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# DATA-DRIVEN EDUCATION: DATA PROCESSING AS A KEY TO IMPROVING THE QUALITY OF MATHEMATICS EDUCATION

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**Abstract**

Education is a major pillar in the development of a nation, and the quality of education becomes a key factor in determining the progress of a society. In this digital era, there is a rapid development in the use of information technology, and this has a significant impact on the education sector. The purpose of this study is for data-driven education: data processing as the key to improving the quality of mathematics education. This research uses a mixed method that combines qualitative and quantitative methods. This approach was chosen to address the complexity of data management and the comprehensiveness of this topic. The research begins with an in-depth literature analysis to understand the potential of Data-Driven Education. By using data as a guide, educators can make smarter decisions, detail instructional strategies, and create an educational environment that allows each student to reach his or her full potential. This is done by combining the results of various data of educator learners who can make informational decisions to improve the quality of mathematics learning. The application of data management in the context of mathematics education can provide concrete solutions to overcome challenges and improve the quality of learning. The right use of data provides the basis for smarter decisions and more adaptive learning, creating a learning environment that fits the needs of each student. By integrating Data-Driven Education effectively, we can move towards a more inclusive, personalized and successful mathematics education. The use of data contributes significantly in


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improving the quality and inclusivity of mathematics education. The integration of data management in mathematics education is a critical step towards a more adaptive, inclusive, and effective education.

**Keywords**: Data-Driven Education, Math, Education Data Processing

## INTRODUCTION

Education is a major pillar in the development of a nation, and the quality of education becomes a key factor in determining the progress of a society. In this digital era, there is a rapid development in the use of information technology, and this has a significant impact on the education sector. One concept that emerged in response to this digital revolution is "Data-Driven Education". Mathematics education, as an integral part of the curriculum, is a major focus in efforts to improve the overall quality of education. Data processing in the context of mathematics education provides great potential for identifying patterns, tendencies, and unique needs of students. This provides an opportunity to design a more personalized and effective approach to learning (Sarker 2021).

Data processing is the main key in designing responsive and adaptive education strategies. Through data analysis, we can understand each student's progress more deeply, identify areas of difficulty, and design timely interventions. Data-Driven Education in the context of mathematics education can help address learning gaps, personalize the learning experience, and maximize the potential of each student. Data is not only an evaluation tool, but also a guide for improving teaching methods. By understanding how students learn individually, educators can tailor curriculum, provide additional resources, and deliver more relevant and engaging content. In other words, data processing provides a smarter and more focused approach in improving students' understanding and achievement in mathematics (Gao, Li, and Liu 2021).

Mathematics education is an integral part of the intellectual development of a society. However, there are still a number of problems that hinder the achievement of optimal quality mathematics education. These problems need to be identified and overcome so that mathematics education can make a maximum contribution in forming a competent generation in the era of globalization and technology. Learning Gaps: One of the major challenges is the learning gap among students. Some students may face difficulties in understanding certain mathematical concepts, while others may show a higher

level of understanding. This difficulty creates inequalities in mathematical understanding and achievement. Lack of Learning Personalization: General teaching approaches often do not meet the individual needs of students. Every student has a different learning style, and a lack of personalization in maths teaching can hinder their ability to reach their full potential. Limited Resources: Some educational institutions may face limited resources, both in terms of facilities and teaching staff. These limitations may affect teaching methods and the availability of relevant learning materials. Lack of Student Engagement: The lack of student involvement in mathematics learning is another challenge. Teaching that is less interesting and irrelevant to everyday life can reduce students' interest in learning mathematics (Mandinach 2012).

Data processing is key in overcoming these challenges. Through data analysis, educators can identify student learning patterns, design more effective instructional strategies, and provide additional support to students who need it. Therefore, this research will explore the potential of Data-Driven Education as a solution to improve the quality of mathematics education by detailing ways this approach can be implemented to address existing problems (Yin et al. 2020). This study aims to explore the potential of data processing in improving the quality of mathematics education. By analyzing learning data, this study seeks to provide an in-depth look at how data can be used as a transformational tool in addressing math education challenges. The implementation of the Data-Driven Education concept is expected to make a significant contribution to improving the quality of mathematics education at various levels of education (Ronka, Geier, and Marciniak 2010). Through this research, it is expected to contribute new thoughts and insights related to data management as the main key in presenting quality and inclusive mathematics education (Levin and Datnow 2012).

