Data-Driven Decision-Making and Its Impacts on Education Quality in Developing Countries: A systematic review

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Abstract: **Data-driven decision-making (DDDM) technologies are increasingly being utilized, aiming to enhance education quality. However, the implementation of these technologies in developing countries is at an early stage, and evidence regarding their impacts on education quality remains limited. Therefore, this paper examines articles that explore the implementation of DDDM technologies and their effects on education quality. We employed PRISMA to select relevant articles published between 2018 and 2022 from ERIC, Science Direct, IEEE Xplore, and Google Scholar databases. A total of 26 studies were identified, showcasing various DDDM technologies employed in developing countries' educational sectors, including learning management systems (LMS), learning analytics tools, massive open online course (MOOC) platforms, e-learning tools, e-assessment systems, recommender and guidance systems, data-driven approaches, personal response systems, collaborator tools, and educational management information systems (EMIS). The adoption of these technologies has shown positive effects such as improved academic performance, timely dissemination of information, enhanced collaboration, improved communication, better decision-making processes, enhanced ICT skills, improved monitoring, immediate feedback provision, and efficient time management. Although DDDM technologies have been more prevalent in higher education settings, their effective utilization in the educational sector of developing countries has not been fully realized. Nonetheless, the adoption and diversification of DDDM technologies in education hold substantial potential for the future. Further research should focus on quantifying the contribution of DDDM technologies to educational quality through rigorous statistical analysis. Additionally, it is essential to explore any potential adverse effects that DDDM may have on educational quality in developing countries.**

Keywords— ***Data-driven decision-making; data-driven decision-making technologies; learning management system; education quality; developing countries***

I. INTRODUCTION

Data-driven decision-making (DDDM) in education refers to the systematic collection, analysis, and utilization of data from various sources to inform decisions aimed at improving student and school success [1]. To harness the vast amount of data generated within and outside educational institutions, several data-driven educational technologies are being employed. A truly data-driven education system relies on educational technologies focused on data to enhance all aspects of the education system, such as the student information system, learning management system, and data warehouse [2]. Data analytics, a crucial component of data-driven educational systems, involves employing techniques and tools to analyze extensive collections of data from diverse sources, with the goal of facilitating and enhancing the decision-making process [3].

The implementation of data-driven educational systems or technologies has been found to enhance education quality in various regions worldwide. Developed countries have extensively utilized data-driven decision-making educational technologies [4], [2]-[5], and some developing countries have also adopted these technologies, resulting in improvements in education quality [6]-[7], [8]-[9]. Studies have shown that implementing data-driven decision-making technologies in developing countries has positive effects on education quality, including improved academic performance, enhanced collaborative learning, improved communication, better decision-making, timely dissemination of information, and increased knowledge sharing [6]-[7], [8]-[10], [9]-[11],[12]-[13],[14]-[15],[10]-[16], [17]-[18].

However, a study by [19] revealed that African countries, classified as developing nations, face challenges in keeping pace with the rapidly evolving data-driven global economy. Although this negative effect is not amplified in our study, it is worth noting that the implementation of e-learning during the COVID-19 lockdown did not yield significant changes due to inadequate infrastructure and networking [20], potentially resulting in financial burdens.

While extensive research has been conducted on the significant impact of data-driven decision-making in achieving educational success in developed nations, to our knowledge, no systematic review has focused on data-driven decision-making and its effects on enhancing education quality in developing countries. Furthermore, a research gap exists in understanding the current state of utilization of data-driven educational technologies and their impact on improving education quality in developing countries. Therefore, the objective of this systematic review is to identify the various types of data-driven technologies used in developing countries and examine their effects on enhancing education quality. The findings of this review can benefit educational stakeholders, policymakers, and institutions that have been slower in implementing data-driven technologies, providing them with valuable insights to adopt and utilize different data-driven decision-making technologies. Therefore, this review addresses the following question: What are the effects of using data-driven decision-making educational technologies on education quality in developing countries? To adequately answer this question, the study examines the types of data-based educational technologies utilized in developing countries across all levels of education, from primary to tertiary. Additionally, it

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will explore the implementation of data-driven decision-making in education within developing countries.

By conducting this systematic review, we aim to contribute to the existing knowledge base on the utilization of data-driven educational technologies and their effects on education quality in developing countries. Ultimately, the review can help to promote the effective use of data-driven technologies to enhance education quality and facilitate positive educational outcomes in developing nations.

II. Methods

This review was carried out using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Checklist.

A. Eligibility Criteria

To find articles that matched the study's objectives, we used the inclusion and exclusion criteria listed in Table 1 below.

