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The Digital Impact on Teaching Mathematics in Secondary Schools in Lusaka District, Zambia: A Case Study of Matero Boys Secondary School

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Abstract

This research aims to investigate digital tools' impact on mathematics teaching in secondary education, focusing specifically on Matero Boys Secondary School in Lusaka District, Zambia. The objective is to evaluate the effectiveness and challenges associated with integrating technology into the mathematics curriculum, evaluate the teacher's perception, and identify the barriers to effective implementation. It also examines the influence of technology on education, focusing on how digital tools and resources have transformed teaching and learning in mathematics. A mixed-methods approach was employed to collect data via surveys, interviews, and classroom observations involving instructors and students. The findings exhibit how digital technology, such as interactive software and online resources, can improve student engagement and facilitate differentiated instruction and comprehension in mathematics. The assessment involved analyzing variations in performance metrics linked to the utilization of these interactive digital tools. The results elucidate the potential of digital tools to transform pedagogical approaches and address challenges in mathematics education, such as limited technological access, inadequate teacher training, and infrastructural deficiencies, ultimately assessing their impact on overall educational outcomes. The result also showed that effective digital integration in educational contexts may enhance workforce proficiency, which is essential for addressing the evolving requirements of sectors such as healthcare and engineering.

This study highlights the necessity of revising educational policy and improving digital infrastructure to create a more adaptable learning environment that prepares students for future challenges. This project has developed a systematic approach for integrating digital resources into mathematics education, which may serve as a framework for other subjects facing similar pedagogical challenges. The study endeavors to emphasize the significance of strategically integrating digital resources and offering professional development for educators to utilize technology in mathematics instruction effectively. Finally, this study hopes to improve the discourse surrounding educational technology in sub-Saharan Africa, by providing critical insights for policymakers and educational stakeholders dedicated to enhancing mathematics instruction in secondary schools.

KEYWORDS: Investigate, Digital, Mixed Method Approach, Comprehension, Integration, Pedagogical Challenges, Educational Technology, Policymakers

1. Introduction

In recent years, the integration of digital technology in education has gained prominence as a transformative approach to teaching and learning, particularly in subjects like mathematics that require conceptual understanding and problem-solving skills. With the advent of diverse digital tools and resources, such as interactive applications and online learning platforms, educators in secondary schools are increasingly tasked with enhancing their pedagogical practices to engage students effectively. This trend is particularly significant in the Lusaka District, Zambia, where there is a growing emphasis on the need for educational institutions to adapt to the changing technological landscape.

At Matero Boys Secondary School, the exploration of digital technology's impact on mathematics teaching analyzes current instructional strategies and identifies the challenges and advantages arising from such integration. The research problem central to this research paper focuses on the effectiveness of digital tools in facilitating mathematics learning and understanding among students, along with the barriers educators face in implementing these technologies effectively. This investigation aims to comprehend how digital resources currently employed at Matero Boys are reshaping teaching methodologies, student engagement, and academic performance in mathematics, thereby establishing a crucial link between technology and education.

The specific objectives of this research include identifying and evaluating digital tools currently employed for mathematics instruction at Matero Boys, examining teachers' perception regarding the effectiveness of the digital tools in enhancing learning outcomes in mathematics and evaluating the challenges educators encounter related to technology access and professional development for successful integration and implementation of technology in teaching Mathematics.

The significance of this research extends beyond academic inquiry, as the findings may inform policy recommendations and practical strategies for enhancing mathematics education in Zambia, a country striving for improved educational outcomes a midst global technological advancements. As identified in existing literature, "Ongoing opportunities for teachers to participate in professional learning, including in-person and tech-enabled learning, are crucial" (e-School News). By addressing the intersection of digital education and mathematics pedagogy, this study aspires to contribute valuable insights to both educational practice and policy development, providing a framework for future initiatives that could enrich the learning experiences of students in Zambia and similar contexts.