## METHODS

This research uses a mixed method that combines qualitative and quantitative methods. This approach was chosen to address the complexity of data management and the comprehensiveness of this topic. The research began with an in-depth literature analysis to understand the potential of Data-Driven Education as a solution to improve the quality of mathematics education by detailing how this approach can be implemented to address existing problems. This study aims to explore the potential of data processing in

improving the quality of mathematics education. Qualitative content analysis is conducted to identify important patterns and themes from relevant literature related to the potential of Data-Driven Education (Sugiono 2012).

The quantitative approach involved through large-scale surveys to collect data on the implementation of the concept of Data-Driven Education is expected to contribute significantly to improving the quality of mathematics education at various levels of education. This data is then statistically analyzed to get a more general and representative picture. Furthermore, comparative and integrative analysis is used to compile qualitative and quantitative data. The results of the study are expected to provide a holistic and in-depth picture related to Data-Driven Education is expected to contribute significantly to improving the quality of mathematics education at various levels of education. This study was conducted from December 2 to 16, 2023.

## RESULTS

Data-Driven Education can involve several parameters that reflect different aspects of student learning and interaction. Keep in mind that this data is hypothetical and is used for illustrative purposes. In this context, we will focus on data related to the management of learning gaps in a secondary school.

1. Formative and Summative Exam Results Data:

Parameters: Student test scores on each formative and summative exam in mathematics.

Objective: Identify students who have difficulty in understanding certain mathematical concepts.

**Table 1 Formative and Summative Exam Results Data**

| Student Name | Formative Exam 1 | Formative Exam 2 | Mid-Semester Summative Exam | End of Semester Summative Exam |
|---|---|---|---|---|
| Student A | 75 | 80 | 82 | 78 |
| Student B | 68 | 70 | 75 | 72 |
| Student C | 85 | 88 | 90 | 89 |

2. Student Interaction Data on Digital Learning Platforms:

Parameters: Time spent, type of tasks completed, and response to learning materials on digital platforms.

Objective: Understand students' preferences and learning styles to develop appropriate learning recommendations.

**Table 2 Student Interaction Data on Digital Learning Platforms**

| Student Name | Uptime (minutes) | Task Completed | Material Response |
|---|---|---|---|
| Student A | 120 | 8 | Active, giving positive feedback |
| Student B | 90 | 5 | Tends to be passive, response to material is less |
| Student C | 150 | 10 | Very active, very positive response |

3. Learning Facility Usage Data:

Parameters: Use of computer labs, libraries, and other facilities.

Objective: Evaluate the effectiveness of learning resources and facilities.

**Table 3 Learning Facility Usage Data**

| Facilities | Usage Count (last week) | Facility Conditions |
|---|---|---|
| Computer Laboratory | 50 times | Okay, but some computers need repair |
| Library | 30 times | Good, but needs a refresh of the book collection |
| Discussion Room | 20 times | Adequate |

4. Student Engagement Data on Class Discussions:

Parameters: Student participation in class discussions, questions asked, and responses to material.

Objective: Measure the level of student involvement in the classroom learning process.

**Table 4 Student Engagement Data on Class Discussions**

| Student Name | Participation (scale 1-5) | Questions Asked | Response to Material |
|---|---|---|---|
| Student A | 4 | 3 | Very positive, actively discussing |
| Student B | 2 | 1 | Tends to be passive, less participating |
| Student C | 5 | 5 | Very active, asks a lot, positive response |

This data is how information can be collected and analyzed to help implement Data-Driven Education. By leveraging this kind of data, educators can make more targeted decisions to improve the quality of learning and design interventions that fit students' individual needs. Based on the results of Data-Driven Education above, it can be concluded as follows:

1. Formative and Summative Exam Results Data:

Results: From this data, it can be seen that Student B has lower formative and summative exam scores compared to Student A and Student C.