TABLE 1. INCLUSION AND EXCLUSION CRITERIA

	Criteria
Inclusion	Articles published in English in the last five years (between the years 2018 to 2022)
	Full text available to the investigators
	Published in peer-reviewed journals
	Articles discussing data-based decision-making technologies in primary, secondary, and tertiary educational institutions in developing countries.
	Articles reporting on at least one main or sub-component of data-driven decision-making.
	Articles report data-driven decision-making with the aid of information and communication technology.
	Studies report data-driven decision-making and its impact on education quality in developing countries.
Exclusion	Articles do not discuss data-driven decision-making technologies in countries other than developing ones.
	Articles do not discuss the impacts of DDDM technologies on education quality in developing countries.
	Articles discussing only DDDM without ICT
	White papers, books, reports, conference papers, and articles written in languages other than English

B. Information sources, search strategy, and selection process

To achieve our research objective and gather relevant research articles, we conducted scoping searches on open-access databases using our predetermined key terms. The aim was to identify articles that align with our research goal. We utilized four databases, including the Education Resources Information Centre (ERIC), Science Direct, Institute of Electrical and Electronics Engineers (IEEE Xplore), and Google Scholar. Additionally, we performed a manual search using the Google search engine to locate additional relevant resources. These databases and search engines were chosen for their potential to provide valuable data for our review inquiries.

To identify pertinent articles, we developed three core concepts to construct our search phrases: Concept 1: Data-driven decision-making, Concept 2: Education, and Concept 3: Developing countries. Once we established these key concepts, we employed a standard dictionary and expert knowledge to identify synonyms and related terms. The search string we used is as follows:

((“Data-driven decision making” OR “Data-driven Approach” OR “data-driven decision support system” OR “Data” OR “analytics” OR “data analytics” OR “learning analytics” OR “ big data” OR “big data analytics” OR “educational data mining” OR “educational innovations” OR “Educational applications” OR “educational software” OR “learning management systems” OR “student information systems” OR “e-learning” OR “online courses”) AND (“Education” OR “Primary education” OR “secondary education” OR “tertiary education” OR “Higher education” OR “higher education institutions” OR “higher learning institutions” OR “University”) AND (“Developing countries” OR “developing nations” OR Third world countries” OR “least developed countries” OR “Africa” OR “Asia”))

Furthermore, we tested the search phrases across different databases. Based on the results of the tests and the specific search criteria of each database, we made adjustments and customizations to certain search sources to optimize the search process.

During our research, we conducted a manual search using the phrase "Data-driven decision-making and its impact on education in developing countries" on various databases and websites. We intentionally excluded the term "quality" from the search phrase to ensure comprehensive coverage of relevant publications. Peer-reviewed journals were specifically included in the search.

To streamline the review process, we imported all search results into Mendeley and removed duplicate records. The first author assessed the relevance of titles and abstracts based on predetermined criteria. Selected articles were independently read by the first and second authors, who determined their inclusion based on the selection criteria. The two authors compared their choices, reached a consensus, and independently evaluated the quality of the included studies using predetermined criteria. Any disagreements were settled through discussion, with input from the third author.

C. Data collection process, data items, data analysis and synthesis

For data collection, we used the primary concepts from our research question. A pilot-tested data extraction form was developed, and information such as author names, publication year, research design, data collection methods, study participant types, intervention types, and various outcomes were extracted from each study. We identified different data-driven decision-making technologies used in educational institutions across primary to tertiary levels and documented the findings.

During data analysis, the extracted information was categorized into two groups: impacts and DDDM technology. Additional relevant terms were further classified according to educational levels. A comprehensive review and comparison of our findings with earlier literature on the identified topics were conducted.

Overall, we performed a systematic review by searching databases and websites, eliminating duplicates, assessing relevance, evaluating study quality, and extracting data. The analysis focused on categorizing impacts and DDDM technology, considering educational levels. This rigorous process ensured the comprehensive exploration of data-driven decision-making and its impact on education in developing countries.

D. Risk of bias

Each study included in the review underwent an evaluation process utilizing a checklist developed by [21] consisting of ten criteria designed to assess the quality of the qualitative studies. The appraisal of the studies was conducted independently by two authors, and the outcomes were compared, and articles that achieved the highest scores

on the checklist were included in our analysis. We carefully adhered to the protocol in order to mitigate any potential biases in the selection of studies to reporting of the findings.

III. Results

A. Study Selection

The search was conducted between October 21, 2021, and July 18, 2022. The search yielded a total of 7,972 articles from the databases and websites included. After removing 995 duplicates, we were left with 6,977 articles. In the first round screening phase, 6,821 articles were excluded based on the selection criteria, leaving us 156 articles for full-text screening. After scanning the full text of these articles, we identified 26 articles that met the inclusion criteria and were selected for further analysis. During the full-text scanning process, three articles were excluded as they did not report on any elements or components of DDDM and did not meet the quality assessment criteria. Therefore, we were left with 26 articles for further analysis.