2. Role of Digital Tools in Enhancing Engagement

The integration of digital tools in teaching mathematics not only supports curricula but also plays a crucial role in enhancing student engagement, particularly in the context of secondary education at Matero Boys Secondary School. Findings from this study reveal that the employment of educational technology, especially platforms like GeoGebra, significantly increased the level of interest and participation among students during lessons focused on geometric transformations. Specifically, 80% of students reported that the use of these digital resources made mathematics more enjoyable and accessible. This contrasts with traditional teaching methods, where students often struggle to connect with abstract mathematical concepts. Additionally, the qualitative feedback collected during interviews supports the quantitative data, as students articulated their preference for interactive learning environments where they could visualize and manipulate mathematical ideas directly through technology. Practically, the study highlights the necessity of investing in training programs for teachers, equipping them to effectively leverage digital tools in the classroom. Finally, fostering engagement through digital tools provides an avenue for

addressing educational disparities, aligning with the broader push for inclusive mathematics education that caters to the diverse learning needs of learners. Thus, this research not only elucidates the essential relationship between digital tools and student engagement but also advocates for actionable frameworks that support both teachers and students in maximizing the potential of technology in teaching mathematics.

3. FACTORS INFLUENCING THE EFFECTIVENESS OF TECHNOLOGY INTEGRATION

The effectiveness of technology integration in mathematics education at Matero Boys Secondary School is influenced by several key factors that shape the teaching and learning environment as highlighted in the table below.

Factor	Description	Impact on Effectiveness
Teacher Training	The level of training that teachers have received in using technology for teaching.	High
Access to Technology	Availability of computers, tablets, and internet access for both teachers and students.	Medium
Curriculum Design	Incorporation of technology-focused learning objectives within the mathematics curriculum.	High
Student Engagement	Level of student interest and interaction with technology-enhanced learning activities.	High
Support from Administration	Support provided by school administration for technology integration initiatives.	Medium

Table 5.1.4. Factors Influencing the Effectiveness of Technology Integration in Mathematics Teaching

4. TEACHERS' PERCEPTIONS OF DIGITAL TOOLS

The perceptions of teachers regarding digital tools play a critical role in the successful implementation of technology in mathematics education at Matero Boys Secondary School, shaping both their instructional strategies and the learning experiences of students. Findings from this study indicate that the majority of teachers expressed positive attitudes towards the use of digital resources, particularly highlighting their ability to foster student engagement and enhance understanding of mathematical concepts. Over 75% of the teachers reported increased enthusiasm among students when lessons incorporated technology.

However, despite these positive perceptions, teachers also voiced concerns regarding their preparedness to utilize these tools effectively, with many indicating a need for more comprehensive training and support. Interestingly, while teachers recognized the benefits of technology, they also identified infrastructural challenges, such as limited access to reliable internet and insufficient technological resources, as critical barriers to effective technology integration. Qualitative feedback gathered from interviews indicated that teachers feel more comfortable implementing digital tools in collaborative lesson formats, suggesting the necessity for teaching strategies that incorporate peer learning and professional development opportunities. The implications of these findings are significant.

Theoretically, they support the notion that teacher perceptions are fundamental to the successful integration of technology in education, highlighting the need for educational policies that prioritize teacher training and technological infrastructure. Practically, addressing the gaps in teacher preparedness can transform the mathematical learning landscape, enabling teachers to fully leverage digital tools to improve student outcomes. By fostering a supportive environment that equips teachers with the skills necessary to integrate technology seamlessly, this research suggests a framework for enhancing mathematical instruction through the strategic use of digital resources. The evidence presented here contributes to a growing body of research advocating for the integration of technology as a necessary component of modern educational practices. Ultimately, understanding teachers' perceptions is imperative for shaping effective educational strategies that bridge the digital divide and support meaningful learning experiences in mathematics education at Matero Boys and similar institutions.

5. BARRIERS TO EFFECTIVE INTEGRATION

The process of integrating digital tools into mathematics education at Matero Boys Secondary School is fraught with several barriers that challenge its effectiveness and sustainability. Findings from this study indicate that inadequate infrastructure, particularly unreliable internet access and limited availability of devices, poses significant obstacles for both teachers and students in incorporating digital tools in teaching and learning mathematics. These infrastructural limitations are particularly relevant in the Zambian context, where many schools contend with outdated technology and insufficient resources, poor network coverage, and financial insufficiency, ultimately hindering the potential takeoff of digital integration in the teaching of mathematics.

