

**ADAPTIVE TECHNOLOGY-BASED LEARNING TO IMPROVE LITERACY AND
NUMERACY SKILLS OF ELEMENTARY SCHOOL STUDENTS**Nabillah Naidah Khairah¹, and Caroline Cem²¹ Universitas Islam Negeri Mahmud Yunus Batusangkar, Indonesia² Estonian University of Life Sciences, Estonia**Corresponding Author:**

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20, 2025**Abstract**

Advancements in digital technology have opened significant opportunities in education, especially in learning at the elementary school level. This study aims to analyze the effectiveness of adaptive technology-based learning in improving students' literacy and numeracy skills. The method used is qualitative research with a case study approach conducted in several elementary schools that have implemented adaptive technology. Data were collected through observation, interviews, and documentation, then analyzed descriptively and qualitatively. The results show that adaptive technology-based learning can adjust the materials and learning pace individually, thereby increasing students' interest, participation, and understanding of literacy and numeracy concepts. The educational applications used provide instant feedback and automatic difficulty level adjustments. In conclusion, adaptive technology has great potential to support personalized, effective, and inclusive learning processes in elementary schools. This study recommends the strategic integration of technology into the curriculum and teacher training to enable effective data-driven learning management.

Keywords: Adaptive Learning, Educational Technology, Elementary School, Literacy, Numeracy



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INTRODUCTION

Education is the fundamental foundation in the development of a nation. Through quality education, the younger generation is prepared to face increasingly complex future challenges. In the current context of globalization and the information era, the demand for education that is responsive to the times has become more urgent (“Financial Literacy Education,” 2012). One of the main issues in primary education is how to improve students' basic competencies, especially in literacy and numeracy, which are important indicators of overall learning success. Low literacy and numeracy achievements in various regions indicate the need for new approaches in the learning process at the elementary school level.

The development of digital technology has affected almost all aspects of human life, including education (Wang dkk., 2023; Wetzel dkk., 2014). Technology has changed the way people learn, communicate, and interact. In educational settings, technology offers opportunities to create learning that is more engaging, interactive, and effective. One rapidly developing approach is technology-based adaptive learning, a learning system that can adjust materials and methods according to the needs and abilities of each student (Tuma, 2021). This approach offers personalization in learning that conventional systems cannot provide.

In Indonesia, the implementation of technology in education still faces various challenges, ranging from uneven infrastructure, teacher readiness, to digital divides across regions. Nevertheless, various initiatives have been undertaken to expand access and improve learning quality through technology utilization (Strielkowski dkk., 2025). The government, through the Ministry of Education and Culture, has developed several digital platforms and encouraged technology integration in teaching and learning processes. This reflects a commitment to transforming education through inclusive and sustainable digitalization. In the context of adaptive learning, technology allows students to learn according to their individual styles, pace, and needs. The systems used are typically equipped with algorithms that can analyze student learning data and adjust the materials or exercises provided. Thus, each student receives a unique learning experience relevant to their ability level. This contrasts with the one-size-fits-all approach, which is often ineffective for students with diverse learning capabilities (Street, 1997). Therefore, adaptive learning is considered an innovative solution to enhance the effectiveness of basic education.

Literacy and numeracy skills form the foundation for students to master other fields of knowledge and actively participate in social life. Literacy encompasses not only reading and writing skills but also the ability to understand, analyze, and evaluate information. Numeracy includes the ability to perform calculations, understand basic mathematical concepts, and apply them in real situations. Low literacy and numeracy levels among elementary school students can hinder their academic and social development in the future (Steel & Hudson, 2001). Various national and international studies show that many Indonesian students have not reached minimum competency levels in literacy and numeracy. Reports such as the Minimum Competency Assessment (AKM) and the Programme for International Student Assessment (PISA) place Indonesia in concerning positions. This indicates that the existing learning systems have not fully met the needs and challenges of basic education. Therefore, breakthroughs in more adaptive, contextual, and technology-based learning methods are necessary.