B. Study characteristics

An overview of the articles included in the study is presented in Figure 1. Except for one article that was published in 2017, all of the articles were published between 2018 and 2022. Because of its potential relevance to our study, the article published in 2017 has been included in the review. Given the broad applicability of information and communication technology (ICT) in various disciplines, the articles were published in different journals focusing on ICT, education, humanities, nursing, informatics in medicine, technological forecasting, and other related fields. The majority of the articles, a total of 13 articles, were published in the Journal of Education and Technologies, followed by E-learning and Digital Media, Information and Management Journals, and others. The selected studies were conducted in seven African and eight Asian countries.

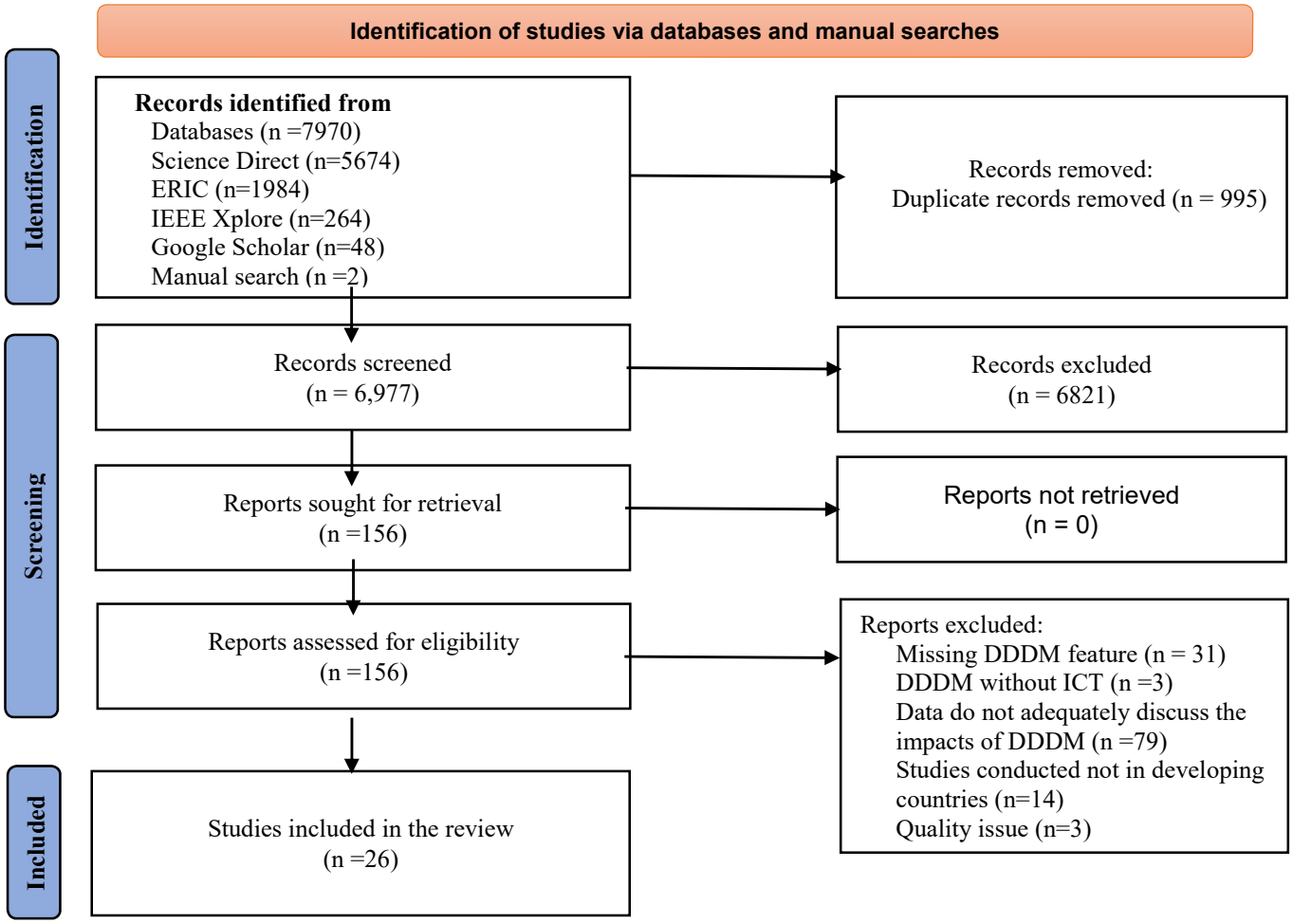

Fig 1. *Flow chart of the article selection process based on PRISMA 2020 (modified from Page et al)*

This section presents the findings from the selected articles, focusing on the types of data-driven decision-making (DDDM) technologies used in educational institutions in developing countries and the impacts of DDDM on education quality.