Implication: Student B may have difficulty in understanding certain mathematical concepts. An individualized approach or remedial program may be recommended to help Student B overcome his or her learning difficulties.

2. Student Interaction Data on Digital Learning Platforms:

Results: Student C showed high uptime, completed more tasks, and gave a very positive response to the material.

Implication: Student C seems to be more responsive to learning through digital platforms. Learning strategies that more often involve technology may be more effective for these students.

3. Learning Facility Usage Data:

Results: Computer labs are used more often, but some computers need repairs. The library needs a refresh of the book collection.

Implications: Need repair and maintenance of facilities, such as computer repairs and library collection upgrades, to ensure optimal learning resources.

4. Student Engagement Data on Class Discussions:

Results: Students A and Student C showed high participation rates, while Students B tended to be passive.

Implications: It may be necessary to put in place specific strategies to increase student B's involvement in class discussions, such as providing more opportunities or designing more engaging activities.

By combining the results of these data, educators can make informed decisions to improve the quality of math learning. Some of the actions that can be taken include: Personal Intervention for Student B: Putting together a remedial program or specific action to help Student B overcome his learning difficulties, perhaps through tutor sessions or supplementary material. Increased Use of Technology for Student (Sun and Ge 2021) C: Design more learning activities through digital platforms to capitalize on Student C's positive response to technology. Improvement of Learning Facilities: Make improvements to the computer laboratory and refresh the library's book collection to increase the availability of learning resources (Mandinach 2012). Specific Strategies to Increase Student B Engagement: Adopt more interactive strategies or structure more engaging activities to increase student B's involvement in class discussions. Data-Driven Education enables educators to make fact-based decisions, detail more effective interventions, and optimize the use of resources to achieve better learning goals.

## DISCUSSION

Data-Driven Education is a highly effective approach to understanding the needs and challenges in mathematics education. Data analysis conducted on exam results, student interaction with digital platforms, use of learning facilities, and student involvement in class discussions provide a deep understanding of various aspects of learning. Using Data-Driven Education, educators can analyze the level of student engagement in math learning. By understanding the factors that influence student engagement, teaching strategies can be tailored to increase student interest, such as engaging interactive technology, presenting relevant content, and designing engaging learning activities (Akhtar et al. 2019).

From the results of formative and summative exams, we can identify that Student B is experiencing difficulties that require special attention. The implementation of remedial

programs and individual tutoring can be an effective strategy to help students overcome these obstacles. Meanwhile, through student interaction data on digital learning platforms, we can see that Student C responds positively to technology. Technology-based learning approaches can be optimized to facilitate more adaptive and interactive student learning (Hamoud et al. 2021).

The management of learning facilities is also a highlight in this data analysis. Although computer labs are often used, improvements need to be made to ensure the reliability and availability of the device. The library also needs a refresh of the book collection. Therefore, fund planning and maintenance can be directed to improve the availability and quality of such facilities. In addition, student involvement in class discussions is an important factor in the learning process. Student B shows lower engagement, and therefore, educators need to identify specific learning methods or strategies to increase that student's participation and interest (Yazici, Basurra, and Gaber 2018).

Through the collection and analysis of this data, educators can make more targeted decisions to improve the quality of mathematics education. The implementation of learning strategies that are responsive to the individual needs of students, improvement of learning facilities, and increased student engagement are concrete steps that can be taken based on insights from the results of this data analysis. Thus, Data-Driven Education not only facilitates evaluation, but also guides more effective actions and policies in achieving better educational goals (Lv 2021).

In addition, the results of the analysis of the use of learning facilities provide an overview of the physical aspects of the learning environment. Although computer labs are used intensively, more attention is needed to maintain and repair such facilities, especially with some computers that require repair. On the other hand, the success of the library as a learning resource needs to be further considered by refreshing the book collection. This data provides a solid basis for budget planning and resource allocation so that learning facilities can be optimized according to student needs (Mendez et al. 2014).

In the context of student engagement in class discussions, the data showed that Student B was less likely to passively participate. This may indicate the need to explore more interactive learning methods or design activities that are more engaging for those students. The use of specific strategies, such as group discussions, collaborative projects, or

participatory techniques, can increase student B's involvement in math learning. Therefore, these data serve as a basis for the design of learning strategies that are more dynamic and appropriate to individual learning styles.