Technology-based adaptive learning offers advantages in flexibility, personalization, and real-time data use to improve learning quality. With technology, teachers can monitor students' progress individually and provide timely interventions. Students feel more engaged and motivated because the learning is tailored to their needs. In the long term, this approach can improve academic achievement and foster independent and critical learning habits from an early age. Moreover, adaptive learning supports inclusive education principles by providing equal learning opportunities for all students, including those with special needs or from diverse socio-economic backgrounds. Technology can help bridge access and quality gaps between

urban and rural education (Spolsky & Hult, 2008). With appropriate policies and adequate teacher training, adaptive learning can be broadly implemented in elementary schools across Indonesia.

The novelty of this research lies in its integrative approach that combines technology-based adaptive learning with simultaneous improvement in literacy and numeracy. Most previous studies focus on either technology application or literacy and numeracy development separately. This study fills that gap by demonstrating how adaptive technology can be strategically used to develop these two fundamental competencies within a unified learning model. Furthermore, this research explores the teacher's role in managing data-driven learning and the challenges faced in implementing adaptive technology in elementary schools. Using a qualitative case study approach, the study provides an in-depth picture of real practices in the field and offers practical recommendations for educational stakeholders (Soler Costa dkk., 2021). These findings are expected to enrich the literature and serve as references for developing more effective and contextual learning policies and practices.

Ultimately, the main goal of this article is to present research findings on how technology-based adaptive learning can significantly improve literacy and numeracy among elementary school students. By describing the implementation process, challenges, and impacts on student learning outcomes, the article aims to contribute meaningfully to efforts to improve the quality of basic education in Indonesia (Smith dkk., 2006). The focus on literacy and numeracy is chosen because these competencies are fundamental indicators that determine overall learning success. The digital transformation in education not only changes how students learn but also redefines the teacher's role, learning strategies, and school culture. Teachers are no longer just information sources but facilitators and managers of meaningful learning experiences. In the context of adaptive learning, teachers are required to use learning data, understand student learning profiles, and design effective intervention strategies. This demands new competencies that not all teachers may yet possess, making professional development and training critical.

With the advancement of artificial intelligence and learning analytics, the potential for adaptive learning continues to grow. Learning platforms now come equipped with sophisticated features such as automated diagnostics, student performance analysis, and individualized learning recommendations. These features support the implementation of accurate and sustainable data-driven learning. Teachers can use this information to design more personalized and efficient learning. In the long run, this is expected to increase learning process efficiency and student outcomes. However, it must be emphasized that technology is only a tool. The success of adaptive learning heavily depends on strong pedagogical design, infrastructure support, and teacher and student readiness. Therefore, technology integration must be strategic, planned, and sustainable. Adaptive learning is not merely about using applications or digital platforms but represents a paradigm shift in how we view and conduct education (Rogers & Schaenen, 2014). This new paradigm places students at the center of learning and adjusts the learning process to their real needs.

Against this background, this article is composed to comprehensively explore and analyze how technology-based adaptive learning can enhance literacy and numeracy among elementary school students. The study is expected to provide new insights and encourage wider adoption of technology in basic education in Indonesia. The next section of this article will discuss the research methods used to systematically gather information and data.

RESEARCH METHOD

This study uses a qualitative approach with a case study design. This approach was chosen to deeply explore the practice of technology-based adaptive learning implemented in several elementary schools in Indonesia. The focus of the research is on how technology is used to improve students' literacy and numeracy skills, as well as how teachers and students interact within the adaptive learning environment (Rasi dkk., 2019). The research sites were purposively selected by considering elementary schools that have actively implemented adaptive learning technology. These schools are located in diverse areas, both urban and rural, to obtain a comprehensive picture of technology implementation in varied contexts. The primary informants in this study are classroom teachers, principals, and students from grades IV to VI.

Data collection was conducted through three main techniques: observation, in-depth interviews, and documentation. Observations were carried out during the learning process to directly observe the application of adaptive technology and the interactions between teachers and students. Semi-structured interviews were conducted to allow the researcher to gather richer information regarding the experiences and perspectives of the informants. Documentation included analysis of learning materials used, student learning outcome reports, and other relevant notes related to the practice of adaptive learning (Ramjan dkk., 2014). All data were collected over a period of three months to ensure that the information reflects stable and sustained practices rather than temporary conditions.