The existence of gaps in teacher training is another essential barrier to the successful implementation of technology in mathematics instruction. Some teachers expressed a lack of confidence in their ability to utilize digital tools, indicating that significant professional development efforts are required to boost their competence and comfort levels in handling and using digital tools. Varying degrees of technological familiarity among students due to their varied social status emerged as a notable element influencing the seamless integration of these tools in classrooms. The implications of these findings are diverse, given the

theoretical relevance of developing robust frameworks in education that address both infrastructural and pedagogical challenges in technology integration in the teaching of Mathematics.

Addressing these barriers will require ongoing advocacy and collaboration between policymakers, educators, and community stakeholders to create conducive learning environments that leverage the potential of digital technologies in mathematics education in secondary schools. In conclusion, while digital integration holds promise for enhancing mathematics instruction at Matero Boys, it is imperative to systematically address the barriers identified in this study to realize its full potential. By fostering a supportive ecosystem that enables both teachers and students to engage meaningfully with digital tools. Thus, this inquiry calls for a comprehensive strategy to transform the educational landscape into one that equips all students for success in an increasingly digital world.

6. FUTURE DIRECTIONS

In light of the findings from this study on the digital impact on teaching mathematics at Matero Boys Secondary School, several recommendations emerge for educators aiming to enhance their instructional practices through the effective integration of technology.

I. It is essential for educators to actively seek professional development opportunities focused on digital tools specifically designed for mathematics education. The study found that teachers who engaged in training demonstrated increased confidence and competence in utilizing available resources resulting in improved student engagement and performance.

II. Consequently, fostering a culture of ongoing learning and adaptation among teachers is paramount to maximizing the benefits of digital technology in the classroom.

III. Furthermore, educators should prioritize collaborative approaches in lesson planning that incorporate interactive digital resources.

IV. Key findings show that collaborative learning activities facilitated through technological tools significantly boosted student interest and understanding of complex mathematical concepts.

V. Teachers can enhance problem-solving skills and critical thinking by designing lessons that allow students to explore mathematical ideas collaboratively.

VI. Additionally, it is recommended that mathematics educators utilize formative assessments to gauge student understanding and inform instructional adjustments. The ability to gather real-time feedback through digital platforms can provide educators with valuable insights into students' ongoing challenges, enabling timely interventions that address learning gaps effectively. Research indicates that effective use of formative assessments can lead to substantial improvements in academic performance.

These recommendations extend beyond individual classrooms, influencing broader educational practices within Zambian secondary schools. By embracing professional development, collaborative instructional strategies, and formative assessments, educators can create a more engaging and supportive environment that fosters student success. These initiatives can serve to advance the discourse on the digital integration of mathematics education, laying the groundwork for systematic changes that enhance teaching quality across the region. As such, these recommendations are designed not only to benefit current pedagogical practices but also to support the evolution of mathematics education in Zambia. Ultimately, by

implementing these strategies, educators can play a pivotal role in shaping a more inclusive and effective learning landscape that prepares students for future challenges in mathematics and beyond.

7. CONCLUSION

Throughout this study, the exploration of the digital impact on teaching mathematics at Matero Boys Secondary School has provided significant insights into the transformative effects of technology on educational practices. Key findings revealed that integrating digital tools heightened engagement levels wherein approximately 80% of students reported greater motivation and enjoyment in their mathematics classes and increased understanding of the content. This effectively answers the research problem by clearly demonstrating that digital technology can play a crucial role in enhancing student learning outcomes and engagement in mathematics education. The implications of these findings extend beyond the confines of a singular case study, contributing valuable evidence to the academic discourse surrounding digital education in mathematics. It underscores the imperative for educational officials to prioritize expenditures in technology and teacher training, ensuring that all educators possess the requisite skills for the efficient integration of digital resources in their instructions and student learning.

addressing infrastructural barriers remains critical based on the findings. Looking toward the future, further research should consider longitudinal studies that track the sustained impact of digital tool usage on student performance over multiple academic years, as such research could provide deeper insights into how technology influences learning trajectories.

Exploring the effectiveness of a wider range of technological educational resources across various mathematical domains would support teachers in identifying the most beneficial tools for enhancing learning.

Engaging with different stakeholder perspectives, especially the parents and the school board members, can further enrich the understanding of technology integration and its impact on educational environments. Ultimately, the final thoughts of this research reinforce not only the importance of digital tool integration in mathematics education but also the need for ongoing conversation and collaboration among educators, policymakers, and communities to optimize technology's impact on learning outcomes. This study, therefore, catalyzes continued exploration and investment in the intersection of technology and education.

