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The Role of AI Technology in Improving Education Efficiency and Budget on Education Quality: A Review

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ABSTRACT

Artificial intelligence technology has penetrated various aspects of life and organization, including the field of education. The purpose of this study is to see how the role of artificial intelligence (AI) technology in increasing efficiency and education budgets towards the quality of education. This study was conducted by reviewing various literatures recorded in sciencedirect and conducting a systematic review or systematic literature review (SLR). The data reviewed were 361 literatures and processed using PRISMA, 6 literatures were obtained. The results of this study are that artificial intelligence (AI) technology can increase efficiency and education budgets towards the quality of education.

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Introduction

Education is a fundamental pillar of a nation's social and economic development. Through quality education, a country can prepare a competent, innovative young generation capable of competing in the global market (Grant, C., 2017). However, realizing a high-quality, inclusive, and sustainable education system is not an easy task, especially when resources are limited. One rapidly evolving approach to improving educational efficiency and quality is the integration of technology, particularly artificial intelligence (AI). AI technology offers various solutions, ranging from administrative automation to personalized learning, which have the potential to enhance the quality of education while maintaining efficient budget allocation.

AI in education encompasses a variety of technological applications designed to support learning and educational management activities, including automated administration systems and adaptive learning technologies. Common examples of AI applications in education include:

1. **Adaptive Learning**: Adaptive learning systems use AI algorithms to tailor educational content according to each student's ability and needs.
2. **Administrative Automation**: AI helps reduce administrative burdens on educators and school staff. Its implementation in educational management systems enables more efficient processes such as grading, automated assessments, and student data management.
3. **Virtual Teaching and Chatbots**: AI-powered chatbots can provide students with instant academic support.
4. **Learning Analytics**: AI can analyze data generated during the learning process to offer insights into student progress.
5. **Resource Monitoring and Management Analysis**: AI-based systems are also used to monitor the use of educational facilities, analyze budget requirements, and predict operational needs.

Despite the promise AI holds for supporting educational systems, its implementation is not without challenges. These include:

1. Limited educational budgets;
2. Uneven budget distribution;
3. High implementation costs;
4. Lack of understanding regarding the effectiveness of technology;
5. Ongoing demands for continuous quality improvement.

Given both the potential and the limitations of AI technology in education, this study aims to explore "The Role of Artificial Intelligence Technology in Improving Education Efficiency and Budget on Education Quality: A Systematic Review," with the objective of examining how AI

technology can serve as a solution to increase the efficiency of education budget allocation without compromising quality.

Literature Review

Education Quality in the Context of AI Technology

Educational quality is a multidimensional concept that encompasses various aspects such as teaching effectiveness, student learning outcomes, curriculum relevance, and the ability of educators to deliver meaningful learning experiences. In the context of artificial intelligence (AI) technology integration, education quality further expands to include elements of innovation and operational efficiency that contribute to enhanced and optimal learning outcomes. AI holds substantial potential in overcoming budgetary limitations and enhancing learning quality through mechanisms such as automation and personalization.

Several dimensions can be examined to understand how AI contributes to education quality:

1. Teaching Effectiveness: This refers to the degree to which the teaching and learning process achieves its intended objectives. AI-enabled adaptive learning systems allow for targeted instruction tailored to students' needs and learning styles (Nguyen et al., 2023).
2. Student Learning Outcomes: Considered one of the most essential indicators of educational quality. With AI-powered data analytics, student performance can be monitored in real time, enabling timely and appropriate interventions. Moreover, AI supports the development of labor market-responsive curricula, enhancing the relevance of learning outcomes (Bond et al., 2020; Zawacki-Richter et al., 2019).
3. Resource Availability and Efficiency: AI enhances the efficiency of educational resources in terms of cost and time. Administrative tasks, such as data management, evaluation, and attendance tracking, can be automated, allowing budgets to be more effectively allocated toward core educational activities (Holmes & Luckin, 2016; Spanjol et al., 2023).
4. Curriculum Quality: A high-quality curriculum aligns with technological developments and labor market needs. AI facilitates industry trend analysis and market data integration to ensure that curricula remain up-to-date and aligned with required skills (Iweuno et al., 2024).
5. Student Interaction and Learning Experience: AI can create responsive learning environments through virtual tutors and chatbots that support students throughout their educational journey, fostering more personalized and continuous learning experiences (Spanjol et al., 2023; Zhang & Aslan, 2021).