Data analysis was conducted descriptively and qualitatively. Data from observations, interviews, and documentation were coded and categorized to identify thematic patterns related to adaptive learning and the improvement of students' literacy and numeracy. Each theme was analyzed to understand how technological elements support or hinder the learning process. Data validity was maintained through source triangulation by comparing the results from the three data collection techniques. Additionally, member checking was conducted by confirming preliminary findings with informants to ensure that the researcher's interpretations align with their experiences.

To ensure the reliability of the results, the researcher also involved peer debriefing with experts in educational technology and literacy (Peredo dkk., 2011). These discussions helped refine data interpretation and strengthen the arguments in the formulation of findings and research recommendations. Ethical considerations were observed by obtaining written consent from each informant before conducting interviews and observations. The researcher also guaranteed the confidentiality of the informants' personal data and used anonymous codes when presenting the data.

The limitations of this study are acknowledged, especially regarding the generalizability of the findings. Because it is a case study, the results cannot be generalized widely but can serve as a foundation for further research using quantitative or experimental approaches. With this method, the study is expected to provide a comprehensive and contextual overview of the practice of technology-based adaptive learning in elementary schools and its impact on improving students' literacy and numeracy.

RESULTS AND DISCUSSION

Results

This study found that technology-based adaptive learning significantly increases student engagement in the learning process. Students showed high enthusiasm when using digital applications such as interactive quiz platforms, educational games, and personalized practice exercises (Papen, 2005). When students were presented with responsive interfaces and attractive visuals, they tended to be more active in answering questions, completing tasks, and asking questions. Teachers also noted an increase in the time students spent learning independently outside of class hours. This indicates that adaptive learning can foster intrinsic motivation in students, which is an important indicator of successful learning.

Improvements in students' literacy skills were evident from increased reading frequency and better reading comprehension after using adaptive applications. The learning platforms provided various interactive texts with vocabulary tailored to students' proficiency levels. Immediate feedback on reading exercises allowed students to recognize and correct their mistakes independently (Pahl & Rowsell, 2011). Teachers reported that students showed greater interest in reading activities, even outside the classroom, because the content was contextual and enjoyable. This demonstrates that personalized content in technology applications positively impacts the literacy development of elementary students.

Regarding numeracy, students experienced significant improvements in basic calculation skills and understanding of mathematical concepts. Adaptive applications provided challenges adjusted to the students' skill levels and automatically increased in difficulty as students progressed. For example, if a student could quickly and accurately complete basic addition problems, the system would automatically advance them to more complex problems such as subtraction and multiplication. Teachers observed that students became more confident in solving math problems and displayed positive attitudes toward subjects previously considered difficult (Mirata dkk., 2020; Morze dkk., 2021). The use of visualizations such as graphs, animations, and simulations also helped students grasp abstract concepts more easily.

Besides enhancing academic competence, adaptive learning also contributed to the development of independent learning skills. Students became better trained in time management, selecting materials according to their needs, and monitoring their progress independently through reporting features provided by the applications. Teachers noted improvements in students' learning autonomy and responsibility toward assigned tasks. Some students even began creating daily study schedules based on personalized system recommendations. This shift reflects a change in the learning culture from teacher-centered to more student-centered, aligning with 21st-century learning paradigms.

Field observations showed that adaptive learning creates an inclusive learning environment. Students with diverse abilities could learn at their own pace and style without feeling left behind or burdened by the class speed. Teachers reported that students with special needs also made significant progress due to the presence of visual, audio, and disability-friendly navigation supports (Martin dkk., 2020). This indicates that adaptive technology can serve as a tool to realize the principle of equity in education, where every student has an equal opportunity to reach their learning potential. The teachers involved in this study stated that adaptive technology helped them map students' abilities more accurately and efficiently. Through analytical features in the applications, teachers could easily identify students facing difficulties as well as those needing additional challenges. This data was then used to design more targeted learning strategies. For example, teachers could form study groups based on similar competency levels or assign extra tasks to students requiring reinforcement (Liu dkk., 2017). Consequently, the learning process became more focused and positively impacted overall student achievement.