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References

1. Abu Talib, M., Bettayeb, A. M., & Omer, R. I. (2021). Analytical study on the impact of technology in higher education during the age of COVID-19: Systematic literature review. Education and information technologies, 26(6), 6719-6746.
2. Adams, R. J., Wilson, M. R., & Wang, L. (2018). *Mathematics and higher education: A key to success*. Educational Testing Service.

3. Alcardo Alex Barakabitze, William A. L. Anangisye, Neterindwa Ainea, Michael Hamza Mkwizu, Hellen Maziku, Alex Xavery Matofali, Aziza Juma Iddi, et al. (2019). Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities. Volume(2019), 1-29. Education Research International.
4. Alice Makunganya, O. Amos (2024). ATTITUDES OF TEACHERS TOWARDS ICT INTEGRATION IN TEACHING OF MATHEMATICS IN PUBLIC SECONDARY SCHOOLS IN MOROGORO MUNICIPAL, TANZANIA. International Journal of Education Humanities and Social Science.
5. Amaya D., Attard C., Baek E., Durksen T.L., Gustiani I., Hansen T.I., Leis M., et al. (2018). "Construction and validation of a questionnaire to assess student satisfaction with mathematics learning materials". 'Association for Computing Machinery (ACM)'. https://core.ac.uk/download/225123986.pdf
6. Andrade, H. (2005). Teaching with rubrics: The good, the bad, and the ugly. *College Teaching*, 53(1), 27-31.
7. Attard, C. & Holmes, K. (2022). An exploration of teacher and student perceptions of blended learning in four secondary mathematics classrooms. Mathematics Education Research Journal.
8. Baker, D. J., & Goetz, E. (2013). The impact of technology on mathematics education: A critical review. *International Journal of Mathematics Teaching and Learning*, 14(3), 1-15.
9. Baker, R. S., D'Mello, S. K., & Ramineni, C. (2016). Educational data mining: A review of the state of the art. *Journal of Educational Data Mining*, 8(1), 1-13.
10. Baker, R. S., D'Mello, S. K., & Ramineni, C. (2018). Educational data mining: A review of the state of the art. *Journal of Educational Data Mining*, 10(1), 1-59.
11. Barnett, R., & Coate, K. (2005). *Engaging the curriculum in higher education*. McGraw-Hill Education.
12. Becker, K., & Park, K. (2011). Effects of integrative approaches among STEM subjects on students' learning: A preliminary meta-analysis. *Journal of STEM Education Research*, 2(2), 23-37.
13. Bernard Mukeshimana, H. Andala (2024). Technological Usage and Students' Performance in Mathematics in Public Secondary Schools in Rwanda: A Case of Kayonza District. African Journal of Empirical Research.
14. Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university*. McGraw-Hill Education.
15. Björn Haßler, Louis Major, Sara Hennessy (2015). Tablet use in schools: a critical review of the evidence for learning outcomes. Volume(32), 139-156. Journal of Computer Assisted Learning.
16. Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policies, and Practices*, 5(1), 7-74.
17. Bosco Mudaheranwa, Celestin Ntivuguruzwa (2024). Perception of Teachers and Students on the Use of Smart Classroom in Teaching and Learning Mathematics for Rwandan Secondary Schools in Nyarugenge District. Journal of Research Innovation and Implications in Education.
18. Brown, A. (2021). Effective pedagogical strategies in mathematics education. *Journal of Mathematics Education*, 12(3), 45-58.
19. BWALYA, DARREN (2019). "Influence of Geogebra on Students' Achievement in Geometric Transformations and Attitude towards Learning Mathematics with Technology". The International Institute for Science, Technology and Education (IISTE).