Efficiency and Education Budgeting

Efficient and effective management of educational budgets has become a central concern for educational institutions worldwide. The goal is to optimize resource utilization, reduce unnecessary spending, and ensure the strategic allocation of funds to support quality learning experiences.

The rise of AI provides new opportunities to enhance budget efficiency, ultimately contributing to educational quality. Several dimensions of AI-based implementation in education budgeting include:

1. Optimized Operational Budget Management: AI enables automation of high-cost administrative tasks such as data processing and HR management, reducing operational costs by up to 30% as reported by Zhang & Aslan (2021) and Suherman et al. (2022).
2. Predictive Resource Allocation: AI's predictive analytics help identify budget needs based on historical trends and data patterns, minimizing unnecessary expenditures and redirecting funds to priority areas (Chen et al., 2020; Pedro & Subosa, 2019; Baker & Siemens, 2014).
3. AI-Driven Efficiency Measurement: AI assists institutions in tracking and assessing efficiency using key performance indicators (KPIs), such as cost per student or academic outcomes per unit of expenditure (Kolluru et al., 2018; Vir Singh & Kant Hiran, 2022).
4. Cost-Effective Teacher Training Allocation: AI enables the development of scalable and affordable online training platforms that enhance teacher competence without incurring the high costs of traditional training methods (Collin & Halverson, 2009).
5. Savings Through Automated Learning and Assessment: AI systems streamline learning and assessment processes, reducing manual workloads and operational costs, and improving overall budget efficiency (Muhammad Tahir et al., 2024).

Method, Data, and Analysis

This study employs a *Systematic Literature Review (SLR)* to explore and analyze the role of artificial intelligence (AI) technology in improving education efficiency and budgeting, as well as its impact on educational quality.

The SLR follows structured procedures including literature search protocols, inclusion and exclusion criteria, data analysis, and synthesis of findings (Chakraborty & Liebel, 2022; Kitchenham et al., 2010). Articles were sourced from the ScienceDirect database, filtered for "open access" status, and published between 2017 and 2022. Keyword combinations included:

1. Artificial Intelligence in Education;
2. Education Funding Efficiency;
3. AI and Education Quality;
4. SLR in Educational AI.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	**Exclusion Criteria**
• Indexed in ScienceDirect • Relevant to AI, Education Budget Efficiency, Education Quality • Journal articles • English-language articles • Non-duplicated data	• Not indexed in ScienceDirect • Not relevant to AI, funding efficiency, or education quality • Not journal articles • Non-English articles • Duplicated data

This review followed the **PRISMA** flowchart method (Peixoto et al., 2021; Yusop et al., 2022), covering the following stages:

1. Data Identification;
2. Data Screening;
3. Eligibility Assessment;
4. Data Analysis.

Result and Discussion

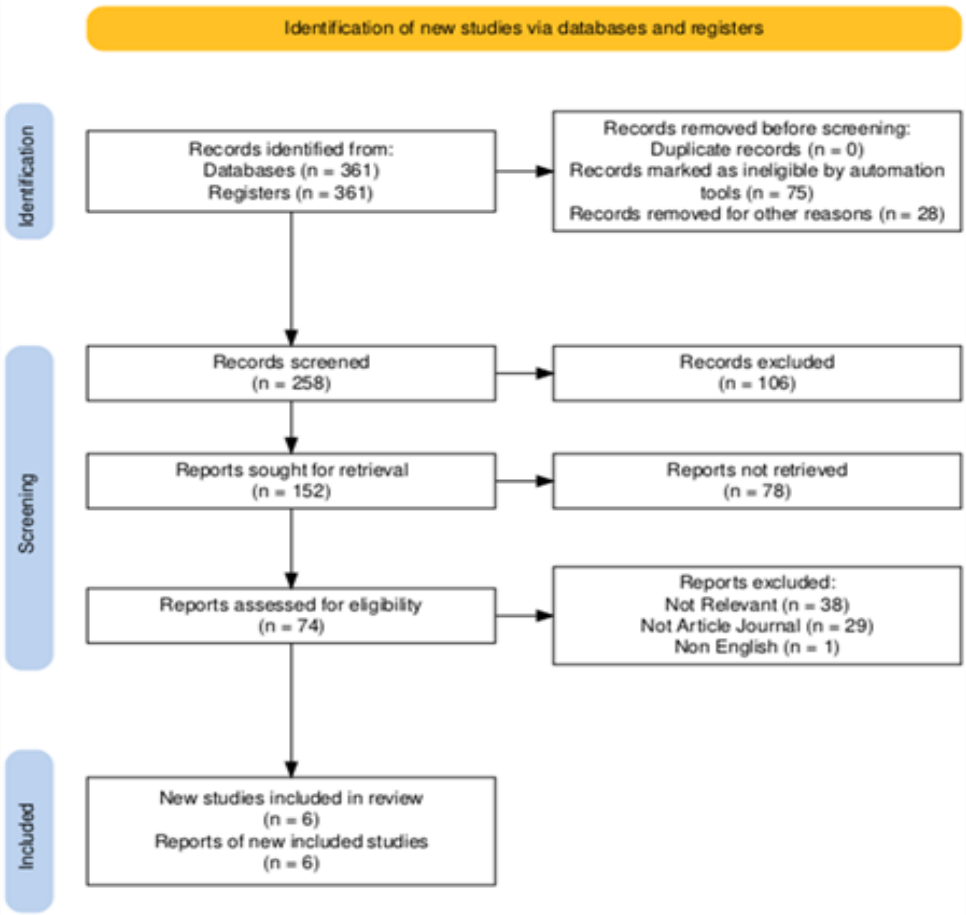
The data search was limited to the period 2017 to 2022. The initial search in the ScienceDirect search box with the article status "open access" resulted in 361 articles. All 361 data obtained were registered on the ScienceDirect page. And from this data there was no duplication of article data. Only 75 article data were automatically recorded as unfit for the next step. And 28 of these data could not be continued because it was indicated that the article was no longer recorded in the journal. So that the data that could be used for the next step was 258 data.

Of the 258 data that were successfully identified, it turned out that there were 106 data that could not be referenced for review. So that the data that could be reviewed was 152 data. However, after a deeper study of these 152 data, there were still 78 data that could not be studied. Thus, the data that could be studied was 74 data.

Of the 74 data, 38 are not relevant to the topic of this study, and 29 are not journal articles and 1 is not in English. So that the data that is suitable for Literature Review is 6 journal articles.

With the help of the PRISMA application for Literature Review, the results are as shown in the chart below:

Chart 1. PRISMA for SLR with data of 361 articles



Source: (Haddaway et al., 2022)

Discussion

From the articles and studies reviewed, it can be seen that with innovation and technological advancement has encouraged the development of artificial intelligence in various lives. This also penetrates the education sector. The demand for quality education today, forces the use of artificial intelligence technology is very necessary. On the other hand, efficiency and budget use are also determinants for the use of artificial intelligence.

No	Year	Author(s)	Title	Problem	Grand Theory / Assumptions
1	2020	Lijia Chen, Pingping Chen, Zhijian Lin	Artificial Intelligence in Education: A Review	Can artificial intelligence (AI) be used in education?	Artificial intelligence (AI), education patterns.

