resources while simultaneously promoting environmental sustainability. The use of recycled paper supports resource conservation, reducing waste disposal and contributing to broader sustainability goals (Fatimah et al., 2020; Kuo et al., 2021). However, the economic viability of the project is sensitive to external economic conditions, such as fluctuations in raw material costs and labor wages. The financial analysis assumes ideal market conditions; therefore, profitability may vary under different economic scenarios. This sensitivity highlights the importance of financial planning and risk assessment for schools or organizations interested in adopting such initiatives.

The results from an engineering point of view confirm that this project is promising. Since the equipment to support the process can come from commercially available devices or equipment, scaling up to 20 kg of recycled paper can be done without problems. Calculating the total production cost per pcs per year of 655,92 USD, resulting in a profit of 33959,32 USD, the paper recycling business can be a project with a large profit impact after five years of production.

Based on the above analysis, projects in ideal conditions are prospective. However, when there is a change in economic circumstances, paper recycling manufacturing projects are only profitable under certain economic conditions. In short, if the project is carried out under circumstances outside certain financial situations, then the project will lose.

After the waste paper is recycled into a suitable paper, the next step is for teachers to turn the paper into a literacy tree to be used in learning activities in Elementary Schools (Condie & Pomerantz, 2020). Literacy trees from waste recycling can be helpful and contribute positively to the environment, education, and school environmental awareness. Among the benefits of making literacy tree media are: (i) can reduce waste, (ii) resource conservation, (iii) education and

awareness, (iv) energy and water savings, and (v) empowering school residents to utilize waste paper (Shackleton et al., 2015; Bus et al., 2015). Thus, the literacy tree from paper recycling helps protect the environment and promotes literacy and awareness among school residents of the importance of paper recycling.

Implications for educational practice

The dual focus of this study—on both educational innovation and economic feasibility—provides practical insights for educators, school administrators, and policymakers. The findings suggest that literacy tree media is not only an effective tool for enhancing language and literacy development, but also a sustainable solution that aligns with environmental education objectives based on SDGs 4 and 13. This adds new information regarding SDGs as reported elsewhere (Nurramadhani et al., 2024; Krishnan et al., 2024; Djirong et al., 2024; Kerans et al., 2024; Makinde et al., 2024; Gemil et al., 2024; Haq et al., 2024).

By integrating recycled materials into educational media, schools can foster environmental awareness among students while maintaining budget-friendly practices. This approach contributes to holistic education, where students learn about literacy, language, and sustainability simultaneously (Delgadova, 2015).

Conclusion

This study highlights the dual value of literacy tree media as both an educational innovation and a sustainable economic initiative. The integration of literacy tree media into elementary school classrooms has proven effective in enhancing language and literacy development, particularly in promoting reading, writing, and language comprehension. The interactive design of the media fosters student engagement, motivation, and collaborative learning, contributing to a more dynamic classroom environment.

In addition to its pedagogical impact, the economic evaluation of producing literacy tree media using recycled paper demonstrates that the project is financially viable under ideal conditions. The analysis showed a positive return on investment, with profitability emerging after the sixth year and sustained over twenty years. This approach not only offers a cost-effective solution for schools but also supports environmental sustainability by reducing paper waste and promoting resource conservation.

However, the project's economic feasibility remains sensitive to market fluctuations and economic variables such as raw material costs and labor expenses. Therefore, while the findings support the scalability of this initiative, they also emphasize the need for financial risk assessment and support mechanisms, including potential funding from government agencies or corporate social responsibility (CSR) programs.

In summary, the literacy tree learning media serves as a holistic educational tool that enhances literacy outcomes while aligning with the SDGs. The study provides a model for integrating educational innovation with environmental responsibility, offering practical insights for educators, school leaders, and policymakers committed to developing curriculum, promoting literacy and sustainability in primary education.

Declaration of conflicting interest

The authors declare that there is no conflict of interest in this work.

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References

Ahmadi, B., & Al-Khaja, W. (2001). Utilization of paper waste sludge in the building construction industry. *Resources, Conservation and Recycling*, *32*(2), 105-113.

Apriliani, A., Waahyudin, C., Ramdani, F.T., Martin, A.Y., Syahrudin, D., Hernawan, D., and Salbiah, E. (2026). Techno-economic analysis of sawdust-based trash cans and their contribution to Indonesia's green tourism policy and the sustainable development goals (SDGs). *ASEAN Journal for Science and Engineering in Materials*, *5*(1), 17-36.

Aykut, E., & Terzi, Ü. K. (2020). Techno-economic and environmental analysis of grid connected hybrid wind/photovoltaic/biomass system for Marmara University Goztepe campus. *International Journal of Green Energy*, *17*(15), 1036-1043.