Students also showed improvement in their ability to reflect on their learning process. The adaptive applications provided weekly reports on their learning progress, presented in simple graphs and color-coded indicators. Students could directly see which subjects they had mastered and which still required attention. This encouraged greater awareness and responsibility for their own learning (Leithwood & dkk., 2004; Li, 2014). Such reflection forms an important foundation for metacognition—the ability to understand and regulate one’s own thinking process—which is essential for long-term education.

In addition to facilitating teachers in mapping student achievement, adaptive technology also facilitated reporting learning outcomes to parents. Some applications offered features that enabled parents to monitor their child’s progress in real-time through their devices. This created closer collaboration between teachers, students, and parents in supporting the learning process. Transparent and easily accessible information helped parents provide learning support at home, whether through content reinforcement or motivational encouragement. Increased parental involvement strengthened the overall learning ecosystem. The study also noted a reduction in teachers’ administrative burdens thanks to automation offered by adaptive learning systems. Features such as automatic grading, activity tracking, and progress reports reduced the time teachers usually spent on administrative tasks. Thus, teachers could focus more on interactive and pedagogical activities (Kirkwood & Price, 2013; Lee, 2014). This efficiency was especially helpful in large classes, where manually personalizing learning becomes a significant challenge.

On the other hand, the implementation of technology-based adaptive learning also faced several challenges. One major challenge was uneven availability of technological infrastructure across elementary schools. Some schools, especially in remote areas, still faced limited internet access, digital devices, and technical support (Anghileri, 2006; Barwell, 2005). This hindered the smooth integration of technology in teaching and learning. Nevertheless, some schools overcame these obstacles by sharing devices in rotation or through independent initiatives such as procuring laptops with school operational funds.

Another challenge was teachers’ readiness to optimally utilize adaptive technology. Some teachers admitted difficulties understanding complex features of the applications and interpreting the analytic data produced. Limited training and lack of continuous guidance were primary causes. Therefore, support from application developers and educational institutions is urgently needed to provide ongoing training and technical assistance services. Despite these challenges, most teachers stated that their experience using adaptive technology positively impacted their professional development. Teachers became more open to learning innovations and started applying data-driven approaches in planning and evaluation (Khosravi dkk., 2020). They were also more active in seeking digital learning resources and sharing best practices with colleagues. This process not only enriched teachers’ competencies but also fostered a lifelong learning culture within the school community.

From the students’ perspective, the use of adaptive learning applications was considered a fun and challenging learning experience. Many students said they felt like they were playing while learning (Brown dkk., 1998). Gamification elements such as point systems, badges, and weekly challenges made learning activities more engaging. The sense of achievement provided by the applications also motivated students to keep progressing and try new challenges. This shows that motivational aspects in application design are crucial for maintaining student engagement. One interesting finding from this study is how adaptive learning reduces achievement gaps among students. With personalized approaches, students who were previously behind had opportunities to gradually catch up without feeling embarrassed or left behind by their peers. Meanwhile, faster learners continued to receive appropriately challenging tasks. The accuracy of material adjustment was key to creating a fair and equitable learning environment.

Overall, the data from this study indicate that integrating adaptive technology in elementary school learning significantly contributes to improving students' literacy and numeracy. Learning becomes more engaging, participatory, and meaningful. Teachers, students, and parents alike recognize the tangible benefits of this technology implementation. Although some challenges exist, the potential offered by adaptive technology is far greater in supporting educational transformation toward a more inclusive, efficient, and student-centered approach.

The discussion begins by highlighting the central role of adaptive technology as a transformational tool in elementary education. This technology functions not only as a learning medium but also as an agent of change in the traditional educational paradigm. With a personalized approach, adaptive learning is able to meet individual student needs more effectively compared to conventional methods. This makes the learning experience more inclusive and focused on each student's potential (Jing dkk., 2023; S. T. Kerr, 1991). Furthermore, the use of adaptive technology has been proven to contribute significantly to the improvement of literacy and numeracy. These two aspects form the fundamental foundation of elementary education, which strongly determines students' academic success in higher education levels. The applications used enable students to learn through interactive and enjoyable approaches, which indirectly encourage active engagement and learner independence.