2	2019	Olaf Zawacki-Richter, Victoria I. Marín, Melissa Bond, Franziska Gouverneur	Systematic review of research on artificial intelligence applications in higher education – where are the educators?	Educators are not confident in the use of AI in teaching and learning.	Artificial intelligence (AI), teaching and learning.
3	2021	Thomas Engels, Guillaume Trotignon, David Agyemang, Imran Khan, Kann Puthy, Liesbeth Roolvink, Elena Schmidt	Cost and budget impact analysis of a school-based vision screening programme in Cambodia and Ghana: Implications for policy and programme scale-up	Many children do not attend school due to financial constraints	Cost and budget analysis, policy,
4	2022	Alexei Arbona, Víctor Gim´enez, Sebasti´an L´opez-Estrada, Diego Prior	Efficiency and quality in Colombian education: An application of the metafrontier Malmquist-Luenberger productivity index	There is inefficiency and in-quality in education in Colombia	Educational efficiency, educational quality, productivity index
5	2021	Ke Zhang, Ayse Begum Aslan	AI technologies for education: Recent research & future directions	This article reports a comprehensive review of selected empirical studies on artificial intelligence in education (AIEd).	Artificial intelligence (AI)
6	2022	Jajang Suherman, Ayi Najmul Hidayat, N. Dede Khoeriah, Husen Saeful Insan	Budget-Based Education Financing Management	The quality of education is determined by one of them, financing management.	Quality of education, financing management,

No	**Tahun**	**Penulis**	**Judul Artikel**	**Metodologi**	**Simpulan**
1	2020	Lijia Chen, Pingping Chen, Zhijian Lin	Artificial Intelligence in Education: A Review	Qualitative research with literature review	Artificial intelligence (AI) helps implement learning and education
2	2019	Olaf Zawacki-Richter, Victoria I. Marín, Melissa	Systematic review of research on artificial intelligence applications in higher education –	Systematic literature review	The use of artificial intelligence in education is of great help to students,

		Bond, Franziska Gouverneur	where are the educators?		academics and administrators.
3	2021	Thomas Engels, Guillaume Trotignon, David Agyemang, Imran Khan, Kann Puthy, Liesbeth Roolvink, Elena Schmidt	Cost and budget impact analysis of a school-based vision screening programme in Cambodia and Ghana: Implications for policy and programme scale-up	Cost and budget analysis of financial statements	There are financial resource constraints. The need for government policy.
4	2022	Alexei Arbona, Víctor Gim´enez, Sebasti´an L´opez-Estrada, Diego Prior	Efficiency and quality in Colombian education: An application of the meta-frontier Malmquist-Luenberger productivity index	Productivity measurement using good and bad outputs in the context of education	
5	2021	Ke Zhang, Ayse Begum Aslan	AI technologies for education: Recent research & future directions	Empirical studies, meta-analysis	The advancement of AIEd calls for addressing AI ethics and privacy issues and requires interdisciplinary and transdisciplinary collaboration in large-scale longitudinal research and development efforts.
6	2022	Jajang Suherman, Ayi Najmul Hidayat, N. Dede Khoeriah, Husen Saeful Insan	Budget-Based Education Financing Management	Case study method by examining more deeply about financing in education	The quality of education is determined by efficient and effective human resource management and financial management.

From the table data above, several things can be used as literature, where the use of artificial intelligence (AI) is very helpful in the implementation of learning and administration of education itself. Of course, the use of artificial intelligence (AI) also requires collaboration from users and supervision from policy makers. This is revealed by research from Lijia Chen, 2020; Olaf Zawacki-Richter, 2019 and Ke Zhang, 2021. Not only in learning activities, the use of artificial intelligence also makes funding and education budgets more efficient. So that the use

of the education budget can be more optimal. This is in line with the research statements from Thomas Engels, 2021; Alexei Arbona, 2022 and Jajang Suherman, 2022.

These studies collectively demonstrate that AI plays a vital role in supporting both the learning process and administrative functions in education. However, its implementation must be accompanied by collaboration among stakeholders and oversight from policymakers

Conclusion

Based on a systematic literature review, this study concludes that the use of artificial intelligence (AI) can significantly contribute to enhancing educational efficiency and budgeting, which in turn improves the overall quality of education. The findings highlight AI's potential not only as a tool for optimizing resource allocation but also as a strategic solution for educational institutions facing budgetary and performance-related challenges.

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