1. **Types of DDDM Technologies Employed in Developing Country:** Upon analyzing the selected articles, it became evident that various data-driven technologies are employed in educational institutions across developing countries. These technologies encompass a wide range of tools and systems such as learning management systems (LMS), massive open online course (MOOC) platforms, e-learning, online learning, e-assessment systems, recommender and guidance systems, a data-driven approach, learning analytics tools, personal response systems, collaborator tools, and educational management information systems (EMIS).

Among these technologies, LMS emerged as a crucial component of data-driven decision-making (DDDM), extensively utilized in over 90% of the countries studied. LMS is recognized as "web-based systems that facilitate teaching and learning via the Internet with tools that provide interaction between students and their instructors" [8]. The identified LMS types included Moodle, Blackboard, Canvas, and Google LMS [16]-[10], [22]-[8],[23]-[24],[15]. MOOC platforms, known as freely accessible short courses that are delivered online through a suitable

platform [25], were also prevalent in over 50% of the studies, with certain countries developing their platforms such as, SWAYAM in India and Edraak in Jordan [26]–[27]. E-learning and online education were widespread in almost 90% of the studies, typically delivered through LMS or other digital devices [28]-[29], [30]-[31]. Additionally, specific cases highlighted the presence of learning analytics and adaptive learning technologies [8]-[9],[32]. Even if it is reported in one study, developing countries use e-assessment systems [33] and recommender systems [34]. It is worth noting that the majority of the studies focused on higher education, particularly at public universities, while primary and secondary education received limited attention. The distribution of studies among different types of universities revealed that more than 80% were conducted at public universities, 15% at private universities, and 5% at religious universities.

2. **Effects of DDDM on education quality in developing nations:** The results indicate that the implementation of DDDM technology in education has led to improvements in academic performance, timely distribution of learning materials, and increased collaboration and communication among students and lecturers. Additionally, the study identified other positive effects, including enhanced decision-making processes, improved ICT skills, better monitoring, efficient delivery of immediate feedback, and improved time management.

Academic performance is defined as "a measure of the indicative and responsive abilities that express, in an estimated way, what a person has learned as a result of a process of education or training" (Pizarro, 1985) as cited in [35]. We argue that academic performance will be enhanced from different perspectives. In this study, the improvement in the academic performance of students and teachers was reported in 10 articles. Examples from the articles concerning academic performance are the utilization of MOOC improved the ability of teachers [25], the utilization of Moodle LMS improved student performance [8], and the implementation of MIS and LMS improved the productivity, efficiency, quality, teaching, management, and learning process" (*i.e.,* institutional performance) [14]. We can conclude from the results that the evolving effects that occur most frequently, such as the improvement of academic performance, the effective and timely distribution of learning materials, and the improvement of collaboration, point to the fact that educational institutions should prioritize implementing student-centered educational technologies.

Timely and effective dissemination of information: Information dissemination is sharing customer-specific knowledge or information with a sizable group of people or organizations. As a result, the distribution of information, knowledge, and learning resources usually occurs in the educational sector. The timely and effective dissemination of information or learning materials was identified in seven articles. For instance, [14] found that the deployment of Management Information Systems (MIS) and Learning Management Systems (LMS) improved the efficiency and effectiveness of information dissemination. Similarly, [15] highlighted the benefits of implementing Google LMS in providing better access to learning materials. Additionally, [17] and [18] emphasized the effectiveness of online learning through LMS in sharing knowledge with students. While the distribution of learning materials is a crucial aspect of technology-assisted education, this study revealed that it is not adequately observed, which may lead to issues related to data accessibility and other associated concerns.

Improved collaboration: Collaboration is the act of working together to produce something and can encompass various forms in the educational setting, such as the exchange of knowledge or cooperation in the teaching and learning process. Notable instances of improved collaboration were highlighted in some reviewed articles. For instance, [10] noted that using Canvas LMS facilitated student engagement in group discussions. According to [7], Massive Open Online Courses (MOOCs) played a role in fostering collaboration among participants. Additionally, [18] reported that the implementation of cloud-supported collaborative tools, such as Google Drive, resulted in enhanced knowledge sharing.