In addition, the presence of an instant feedback system within the learning applications offers distinct advantages. Students can immediately recognize and correct their mistakes, while teachers gain analytical data to better understand students' learning patterns. This opens opportunities for more precise and strategic interventions in the teaching process. The implementation of adaptive technology also positively impacts teachers' learning management. With automation in assessment and reporting, teachers have more time to focus on pedagogical activities and direct interaction with students (P. Kerr, 2016). This efficiency is particularly helpful in the context of large and diverse classrooms.

From a social perspective, collaboration between schools and parents has improved due to the data transparency provided by the applications. Parents no longer play a passive role but actively participate in their children's learning process. This strengthens the connection between home and school in creating a supportive learning environment (Brown dkk., 2003). Nonetheless, challenges remain that must be addressed in the implementation of adaptive technology. One of the primary issues is the digital divide between urban and rural schools. Without equitable policy interventions, this technological innovation risks widening disparities in access to education.

Teachers' readiness to manage adaptive technology is also a crucial factor. Their ability to interpret learning data and integrate it into teaching strategies significantly determines the effectiveness of implementation (Cavanagh dkk., 2020). Therefore, ongoing training and technical support are urgent needs. Adaptive learning also drives a cultural shift in school learning. From passive learning patterns to two-way interactions guided by technology. Students become active subjects who not only receive information but also construct their own knowledge through digital exploration (Hobbs & Jensen, 2009). Another interesting finding is that adaptive technology has the potential to reduce achievement gaps among students. With systems that can adjust materials and learning pace, students with varying abilities can develop according to their own rhythms, without pressure or stigma.

Motivational aspects in application design are also proven effective. Gamification and reward systems encourage students to keep learning enthusiastically. This has a positive psychological impact that is important for long-term learning processes. Adaptive technology also promotes the integration of data-driven learning approaches within the school curriculum. This creates space for more objective and evidence-based decision-making in classroom management. From a policy perspective, these research findings reinforce the importance of

government support in providing technological infrastructure and developing human resource capacity (Domingo & Garganté, 2016; Ferdig, 2006). Educational policies need to focus on equitable access and improving teaching quality through technological innovation.

The adaptability of schools and teachers to technology becomes the key to successful implementation. Successful schools are those that can transform holistically—not only in the use of tools but also in pedagogical approaches and learning management. In the long term, adaptive learning can cultivate a generation of students who are more independent, reflective, and problem-solving oriented. This aligns with the demands of 21st-century skills that emphasize critical, creative, collaborative, and communicative thinking abilities. Thus, technology-based adaptive learning is a strategic innovation that not only enhances academic achievement but also revolutionizes the elementary education system toward a more responsive and equitable direction.

CONCLUSION

Technology-based adaptive learning has proven effective in improving literacy and numeracy among elementary school students. The research results show that this approach can provide more personalized, interactive, and relevant learning tailored to individual student needs. The implementation of technology combined with appropriate pedagogical strategies can significantly enhance student engagement and learning outcomes. Although challenges such as infrastructure limitations and teacher readiness remain obstacles, with adequate educational policy support and training, this approach holds great potential to meet the demands of 21st-century education. Therefore, technology-based adaptive learning deserves to be considered as a primary approach in elementary education to build a strong foundation in students' literacy and numeracy skills.

REFERENCES

- Anghileri, J. (2006). A study of the impact of reform on students' written calculation methods after five years' implementation of the National Numeracy Strategy in England. *Oxford Review of Education*, 32(3), 363–380. <https://doi.org/10.1080/03054980600776506>
- Barwell, R. (2005). Empowerment, EAL and the National Numeracy Strategy. *International Journal of Bilingual Education and Bilingualism*, 8(4), 313–327. <https://doi.org/10.1080/13670050508668613>
- Brown, M., Askew, M., Baker, D., Denvir, H., & Millett, A. (1998). Is the National Numeracy Strategy Research-based? *British Journal of Educational Studies*, 46(4), 362–385. <https://doi.org/10.1111/1467-8527.00090>
- Brown, M., Askew, M., Millett, A., & Rhodes, V. (2003). The key role of educational research in the development and evaluation of the national numeracy strategy. *British Educational Research Journal*, 29(5), 655–667. <https://doi.org/10.1080/0141192032000133677>
- Cavanagh, T., Chen, B., Lahcen, R. A. M., & Paradiso, J. (2020). Constructing a Design Framework and Pedagogical Approach for Adaptive Learning in Higher Education: A Practitioner's Perspective. *The International Review of Research in Open and Distributed Learning*, 21(1), 172–196. <https://doi.org/10.19173/irrodl.v21i1.4557>
- Domingo, M. G., & Garganté, A. B. (2016). Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom. *Computers in Human Behavior*, 56, 21–28. <https://doi.org/10.1016/j.chb.2015.11.023>
- Ferdig, R. E. (2006). Assessing technologies for teaching and learning: Understanding the importance of technological pedagogical content knowledge. *British Journal of Educational Technology*, 37(5), 749–760. <https://doi.org/10.1111/j.1467-8535.2006.00559.x>