20. C. Orellana (2016). Investigating the use of CAS calculators by senior secondary mathematics students.
21. Capt Emmanuel Jinyunga Kalombe, Dr Dani Eliya Banda (2023). The Decline of Commercial Pilot Training Initiatives in Zambia: Considering the Impending Global Pilot Shortage. Volume(134). International Journal of Research Publications.
22. Chanda Chansa Thelma (2024). An Assessment on Government Funding for Teaching and Learning Materials: A Case of Selected Secondary Schools in Lusaka District, Zambia. Volume(5), 1772-1778. International Journal of Research Publication and Reviews.
23. Chisembe, Clement, Musonda, Allan, Musonda, Felix F., Sampa, et al. (2018). "Teaching of Earth Geometry at Secondary School in Zambia". The International Institute for Science, Technology and Education (IISTE).
24. Choudhary, K., DeCost, B., Chen, C., Jain, A., Tavazza, F., Cohn, R., ... & Wolverton, C. (2022). Recent advances and applications of deep learning methods in materials science. npj Computational Materials, 8(1), 59.
25. Comfort Oluwasesan Akinwamide, S. Olofin, Emmanuel Temidayo Fagbemija (2023). Imperatives of Pedagogical Update for Mathematics Education: The Digital Technology Sensibility in a Resilient Professionals World. British Journal of Education.
26. Cox, M. J., & Marshall, D. (2007). The impact of ICT in schools – A landscape review. *British Educational Communications and Technology Agency*.
27. Dahal, N., Manandhar, N. K., Luitel, L., Luitel, B. C., Pant, B. P., & Shrestha, I. M. (2022). ICT tools for remote teaching and learning mathematics: A proposal for autonomy and engagements. Online Submission, 2(1), 289-296.
28. Davis, N. E., & Wada, M. (2019). Emerging trends in digital technology and education: Implications for secondary education. *Journal of Educational Technology & Society*, 22(3), 23-34.
29. Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward a framework for design and analysis. *Educational Policy*, 23(5), 676-706.
30. Dimitra Kokotsaki, Victoria Menzies, Andy Wiggins (2016). "Project-based learning: A review of the literature". 19. pp. 267-277.
31. Eddie M. Mulenga, José María Marbán Prieto (2020). Is COVID-19 the Gateway for Digital Learning in Mathematics Education? Volume(12), ep269-ep269. Contemporary Educational Technology.
32. Edgar John Sintema (2020). "Effect of COVID-19 on the Performance of Grade 12 Students: Implications for STEM Education". 16.
33. Edith Lindenbauer, Eva-Maria Infanger, Z. Lavicza (2024). Enhancing mathematics education through collaborative digital material design: Lessons from a national project. European Journal of Science and Mathematics Education.
34. Elizabeth Greef (2016). What does the library have to do with it? The success of Finnish education in PISA tests and the role of school and public libraries. IASL Annual Conference Proceedings.
35. Engin Karahan, Sedef Canbazoğlu Bilici, A. A. Ünal (2015). "Integration of Media Design Processes in Science, Technology, Engineering, and Mathematics (STEM) Education". 15. pp. 221-240.
36. Ertmer, P. A. (1999). Addressing the technology integration challenge: The importance of teacher knowledge. *Journal of Educational Technology Systems*, 28(4), 329-340.

37. Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology use as a function of pedagogical beliefs: A developmental model. *Journal of Research on Technology in Education*, 42(3), 255-284.
38. Eva Schmidthaler, Maritta Schalk, Mathias Schmollmüller, Sara Hinterplattner, Corinna Hörmann, B. Anđić, Marina Rottenhofer, et al. (2023). The interdisciplinary implementation of poly-universe to promote computational thinking: Teaching examples from biological, physical, and digital education in Austrian secondary schools. Volume(14). Frontiers in Psychology.
39. Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59-109.
40. Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410-8415.
41. Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, 38(4), 915-945.
42. Garrison, D. R., & Vaughan, N. D. (2008). *Blended learning in higher education: Framework, principles, and guidelines*. John Wiley & Sons.
43. Ghazal, T. M., Hasan, M. K., Alshurideh, M. T., Alzoubi, H. M., Ahmad, M., Akbar, S. S., ... & Akour, I. A. (2021). IoT for smart cities: Machine learning approaches in smart healthcare—A review. Future Internet, 13(8), 218.
44. Giorgi Basilaia, D. K. Kvavadze (2020). "Transition to Online Education in Schools during a SARS-CoV-2 Coronavirus (COVID-19) Pandemic in Georgia". 5.
45. Gita Steiner-Khamsi, Moira V. Faul, Mike Klassen, Keith Lewin, Laura Poswell, Ashleigh Morrell, Devyani Pershad, et al. (2023). Systems Thinking in International Education and Development. . Edward Elgar Publishing eBooks.
46. Gordon, K. (2014). Classroom climate: The key to student achievement. *Educational Leadership*, 72(5), 22-27.
47. Graham, C. R., Borup, J., & Smith, L. (2013). Technology integration in teacher preparation programs: A study of the factors influencing the integration of technology in teacher education programs. *Journal of Technology and Teacher Education*, 21(1), 49-70.
48. Harden, R. M., & Crosby, J. (2000). AMEE Guide No. 20: The good teacher is more than a lecturer – The twelve roles of the teacher. *Medical Teacher*, 22(4), 334-347.
49. Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.
50. Hennessey, S., Ruthven, K., & Brindley, S. (2016). A review of studies of ICT in mathematics education: What do we know and what do we need to know? *Research in Mathematics Education*, 18(1), 22-40.
51. Henri-Bernard Solignac-Lecomte, Delphine Grandrieux, Elizabeth Nash (2021). Education-occupation mismatch in the context of informality and development. OECD Development Centre working papers.
52. Hepp, P., Hinostroza, E., Laval, E., & Reh, A. (2004). Technology in schools: To what extent is it used? *World Bank*.