Improved communication: Information is exchanged between two or more parties through communication. In the education sector, there can be communication between stakeholders and between students and teachers. The impact of enhanced communication was observed in five scholarly articles. Noteworthy instances from these articles include the assertion made by [11] that utilizing a Learning Management System (LMS) resulted in improved communication between academic staff and students. The study by [6] found that the implementation of a personal response system led to the enhancement of students' mathematical communication skills. Additionally, [12] highlighted the significant influence of Massive Open Online Courses (MOOCs) on higher education, particularly regarding effective communication that aligns with core values.

Improved decision-making process: Decision-making refers to the process of making choices by identifying decisions, gathering information, and assessing alternative resolutions [36]. In this discourse, we posit that data assume a significant role in facilitating well-informed decision-making. This notion is supported by two studies, which highlight the positive impact of utilizing data-driven approaches in decision-making processes, whereby [13] demonstrate that employing a data-driven approach leads to enhanced decision-making in the allocation of teachers to schools., and [14] assert that the utilization of Management Information Systems (MIS) and Learning Management Systems (LMS) contributes to greater efficiency and effectiveness in the overall monitoring and decision-making process. It is crucial to emphasize how the implementation of data-intensive technologies is leveraged to augment decision-making in the realm of education.

Enhanced ICT skills: ICT skills are the abilities that enable individuals to utilize various computer programs and technologies effectively. The continuous use of ICT devices has been found to have a positive impact on the development of ICT skills. This research examined the effects of enhanced ICT skills, as discussed in two articles. For instance, [25] found that using a Massive Open Online Course (MOOC) was beneficial in enhancing teachers' ICT skills. Similarly, [9] observed that providing students with learning analytics results facilitated the development of computer skills, enabling them to create applications more easily in face-to-face courses. A single study in our review focused on the use of digital information reports that the use of digital information has "a strong direct effect on students' academic performance, satisfaction, and collaboration behaviors" [37].

Moreover, the research conducted by [14] revealed that the adoption of Management Information Systems (MIS) and Learning Management Systems (LMS) had a positive impact on monitoring, as well as efficient and effective planning. The study by [15] found that the use of Google LMS facilitated the delivery of immediate feedback, while [38] observed that online learning improved time management skills. Additionally, [14] highlighted that MIS and LMS integration supported the coordination of various aspects of the educational system, including teaching, management, administration, and learning activities. Lastly, [27] demonstrated that implementing Massive Open Online Course (MOOC) platforms played a crucial role in reaching marginalized learners. For example, the appropriate utilization of a Learning Management System (LMS) has been shown to enhance monitoring, decision-making, and productivity [[14]. It also facilitates the integration of the entire system [14], enables effective information

dissemination [14]-[15], [10]-[11], [16], improves faculty effectiveness and efficiency, and enables prompt feedback delivery [15]. Additionally, it promotes collaboration through group discussions [14]-[10], enhances communication [11]-[16], and improves academic performance [8]. However, it should be noted that the lack of these effects in some cases that it might be an ineffective utilization of DDDM technologies. Similarly, the utilization of Massive Open Online Course (MOOC) platforms in the studies included in this analysis has resulted in several positive effects on education quality [27]-[25], [12].

IV. Discussion

This study provides insights into the current state of knowledge regarding data-driven decision-making (DDDM) technologies and their impact on the quality of education in developing countries. All the included studies in this review were published within the past five years. We categorized the articles based on their effects, educational levels, types of DDDM technology used, and the countries where they were implemented. Our findings indicate that the most commonly employed DDDM technologies in developing countries are learning management systems (LMS), e-learning (online learning) platforms, and massive open online course (MOOC) platforms. Additionally, although with less prominence in the selected articles, other technologies such as learning analytics tools, personal response systems, cloud-supported collaborative tools (*e.g.*, Google Drive), management information systems (MIS), recommender and e-assessment systems, and digital information were also utilized in the education sector of developing countries.

Due to variations in researchers' objectives and interpretations, certain concepts were used interchangeably or with slight differences. For instance, electronic management information systems were referred to as management information systems in some articles. Similarly, the e-learning platform Blackboard is more commonly known as a learning management system (LMS). While e-learning and online learning were mentioned in nine articles, LMSs were identified in over 90% of the included studies. Hence, it can be concluded that e-learning (online learning) was indirectly identified in 90% of the articles as well. Various LMS platforms, including Blackboard, Moodle, Canvas, and Google LMS, were employed in educational institutions across developing countries.