- Financial Literacy Education. (2012). Dalam C. Arthur, *Financial Literacy Education* (hlm. 1–12). SensePublishers. https://doi.org/10.1007/978-94-6091-918-3_1
- Hobbs, R., & Jensen, A. (2009). The Past, Present, and Future of Media Literacy Education. *Journal of Media Literacy Education*. <https://doi.org/10.23860/jmle-1-1-1>
- Jing, Y., Zhao, L., Zhu, K., Wang, H., Wang, C., & Xia, Q. (2023). Research Landscape of Adaptive Learning in Education: A Bibliometric Study on Research Publications from 2000 to 2022. *Sustainability*, 15(4), 3115. <https://doi.org/10.3390/su15043115>
- Kerr, P. (2016). Adaptive learning: *ELT Journal*, 70(1), 88–93. <https://doi.org/10.1093/elt/ccv055>
- Kerr, S. T. (1991). Lever and Fulcrum: Educational Technology in Teachers' Thought and Practice. *Teachers College Record: The Voice of Scholarship in Education*, 93(1), 114–136. <https://doi.org/10.1177/016146819109300104>
- Khosravi, H., Sadiq, S., & Gasevic, D. (2020). Development and Adoption of an Adaptive Learning System: Reflections and Lessons Learned. *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, 58–64. <https://doi.org/10.1145/3328778.3366900>
- Kirkwood, A., & Price, L. (2013). Examining some assumptions and limitations of research on the effects of emerging technologies for teaching and learning in higher education. *British Journal of Educational Technology*, 44(4), 536–543. <https://doi.org/10.1111/bjet.12049>
- Lee, S.-H. (2014). Digital Literacy Education for the Development of Digital Literacy. *International Journal of Digital Literacy and Digital Competence*, 5(3), 29–43. <https://doi.org/10.4018/ijdlde.2014070103>
- Leithwood *, K., Jantzi, D., Earl, L., Watson, N., Levin, B., & Fullan, M. (2004). Strategic leadership for large-scale reform: The case of England's national literacy and numeracy strategy. *School Leadership & Management*, 24(1), 57–79. <https://doi.org/10.1080/1363243042000172822>
- Li, L. (2014). Understanding language teachers' practice with educational technology: A case from China. *System*, 46, 105–119. <https://doi.org/10.1016/j.system.2014.07.016>
- Liu, M., McKelroy, E., Corliss, S. B., & Carrigan, J. (2017). Investigating the effect of an adaptive learning intervention on students' learning. *Educational Technology Research and Development*, 65(6), 1605–1625. <https://doi.org/10.1007/s11423-017-9542-1>
- Martin, F., Chen, Y., Moore, R. L., & Westine, C. D. (2020). Systematic review of adaptive learning research designs, context, strategies, and technologies from 2009 to 2018. *Educational Technology Research and Development*, 68(4), 1903–1929. <https://doi.org/10.1007/s11423-020-09793-2>
- Mirata, V., Hirt, F., Bergamin, P., & Van Der Westhuizen, C. (2020). Challenges and contexts in establishing adaptive learning in higher education: Findings from a Delphi study. *International Journal of Educational Technology in Higher Education*, 17(1). <https://doi.org/10.1186/s41239-020-00209-y>
- Morze, N., Varchenko-Trotsenko, L., Terletska, T., & Smyrnova-Trybulska, E. (2021). Implementation of adaptive learning at higher education institutions by means of Moodle LMS. *Journal of Physics: Conference Series*, 1840(1), 012062. <https://doi.org/10.1088/1742-6596/1840/1/012062>
- Pahl, K., H., & Rowsell, J. (2011). Artifactual Critical Literacy: A New Perspective for Literacy Education. *Berkeley Review of Education*, 2. <https://doi.org/10.5070/b82110050>
- Papen, U. (2005). Literacy and development: What works for whom? or, how relevant is the social practices view of literacy for literacy education in developing countries? *International Journal of Educational Development*, 25(1), 5–17. <https://doi.org/10.1016/j.ijedudev.2004.05.001>