53. Hew, K. F., & Brush, T. (2007). Integrating technology in K-12 classrooms: Current practices and future directions. *Educational Technology Research and Development*, 55(3), 223-252.
54. Higgins, S., Xiao, Z., & Katsipataki, M. (2012). The impact of digital technology on learning: A summary for the Education Endowment Foundation. *Education Endowment Foundation*.
55. Howland, J. L., Jonassen, D. H., & Marra, R. M. (2014). *Learning to teach with technology: A practical guide for the 21st century classroom*. Pearson Higher Ed.
56. Hsu, Y. S., Ching, Y. H., & Grabowski, B. L. (2015). The role of digital tools in supporting collaborative learning in mathematics. *Mathematics Education Research Journal*, 27(4), 379-400.
57. Iddo Gal, Anke Grotlüschen, Dave Tout, Gabriele Kaiser (2020). "Numeracy, adult education, and vulnerable adults: a critical view of a neglected field". 52. pp. 377-394.
58. Inan, F. A., & Lowther, D. L. (2010). Laptops in the classroom: The impact on student engagement and learning. *Computers & Education*, 55(2), 701-711.
59. J. Marbán, E. M. Mulenga (2022). Social Media Usage Among University Students of Mathematics Education in Zambia: A Quantitative Analysis Approach. International Journal for Technology in Mathematics Education.
60. Jean Byiringiro, Mugiraneza Faustin (2024). Technology-Integrated Instructions and Basic Mathematics Skills Acquisition in Public Secondary Schools in Rwanda: A Case of Nyagatare District. International Journal of Management and Development Studies.
61. Jhang, Y., Chen, Y., & Tseng, C. (2018). The relationship between learning environment and learning outcomes. *Educational Technology & Society*, 21(1), 196-207.
62. Jones, M., & Smith, R. (2022). Creating engaging mathematics learning environments. *Educational Research Review*, 18(4), 201-215.
63. Joshua-Luther Ndoye Upoalkpajor, Cornelius Bawa Upoalkpajor (2020). The Impact of COVID-19 on Education in Ghana. Asian Journal of Education and Social Studies.
64. Kagan, D. M. (1992). Professional growth among preservice and inservice teachers. *Review of Educational Research*, 62(2), 129-169.
65. Kalisto Kalimaposo, Siana Moono, Harrison Daka, Sanny Mulubale, Chivunda Kaumba, Fumbani Mphande (2023). PERCEIVED CHALLENGES OF ICT AS AN EXAMINABLE CURRICULUM SUBJECT IN RURAL SECONDARY SCHOOLS: VOICES OF TEACHERS AND LEARNERS IN SOUTHERN ZAMBIA. Volume(10). European Journal of Education Studies.
66. Kay, R. H., & Knaack, L. (2008). Exploring the use of Web 2.0 tools in K-12 classrooms. *Computers in the Schools*, 25(3), 263-275.
67. Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. National Academy Press.
68. Kirkpatrick, A., Xu, J., & Wang, Y. (2018). The role of leadership in integrating technology into educational settings. *International Journal of Educational Management*, 32(4), 651-664.
69. Kordaki, M., & Potari, D. (2016). The role of digital games in mathematics education: A review of the research. *Journal of Mathematical Behavior*, 41, 117-133.
70. Korte, W. B., & Hüsing, T. (2014). *The integration of ICT in education in Europe*. European Schoolnet.
71. Kumar, P. (2021). The role of digital tools in fostering student engagement in mathematics. *International Journal of Educational Technology*, 9(2), 33-47.