MOOC platforms were also developed to enhance efficiency for different stakeholders. Examples include SWAYAM in India, a national MOOC portal aimed at learners, and TESSA MOOC in eastern Africa, which focuses on capacity building for teacher educators. Furthermore, there were custom-developed learning analytics systems used in conjunction with LMSs, indicating the potential for advancements in learning analytics within developing countries. Therefore, we emphasize the need for locally relevant solutions that align with the cultural and philosophical perspectives of the users. The results highlight the significant role of educational technologies, including DDDM technologies, in improving education in developing countries. A study by [39] also emphasizes that educational technologies have started to play a role in education in developing countries; however, it points out the inequality in technology access both between countries and within countries.

The types of DDDM technologies employed were found to impact education quality by improving academic performance, timely dissemination of information (learning resources), fostering collaboration (group discussions), enhancing communication, facilitating decision-making, improving ICT skills, monitoring, system integration, environmental sustainability, planning, faculty development, and enhancing faculty capabilities. The studies indicate that the effective utilization of DDDM technologies leads to several positive effects on education quality. Studies by [2]-[4], [40]-[41] demonstrate the effectiveness of DDDM technologies such as learning analytics, LMSs, and DDDM in improving education quality and access.

However, it should be noted that using data-driven decision-making technologies, such as online learning, did not provide additional value for medical students in Vietnam. Similarly, e-learning did not significantly improve education in Nigeria due to poor infrastructure and networking challenges. This suggests that efficient networking and infrastructure, which may require financial investments, are crucial for the successfully implementating of data-driven technologies.

The adoption of data-driven decision-making technologies, such as e-learning apps, may also be influenced by the goals set by educational institutions. For instance, the Faculty of Medicine at Pristina University in Kosovska Mitrovica, Serbia, has implemented the e-learning application Moodle on its website for online learning, while other faculties within the university have not adopted it. In general, using digital information was found to have a significant direct impact on students' academic performance, satisfaction, and collaboration.

V. Conclusion and Future Work

In developing countries, the use and types of DDDM technologies for educational purposes are increasing and looking promising for the future. This study reports the kinds of such technologies used in developing countries for educational purposes and their effects on education quality. The findings showed that LMS, MOOC, e-learning, MIS, personal response systems, cloud-supported collaborative tools, learning analytics tools, educational management information systems, recommender systems, and e-assessment platforms were the types of DDDM technologies used. It is also identified that DDDM technologies were used for the improvement of academic performance, timely dissemination of information, collaboration, and communication, *i.e.,* interaction between lecturers, and students and other stakeholders. Moreover, DDDM technologies were applied to enhance monitoring, feedback delivery, time management, ICT skills, and the ability to reach marginalized students. DDDM technologies were utilized to enhance the quality of education. Effective networking and infrastructure are required for considerable changes. As our findings indicated above, one can argue that DDDM has positive impacts on improving education quality.

This study has practical value since it reveals the beneficial effects of DDDM technology in educational settings in developing countries. This fact may help DDDM technology be introduced more broadly and more quickly in the educational systems of developing countries. In general, the findings of this study may help stakeholders have extensive evidence of DDDM and its impact on improving education quality. We recommend future studies to assess to what extent each DDDM technology can enhance educational quality using quantitative analysis (statistical analysis). In addition, we encourage future research to identify the adverse effects of DDDM on education quality in the context of developing countries.

REFERENCES

[1] J.A. Marsh, J.F. Pane and L.S. Hamilton, *Making sense of data driven decision making in education*. 2006, Santa Monica, ca: RAND CORPORATION.

[2] J. New, "*Building a data-driven education system in the United States*," Center for Data Innovation, 2016. Available: http://www2.datainnovation.org/2016-data-driven-education.pdf.

[3] D.G. Sampson, Educational data analytics technologies for data-driven decision making in schools, 2016.Available: https://elearningindustry.com/educational-data-analytics-technologies.

[4] M. Attaran, J. Stark, and D. Stotler, "Opportunities and Challenges for Big Data Analytics in American Higher Education- A Conceptual Model for Implementation Opportunities and challenges for big data analytics in US higher education : A conceptual model for implementation," no. May, 2018, doi: 10.1177/0950422218770937.

[5] J. Murumba and E. Micheni, "Big Data Analytics in Higher Education : A Review," *International Journal of Engineering and Science* (IJES), vol. 6, no.6, 2017 pp. 14–21, doi: 10.9790/1813-0606021421.

[6] S. Simelane-Mnisi and A. Mji, "Technology-Engagement Teaching Strategy Using Personal Response Systems on Student's Approaches to Learning to Increase the Mathematics Pass Rate," *Journal of Information Technology Education: Research*, vol. 18, 2019, pp. 331–353.

[7] T. M. Wong, "Teaching innovations in Asian higher education : perspectives of educators," vol. 13, no. 2, 2018, pp. 179–190, doi: 10.1108/AAOUJ-12-2018-0032.