Condie, C., & Pomerantz, F. (2020). Elementary students' literacy opportunities in an age of accountability and standards: Implications for teacher educators. *Teaching and Teacher Education*, *92*, 103058.

Cardoso, L. M. ., Aeni, N. ., & Muthmainnah, M. (2023). Mobilizing metacognitive strategies through zoom for EFL classrooms: An innovative practice amidst covid 19. *Journal of Language Learning and Assessment*, *1*(1), 19–25. https://doi.org/10.71194/jlla.v1i1.77

Daryanes, F., Darmadi, D., Fikri, K., Sayuti, I., Rusandi, M. A., & Situmorang, D. D. B. (2023). The development of articulate storyline interactive learning media based on case methods to train student's problem-solving ability. *Heliyon*, *9*(4).

Delgadova, E. (2015). Reading literacy as one of the most significant academic competencies for the university students. *Procedia-Social and Behavioral Sciences*, *178*, 48-53.

Djirong, A., Jayadi, K., Abduh, A., Mutolib, A., Mustofa, R.F., and Rahmat, A. (2024). Assessment of student awareness and application of eco-friendly curriculum and technologies in Indonesian higher education for supporting sustainable development goals (SDGs): A case study on environmental challenges. *Indonesian Journal of Science and Technology, 9*(3), 657-678.

Elia, S.H., Maharani, B.S., Yustia, I., Girsang, G.C.S., Nandiyanto, A.B.D., and Kurniawan, T. (2023). Techno-economic evaluation of hyaluronic acid production through extraction method using yellowfin tuna eyeball. *ASEAN Journal of Science and Engineering*, *3*(1), 1-10.

Ervasti, I., Miranda, R., & Kauranen, I. (2016). A global, comprehensive review of literature related to paper recycling: A pressing need for a uniform system of terms and definitions. *Waste Management*, *48*, 64-71.

Eryılmaz, A., Yıldırım-Kurtuluş, H., & Yıldırım, M. (2024). A cross-sectional and longitudinal study on the mediation effect of positive and negative affects in the relationship between self-compassion and resilience in early adolescents. *Children and Youth Services Review*, *161*, 107669.

Farida, F., Supardi, S., & Muchtar, J. (2023). Web based instruction for immersion class in alauddin state islamic university of makassar. *Journal of Language Learning and Assessment*, *1*(2), 57–61. https://doi.org/10.71194/jlla.v1i2.73

Farokhah, L., Herman, T., Wahyudin, W., Khasanah, L.A.I.U., Zulfadhli, M., Abidin, Z., Huda, M.M., and Ariffiando, N.F. (2025). How to teach fraction for empowering student mathematics literacy: Definition, bibliometric, and application using digital module. *ASEAN Journal of Science and Engineering*, *5*(1), 77-102.

Fatimah, Y. A., Govindan, K., Murniningsih, R., & Setiawan, A. (2020). Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia. *Journal of Cleaner Production*, *269*, 122263.

Feiyue, Z. (2022). Edutainment methods in the learning process: Quickly, fun and satisfying. *International Journal of Environment, Engineering and Education*, *4*(1), 19-26.

Fiandini, M., and Nandiyanto, A.B.D. (2024). How to calculate economic evaluation in industrial chemical plant design: A case study of gold mining using amalgamation method. *ASEAN Journal for Science and Engineering in Materials*, *3*(2), 75-104.

Gemil, K.W., Na'ila, D.S., Ardila, N.Z., and Sarahah, Z.U. (2024). The relationship of vocational education skills in agribusiness processing agricultural products in achieving sustainable development goals (SDGs). *ASEAN Journal of Science and Engineering Education*, *4*(2), 181-192.

Haq, M.R.I., Nurhaliza, D.V., Rahmat, L.N., and Ruchiat, R.N.A. (2024). The influence of environmentally friendly packaging on consumer interest in implementing zero waste in the food industry to meet sustainable development goals (SDGs) needs. *ASEAN Journal of Economic and Economic Education*, *3*(2), 111-116.

Hendrayanto, A.R., Muktiarni, M., and Mupita, J. (2022). Perception of junior high school students in using ipusnas app as medium for increase literacy social studies subject. *Indonesian Journal of Educational Research and Technology*, *2*(3), 149-154.

Kerans, G., Sanjaya, Y., Liliasari, L., Pamungkas, J., and Ate, G., Y. (2024). Effect of substrate and water on cultivation of Sumba seaworm (nyale) and experimental practicum design for improving critical and creative thinking skills of prospective science teachers in biology and supporting sustainable development goals (SDGs). *ASEAN Journal of Science and Engineering*, *4*(3), 383-404.