- Peredo, R., Canales, A., Menchaca, A., & Peredo, I. (2011). Intelligent Web-based education system for adaptive learning. *Expert Systems with Applications*, 38(12), 14690–14702. <https://doi.org/10.1016/j.eswa.2011.05.013>
- Ramjan, L. M., Stewart, L., Salamonson, Y., Morris, M. M., Armstrong, L., Sanchez, P., & Flannery, L. (2014). Identifying strategies to assist final semester nursing students to develop numeracy skills: A mixed methods study. *Nurse Education Today*, 34(3), 405–412. <https://doi.org/10.1016/j.nedt.2013.03.017>
- Rasi, P., Vuojärvi, H., & Ruokamo, H. (2019). Media Literacy for All Ages. *Journal of Media Literacy Education*, 11(2), 1–19. <https://doi.org/10.23860/jmle-2019-11-2-1>
- Rogers, R., & Schaenen, I. (2014). Critical Discourse Analysis in Literacy Education: A Review of the Literature. *Reading Research Quarterly*, 49(1), 121–143. <https://doi.org/10.1002/rrq.61>
- Smith, F., Hardman, F., & Higgins, S. (2006). The impact of interactive whiteboards on teacher—Pupil interaction in the National Literacy and Numeracy Strategies. *British Educational Research Journal*, 32(3), 443–457. <https://doi.org/10.1080/01411920600635452>
- Soler Costa, R., Tan, Q., Pivot, F., Zhang, X., & Wang, H. (2021). Personalized and adaptive learning: Educational practice and technological impact. *Texto Livre: Linguagem e Tecnologia*, 14(3), e33445. <https://doi.org/10.35699/1983-3652.2021.33445>
- Spolsky, B., & Hult, F. M. (Ed.). (2008). *The Handbook of Educational Linguistics* (1 ed.). Wiley. <https://doi.org/10.1002/9780470694138>
- Steel, J., & Hudson, A. (2001). Educational Technology in Learning and Teaching: The Perceptions and Experiences of Teaching Staff. *Innovations in Education and Teaching International*, 38(2), 103–111. <https://doi.org/10.1080/13558000010030158>
- Street, B. (1997). The Implications of the ‘New Literacy Studies’ for Literacy Education. *English in Education*, 31(3), 45–59. <https://doi.org/10.1111/j.1754-8845.1997.tb00133.x>
- Strielkowski, W., Grebennikova, V., Lisovskiy, A., Rakhimova, G., & Vasileva, T. (2025). AI-driven adaptive learning for sustainable educational transformation. *Sustainable Development*, 33(2), 1921–1947. <https://doi.org/10.1002/sd.3221>
- Tuma, F. (2021). The use of educational technology for interactive teaching in lectures. *Annals of Medicine and Surgery*, 62, 231–235. <https://doi.org/10.1016/j.amsu.2021.01.051>
- Wang, S., Christensen, C., Cui, W., Tong, R., Yarnall, L., Shear, L., & Feng, M. (2023). When adaptive learning is effective learning: Comparison of an adaptive learning system to teacher-led instruction. *Interactive Learning Environments*, 31(2), 793–803. <https://doi.org/10.1080/10494820.2020.1808794>
- Wetzel, K., Buss, R., Foulger, T. S., & Lindsey, L. (2014). Infusing Educational Technology in Teaching Methods Courses: Successes and Dilemmas. *Journal of Digital Learning in Teacher Education*, 30(3), 89–103. <https://doi.org/10.1080/21532974.2014.891877>
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