72. Ladson-Billings, G. (1994). The Dream keepers: Successful teachers of African American children. *Jossey-Bass*.
73. Lee, J., Lee, H., & Wang, Y. (2014). Effects of virtual manipulatives on students' mathematics learning: A meta-analysis. *Computers & Education*, 78, 309-320.
74. Lee, S., Kim, H., & Park, J. (2019). Digital technology in diverse educational settings: A review of the literature. *Educational Technology Research and Development*, 67(6), 1321-1340.
75. Li, Q., & Ma, X. (2018). A review of technology use in mathematics education: The role of digital tools. *International Journal of Mathematics Teaching and Learning*, 19(1), 1-17.
76. Lubna Rashid (2019). "Entrepreneurship Education and Sustainable Development Goals: A literature Review and a Closer Look at Fragile States and Technology-Enabled Approaches". 11. pp. 5343-5343.
77. Lyn D. English (2016). "STEM education K-12: perspectives on integration". 3.
78. Marie Cronqvist, Fredrik Norén, Emil Stjernholm (2024). Media Tactics in the Long Twentieth Century. . Routledge eBooks.
79. Meyer, B., Richey, R. C., & Rinnov, C. (2018). The Data Revolution: Implications for education. *Computer Assisted Language Learning*, 31(1), 10-32.
80. Miller, D. (2015). Digital tools and mathematics teaching: A review of the literature. *Mathematics Education Research Journal*, 27(2), 151-168.
81. Miller, R. (2003). *Learning outcomes: A practical guide*. Learning and Teaching Support Network.
82. Miller, R. J., McGowan, C., & Smith, L. (2018). Digital divides in urban education: A review of the literature. *Tech Trends*, 62(4), 309-316.
83. Mohammed Amine Togou, Covadonga Lorenzo, Gianluca Cornetta, Gabriel-Miro Muntean (2020). "Assessing the Effectiveness of Using Fab Lab-Based Learning in Schools on K–12 Students' Attitude Toward STEAM". 63. pp. 56-62.
84. Mofreh Al-Zahrani, M. (2013). Electronical practices in mathematics teaching at secondary school and a proposal for improvement.
85. Mouza, C. (2009). The role of teacher beliefs in the integration of technology in the classroom. *Journal of Research on Technology in Education*, 41(1), 1-28.
86. Moyer-Packenham, P. S., & Dindar, M. (2014). The role of technology in mathematics education: An overview of relevant research. *Contemporary Issues in Technology and Teacher Education*, 14(2), 131-156.
87. Moyer-Packenham, P., & Leadbetter, J. (2015). The role of digital tools in mathematics education: A review of research. *Mathematics Education Research Journal*, 27(2), 159-184.
88. Mrs. Brenda Bukowa, bukowab (2017). Young People and The Digital Age : An Investigation of The ' Sociability ' of Teenagers In Lusaka . (Conference ID : CFP / 519 / 2017).
89. Mulenga Mwambazi Chrispine, Francis Simui (2024). Exploring the Art of Pedagogy in Teaching Linear Programming to Support Novice Performance at Munkuye Secondary School in Nkeyema District: A Hermeneutics Phenomenological Perspective. Volume(3), 8-15. American Journal of Life Science and Innovation.
90. NCTM (National Council of Teachers of Mathematics). (2018). *Principles and standards for school mathematics*. NCTM.
91. Nguyen, T. (2018). Connecting concepts through digital technology: Enhancing mathematics instruction. *Mathematics Teacher Education and Development*, 20(1), 56-72.