Kongsaenkham, A. ., & Chano, J. . (2024). Role-play in language learning: a bibliometric analysis and its impact on Thailand secondary education. *Journal of Language Learning and Assessment*, *2*(2), 91–98. https://doi.org/10.71194/jlla.v2i2.117

Krishnamoorthy, M., Periyanayagam, A. D. V. R., Santhan Kumar, C., Praveen Kumar, B., Srinivasan, S., & Kathiravan, P. (2022). Optimal sizing, selection, and techno-economic analysis of battery storage for PV/BG-based hybrid rural electrification system. *IETE Journal of Research*, *68*(6), 4061-4076.

Krishnan, A., Al-Obaidi, A.S.M., and Hao, L.C. (2024). Towards sustainable wind energy: A systematic review of airfoil and blade technologies over the past 25 years for supporting sustainable development goals (SDGs). *Indonesian Journal of Science and Technology, 9*(3), 623-656.

Kuo, T. C., Hsu, N. Y., Wattimena, R., Hong, I. H., Chao, C. J., & Herlianto, J. (2021). Toward a circular economy: A system dynamic model of recycling framework for aseptic paper packaging waste in Indonesia. *Journal of Cleaner Production*, *301*, 126901.

Kurniawan, M., Putri, Y. A., & Alianti, G. C. (2024). Learning Fun English through Pop-Up QR Book: An Audio-Visual Aid for Early Childhood Foreign Language Development. *European Journal of Education and Pedagogy*, *5*(1), 7-14.

Lei, W., Zhou, X., Fang, C., Li, Y., Song, Y., Wang, C., & Huang, Z. (2019). New approach to recycle office waste paper: Reinforcement for polyurethane with nano cellulose crystals extracted from waste paper. *Waste Management*, *95*, 59-69.

Makinde, S.O., Ajani, Y.A., and Abdulrahman, M.R. (2024). Smart learning as transformative impact of technology: A paradigm for accomplishing sustainable development goals (SDGs) in education. *Indonesian Journal of Educational Research and Technology*, *4*(3), 213-224.

Maratussolihah, P., Rahmadianti, S., Tyas, K.P., Girsang, G.C.S., Nandiyanto, A.B.D., and Bilad, M.R. (2022). Techno-economic evaluation of gold nanoparticles using banana peel (*Musa Paradisiaca*). *ASEAN Journal for Science and Engineering in Materials*, *1*(1), 1-12.

Marmoah, S., & Jenny Indrastoeti Siti Poerwanti, S. (2022). Literacy culture management of elementary school in Indonesia. *Heliyon*, *8*(4).

Maryanti, R., Rahayu, N., Muktiarni, M., Al Husaeni, D. F., Hufad, A., Sunardi, S., & Nandiyanto, A. B. D. (2022). Sustainable development goals (SDGs) in science education: Definition, literature review, and bibliometric analysis. *Journal of Engineering Science and Technology*, *17*, 161-181.

Matteo, S. (2025). Applying the Fun Fact Approach for Active Learning. *Вестник Кемеровского государственного университета. Серия: Гуманитарные и общественные науки*, *9*(1 (33)), 104-116.

Meldawati, S. F. ., & Hamid, A. H. A. . (2023). Students' strategies and self-efficacy in reading comprehension. *Journal of Language Learning and Assessment*, *1*(1), 9–18. https://doi.org/10.71194/jlla.v1i1.75

Millatina, S.N., Maryanti, R., and Wulandary, V. (2022). Strengthening literacy of cultural arts and crafts in the material of sculpture for 6th-grade elementary school students through learning video media. *Indonesian Journal of Educational Research and Technology*, *2*(3), 189-194.

Mulya, M.A., Maryanti, R., Wulandary, V., and Irawan, A.R. (2023). The effectiveness of YouTube media to improve knowledge and literacy of elementary school students. *Indonesian Journal of Educational Research and Technology*, 3(1), 19-24.

Nugraha, M.G. (2023). Scientific approach to enhance scientific literacy of junior high school students: Domain of competence. *Indonesian Journal of Educational Research and Technology*, *3*(2), 111-118.

Nurramadhani, A., Riandi, R., Permanasari, A., and Suwarma, I.R. (2024). Low-carbon food consumption for solving climate change mitigation: Literature review with bibliometric and simple calculation application for cultivating sustainability consciousness in facing sustainable development goals (SDGs). *Indonesian Journal of Science and Technology*, *9*(2), 261-286.

Pasang, H., Moore, G. A., & Sitorus, G. (2007). Neighbourhood-based waste management: A solution for solid waste problems in Jakarta, Indonesia. *Waste Management*, *27*(12), 1924-1938.

Pathak, A., Vinoba, M., & Kothari, R. (2021). Emerging role of organic acids in leaching of valuable metals from refinery-spent hydroprocessing catalysts, and potential techno-economic challenges: a review. *Critical Reviews in Environmental Science and Technology*, *51*(1), 1-43.

Peña-Ayala, A. (2021). A learning design cooperative framework to instill 21st century education. *Telematics and Informatics*, *62*, 101632.