[8] I. Mwalumbwe and J. S. Mtebe, "Using learning analytics to predict students' performance in Moodle learning management system: A case of Mbeya University of Science and Technology," *The Electronic Journal of Information Systems in Developing Countries*, vol.79*, no.*1, 2017 pp. 1–13, 2017, doi: 10.1002/j.1681-4835.2017.tb00577.x.

[9] F. G. Karaoglan Yilmaz, "Utilizing Learning Analytics to Support Students' Academic Self-Efficacy and Problem-Solving Skills," *Asia-Pacific Education Researcher*, vol. 31, no. 2, 2019, pp. 175–191, https://doi.org/10.1007/s40299-020-00548-4.

[10] M. N. Yakubu and S. I. Dasuki, "Assessing eLearning Systems Success in Nigeria: An Application of the DeLone and McLean Information Systems Success Model," *Journal of Information Technology Education: Research*, vol. 17, 2018, pp. 183–203, 2018, https://doi.org/10.28945/4077.

[11] M. A. Hamid, S. Salleh, and K. Laxman, "A Study on the Factors Influencing Students' Acceptance of Learning Management Systems (LMS): A Brunei Case Study," *International Journal of Technology in Education and Science*, vol. 4, no. 3, 2020, pp. 203–217.

[12] N. Alhazzani, "MOOC's impact on higher education," *Soc. Sci. Humanit. Open*, vol. 2, no. 1, 2020, doi: https://doi.org/10.1016/j.ssaho.2020.100030.

[13] S. Asim, J. Chimombo, D. Chugunov, and R. Gera, "Moving teachers to Malawi's remote communities: A data-driven approach to teacher deployment," *Int. J. Educ. Dev.*, vol. 65, 2019, pp. 26–43, doi: https://doi.org/10.1016/j.ijedudev.2018.12.002.

[14] M. N. Habib, W. Jamal, U. Khalil, and Z. Khan, "Transforming Universities in Interactive Digital Platform: Case of City University of Science and Information Technology," *Education and Information Technologies*, vol. 26, no. 1, 2021, pp. 517–541, https://doi.org/10.1007/s10639-020-10237-w.

[15] S. Dash, "Google Classroom as a Learning Management System to Teach Biochemistry in a Medical School," *Biochemistry and Molecular Biology Education*, vol. 47, no. 4, 2019, pp. 404–407, doi: https://doi.org/10.1002/bmb.21246.

[16] Y. H. S. Al-Mamary, "Understanding the use of learning management systems by undergraduate university students using the UTAUT model: Credible evidence from Saudi Arabia," *Int. J. Inf. Manag. Data Insights*, vol. 2, no. 2, 2022, doi: https://doi.org/10.1016/j.jjimei.2022.100092.

[17] M. K. Alsmadi *et al.*, "Digitalization of learning in Saudi Arabia during the COVID-19 outbreak: A survey," *Informatics Med. Unlocked*, vol. 25, 2021, doi: https://doi.org/10.1016/j.imu.2021.100632.

[18] N. S. Baanqud, H. Al-Samarraie, A. I. Alzahrani, and O. Alfarraj, "Engagement in Cloud-Supported Collaborative Learning and Student Knowledge Construction: A Modeling Study," *International Journal of Educational Technology in Higher Education*, vol. 17, 2020, doi: https://doi.org/10.1186/s41239-020-00232-z.

[19] S.Osakwe and A.Adeniran, *Strengthening data governance in Africa*, project inception report. Center for the study of the economies of Africa. 2021. Available: https://cseaafrica.org/wp-content/uploads/2021/08/Strengthening-Regional-Data-Governance-in-Africa-1.pdf.

[20] W. O. Oyediran, A. M. Omoare, M. A. Owoyemi, A. O. Adejobi, and R. B. Fasasi, "Prospects and limitations of e-learning application in private tertiary institutions amidst COVID-19 lockdown in Nigeria," *Heliyon*, vol. 6, no. 11, 2020, doi: https://doi.org/10.1016/j.heliyon.2020.e05457.

[21] L.M. Kmet, R.C. Lee, and L.S. Cook, *Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields*, 2004, Alberta Heritage Foundation for Medical Research, 13, pp.1-31.

[22] M. K. Asamoah, "ICT Officials' Opinion on Deploying Open Source Learning Management System for Teaching and Learning in Universities in a Developing Society," *E-Learning and Digital Media*, vol. 18, no. 1, 2021, pp. 18–38.