92. O'Connor, E. A., & McCarthey, K. (2007). Teacher beliefs and the enactment of a new literacy curriculum. *Journal of Educational Research*, 100(4), 233-245.
93. Olaf Zawacki-Richter, Victoria I. Marín, Melissa Bond, Franziska Gouverneur (2019). "Systematic review of research on artificial intelligence applications in higher education – where are the educators?". 16.
94. Omar Arias, David K. Evans, Indhira Santos (2019). "The Skills Balancing Act in Sub-Saharan Africa: Investing in Skills for Productivity, Inclusivity, and Adaptability".
95. Pajares, F. (1992). Teachers' beliefs and educational research: Clearing up a messy construct. *Review of Educational Research*, 62(3), 307-332.
96. Peter Chisanda Baraza Chesitit (2015). Impact of ICT Integration on Mathematics Performance in Kenya: A Case Study of Public Secondary Schools in West Pokot County.
97. Piaget, J. (1973). *To understand is to invent: The psychology of the creative process*. New York: Viking Press.
98. Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, 93(3), 223-231.
99. Richardson, V. (2003). Pre-service teachers' beliefs. In *Handbook of research on teacher education* (pp. 102-119). Routledge.
100. Sara Hennessy, Sophia D'Angelo, Nora McIntyre, Saalim Koomar, Adam Kreimeia, Lydia Cao, Meaghan Brugha, et al. (2022). "Technology Use for Teacher Professional Development in Low- and Middle-Income Countries: A systematic review". 3. pp. 100080-100080.
101. Schmid, R. F., Van der Werf, G., & Hiemstra, B. (2014). The influence of technology on the learning process: A systematic review. Educational Technology Research and Development, 62(3), 345-369.
102. Schwab, K. (2016). The Fourth Industrial Revolution. Crown Business.
103. Shute, V. J. (2008). Focus on formative feedback. Review of Educational Research, 78(1), 153-189.
104. Sifundo Nkomo, Walter Matli (2022). Emergency Remote Education in Southern African Schools: Digital Transformation Bridging the Gap in the COVID-19 Era. Volume(7). International Journal of Educational Development in Africa
105. Smith, L., & Garcia, E. (2017). Understanding the impact of technology on student learning outcomes. Contemporary Educational Technology, 8(2), 118-136.
106. Susan McKenney, Thomas C. Reeves (2018). "Conducting Educational Design Research". https://doi.org/10.4324/9781315105642
107. Taylor, R., & Green, D. (2020). The evolution of technology in mathematics education. Mathematics Education Research Journal, 32(1), 1-20.
108. Thompson, A. D., Schmidt, D. A., & Davis, N. (2005). Framework for teacher knowledge and technology integration. TechTrends, 49(2), 22-28.
109. Thurm, D. & Barzel, B. (2022). Teaching mathematics with technology: A multidimen
110. U.S. Department of Education. (2017). Reimagining the role of technology in education: 2017 National Education Technology Plan Update. Office of Educational Technology.
111. UNESCO. (2019). Digital transformation in education: Education 2030 framework for action. United Nations Educational, Scientific and Cultural Organization.

112. Viberg, O., Grönlund, Å., & Törner, G. (2023). Digital technology tools in mathematics education: A systematic review. Journal of Educational Technology, 15(2), 87-104.
113. Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences: What are the implications for the future? Journal of Curriculum Studies, 44(3), 299-321.
114. W. Phiri (2016). Pupils' and teachers' perception toward the use of Information and Communication Technology (ICT) in the teaching and learning of Mathematics in selected secondary schools of Central Province, Zambia. Volume(3), 77-87. International Journal of Multidisciplinary Research and Development.
115. Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. Educational Technology Research and Development, 53(4), 5-23.
116. Wiest, L. R. (2024). Digital tools and resources in mathematics education: A new frontier. Mathematics Education Research Journal, 26(2), 213-230.
117. Wu, X., Zhang, D., & Wang, Y. (2020). The influence of digital resources on students' learning motivation and achievement in mathematics. Journal of Educational Psychology, 112(5), 912-926.
118. Young, S., & Hsu, C. (2020). Challenges of digital education in under-resourced schools: Lessons from the field. International Journal of Educational Research, 103, 101-110.
119. Yurdakul, I. (2017). The role of professional development in improving teachers' technology integration in mathematics education. International Journal of Educational Research, 83, 172-179.
120. Zevenbergen, R. (2018). Technology and mathematics education: What does the future hold? International Journal of Mathematics Education in Science and Technology, 49(5), 631-639.
121. Zheng, B., Warschauer, M., & Fuchs, C. (2016). The role of technology in the learning process: A systematic review of the literature. Journal of Educational Psychology, 108(4), 483-497.