Pivnenko, K., Eriksson, E., & Astrup, T. F. (2015). Waste paper for recycling: Overview and identification of potentially critical substances. *Waste management*, *45*, 134-142.

Rachmadhani, D.R., and Priyono, B. (2024). Techno-economic analysis of the business potential of recycling lithium-ion batteries using hydrometallurgical methods. *ASEAN Journal for Science and Engineering in Materials*, *3*(2), 117-132.

Ragadhita, R., Fiandini, M., Al Husaeni, D.N., and Nandiyanto, A.B.D. (2025). Sustainable development goals (SDGs) in engineering education: Definitions, research trends, bibliometric insights, and strategic approaches. *Indonesian Journal of Science and Technology, 11*(1), 1-26.

Rahman, M. O., Hussain, A., & Basri, H. (2014). A critical review on waste paper sorting techniques. *International journal of environmental science and technology*, *11*, 551-564.

Rajput, D., Bhagade, S. S., Raut, S. P., Ralegaonkar, R. V., & Mandavgane, S. A. (2012). Reuse of cotton and recycle paper mill waste as building material. *Construction and Building Materials*, *34*, 470-475.

Raut, S. P., Sedmake, R., Dhunde, S., Ralegaonkar, R. V., & Mandavgane, S. A. (2012). Reuse of recycle paper mill waste in energy absorbing light weight bricks. *Construction and Building Materials*, *27*(1), 247-251.

Samsuri, S., Anwar, S., Harini, S., Kartini, T., Monaya, N., Warizal, W., and Setiawan, A.B. (2025). Techno-economic feasibility and bibliometric literature review of integrated waste processing installations for sustainable plastic waste management. *ASEAN Journal for Science and Engineering in Materials*, *4*(2), 225-244.

Saputri, D. R., & Wiranti, D. A. (2024). The Effect of Literacy Tree Media on Student Reading Interest in Indonesian Language Subjects Grade 4 SDN 1 Tigajuru Mayong. *Eduvest-Journal of Universal Studies*, *4*(8), 6737-6745.

Sesrita, A., Adri, H.T., Suherman, I., Rasmitadila, R., and Fanani, M.Z. (2025). Production of wet organic waste ecoenzymes as an alternative solution for environmental conservation supporting sustainable development goals (SDGs): A techno-economic and bibliometric analysis. *ASEAN Journal for Science and Engineering in Materials*, *4*(2), 245-266.

Sinaga, R. R. F., & Oktaviani, L. (2020). The implementation of fun fishing to teach speaking for elementary school students. *J. English Lang. Teach. Learn*, *1*(1), 1-6.

Suprayogi, Y., Luckyardi, S., Kurnia, D. ., & Khairusy, M. A. . (2024). Language skills in business context: a bibliometric analysis using the vos viewer application. *Journal of Language Learning and Assessment*, *2*(1), 1–6. https://doi.org/10.71194/jlla.v2i1.109

Suryawati, E., Suzanti, F., Zulfarina, Z., Putriana, A. R., & Febrianti, L. (2020). The implementation of local environmental problem-based learning student worksheets to strengthen environmental literacy. *Jurnal Pendidikan IPA Indonesia*, *9*(2), 169-178.

Susilawati, D., & Kanowski, P. (2020). Cleaner production in the Indonesian pulp and paper sector: Improving sustainability and legality compliance in the value chain. *Journal of Cleaner Production*, *248*, 119259.

Syahrudin, D., Roestamy, M., Fauziah, R.S.P., Rahmawati, R., Pratidina, G., Purnamasari, I., Muhtar, S., and Salbiah, E. (2026). Techno-economic analysis of production ecobrick from plastic waste to support sustainable development goals (SDGs). *ASEAN Journal for Science and Engineering in Materials*, *5*(1), 9-16.

Villanueva, A., & Wenzel, H. (2007). Paper waste–recycling, incineration or landfilling? A review of existing life cycle assessments. *Waste management*, *27*(8), S29-S46.

Wang, R. (2024). Storytelling in higher education: comparing expectancy- value in task-exposed and non-exposed english learners. *Journal of Language Learning and Assessment*, *2*(2), 73–84. https://doi.org/10.71194/jlla.v2i2.111

Winarni, S., & Lutan, R. (2020). Emphaty and tolerance in physical education: Cooperative vs. classical learning. *Cakrawala Pendidikan*, *39*(2), 332-345.

Zukmadini, A.Y., Rohman, F., Dharmawan, A., Sari, M.S., Rochman, S., and Razak, S.A. (2024). Potential biodiversity from ethnozoology of Enggano Island: Utilization, a quantitative analysis, list of animals conserved by local people, and application of research findings empowering species literacy in biology student teachers. *Indonesian Journal of Science and Technology*, *9*(2), 463-496.