[23] A. Harerimana and N. G. Mtshali, "Types of ICT applications used and the skills' level of nursing students in higher education: A cross-sectional survey," *Int. J. Africa Nurs. Sci.*, vol. 11, 2019, doi: https://doi.org/10.1016/j.ijans.2019.100163.

[24] V. MILIĆEVIĆ *et al.*, "E-learning perspectives in higher education institutions," *Technol. Forecast. Soc. Change*, vol. 166, 2021, doi: https://doi.org/10.1016/j.techfore.2021.120618.

[25] P. W. Wambugu, "Massive Open Online Courses (MOOCs) for Professional Teacher and Teacher Educator Development: A Case of TESSA MOOC in Kenya," *Universal Journal of Educational Research*, vol. 6, no. 6, 2018, pp. 1153–1157. Doi: https://DOI: 10.13189/ujer.2018.060604.

[26] K. Suresh and P. Srinivasan, "Massive Open Online Courses -- Anyone Can Access Anywhere at Anytime," *Shanlax International Journal of Education*, vol. 8, no. 3, 2020, pp. 96–101. Doi: https://doi.org/10.34293/ education.v8i3.2458.

[27] J. A. Ruipérez-Valiente, S. Halawa, R. Slama, and J. Reich, "Using multi-platform learning analytics to compare regional and global MOOC learning in the Arab world," *Computer & Educ.*, vol. 146, 2020, doi: https://doi.org/10.1016/j.compedu.2019.103776.

[28] E. Edelhauser and L. Lupu-dima, "Is Romania Prepared for eLearning during the COVID-19 Pandemic ?," *Sustainability*, 2020, pp. 1–29, doi: 10.3390/su12135438

[29] S. Arora, "Online learning," *International Education & Research Journal*, vol.*3, no.*8, 2019, pp. 32-34.

[30] K. Hadullo, R. Oboko, and E. Omwenga, "Status of e-Learning Quality in Kenya: Case of Jomo Kenyatta University of Agriculture and Technology Postgraduate Students," *International Review of Research in Open and Distributed Learning*, vol. 19, no. 1, 2018, pp. 139–160.

[31] O. Isaac, A. Aldholay, Z. Abdullah, and T. Ramayah, "Online learning usage within Yemeni higher education: The role of compatibility and task-technology fit as mediating variables in the IS success model," *Comput. Educ.*, vol. 136, 2019, pp. 113–129, doi: https://doi.org/10.1016/j.compedu.2019.02.012.

[32] V.Mirata, F. Hirt, P. Bergamin, & C. van der Westhuizen, "Challenges and contexts in establishing adaptive learning in higher education: findings from a Delphi study", 2020, *International Journal of Educational Technology in Higher Education*, vol.17. no.1,doi: https://doi.org/10.1186/s41239-020-00209-y.

[33] H. Bello and N. A. Abdullah, "Investigating the Influence of Quality Factors on User Satisfaction with Summative Computer-Based Assessment," *Electronic Journal of e-Learning*, vol. 19, no. 6, 2021, pp. 490–503.

[34] H. Samin and T. Azim, "Knowledge Based Recommender System for Academia Using Machine Learning: A Case Study on Higher Education Landscape of Pakistan," *IEEE Access*, vol. 7, 2019, doi: 10.1109/ACCESS.2019.2912012.

[35] H. Lamas, "School Performance", *Propósitos y Re- presentaciones*, vol.3, no.1, 2015, pp. 313-386, doi: 10.20511/pyr2015.v3n1.74.

[36] S. Panpatte and V. D. Takale, "To Study the decision making process in an organization for its effectiveness," vol. 3, no. 1,2019, pp. 73–78.

[37] R. E. Bawack and J. R. Kala Kamdjoug, "The role of digital information use on student performance and collaboration in marginal universities," *Int. J. Inf. Manage.*, vol. 54, 2020, doi: https://doi.org/10.1016/j.ijinfomgt.2020.102179.

[38] P. N. T. Ngoc, P. N. T. Thuy, N. P. N. Trong, T. D. Luan, T. D. Khuong, and N. H. Vinh, "Impacts of online education on eeaching quality and satisfaction of medical students during COVID-19: A case study in a private University in Vietnam," *Education Quarterly Reviews*, vol. 4, no. 4, 2021, pp. 145–154.

[39] R.S.Daniel, "Educational Technology in Developing Countries : A Systematic Review," University of Virginia, 2020.

[40] J. Lemmens, "Learning Analytics: A South African Higher Education Perspective," 2017, doi: 10.18820/9781928357186/12.

[41] E. Dahlstrom, D. C. Brooks, and J. Bichsel, "The Current Ecosystem of Learning Management Systems in Higher Education : Student , Faculty , and IT Perspectives,"2014.