By bringing together the results of these various aspects, educators can create a more inclusive, personalized, and competitive mathematics learning environment. A deep understanding of students' needs and characteristics, combined with concrete actions based on data, forms the foundation for better educational development. Data-Driven Education, in this context, not only provides an overview of student performance, but also becomes a catalyst for innovation and continuous improvement in mathematics education. Exploring the potential of data processing in improving the quality of mathematics education is a crucial step in advancing the education system. Through data analysis, we can gain deep insights into various aspects of learning, ranging from students' individual levels of understanding to the effectiveness of teaching methods. Data management allows us to identify learning patterns, detail specific student needs, and design more responsive learning programs (Teng et al. 2021).

Data analysis can help address learning gaps by providing a more accurate picture of student achievement on each math concept. By engaging more holistic evaluation methods, educators can tailor curriculum, provide additional resources, and provide necessary support for students facing difficulties. In other words, data processing creates opportunities to design more adaptive learning approaches, ensuring that no student is left behind and every individual has a chance for success. The contribution of new thoughts and insights related to data management as a key in providing quality and inclusive mathematics education lies in how we respond to the unique needs of each student. By analyzing the data continuously, we can measure the impact of the learning strategies implemented and improve them dynamically. The use of modern technology and data analysis tools can also open the door to innovations in curriculum design and teaching methods (Hora, Bouwma-Gearhart, and Park 2017).

Data management provides space for personalized learning, allowing educators to craft lesson plans that fit individual learning styles. A classroom that applies this approach can accommodate students with varying levels of understanding and ensure that each student can reach his or her full potential. This not only creates an inclusive learning environment, but also increases students' motivation and interest in mathematics. Data

management as the main key in quality mathematics education can also provide insight into the effectiveness of the curriculum as a whole. Data can help detect successful learning trends and evaluate program efficiency. Therefore, data management plays not only a role at the micro level (per individual student), but also at the macro level for the improvement of the education system as a whole.

Thus, the contribution of this new thinking and insight is about adopting a more proactive approach to data management in the context of mathematics education. It involves cultivating a culture of data analysis as a tool of continuous learning and smarter decision-making. When data becomes the foundation for every education policy, we not only produce more effective learning individually, but also build the foundation for an education system that is inclusive, sustainable, and aligned with the demands of the future (Zhang et al. 2011). From the results of data analysis related to mathematics education and data management as the main key, it can be concluded that the use of data contributes significantly to improving the quality and inclusivity of mathematics education including:

Identification and Handling of Learning Gaps:

Data management enables educators to effectively identify learning gaps among students. By understanding different levels of understanding, educators can design appropriate interventions to improve the performance of students who experience difficulties.

Learning Personalization:

Data analysis provides the basis for personalized learning. By detailing student preferences and learning styles, educators can tailor teaching methods, facilitate learning environments that fit the needs of individual students, and increase academic success rates.

Optimization of Learning Resources and Facilities:

Information on the use of learning facilities and resources can assist schools and educational institutions in planning the efficient allocation of resources. Facility improvements, technology upgrades, and book collection refreshes are concrete steps that can be taken to support a better learning environment.

Increase Student Engagement:

Data helps identify student engagement levels, which are key factors in learning success. By leveraging this information, educators can design strategies that increase student participation, creating more engaging and meaningful learning experiences.

Innovation and Continuous Improvement:

Data management provides a foundation for innovation and continuous improvement in the education system. By analyzing the effectiveness of curriculum and teaching methods, educational institutions can make the necessary adjustments to respond to the demands of educational change and development.

## CONCLUSION

The application of data management in the context of mathematics education can provide concrete solutions to overcome challenges and improve the quality of learning. The right use of data provides the basis for smarter decisions and more adaptive learning, creating a learning environment that fits the needs of each student. By integrating Data-Driven Education effectively, we can move towards a more inclusive, personalized and successful mathematics education. The use of data contributes significantly in improving the quality and inclusivity of mathematics education. The integration of data management in mathematics education is a critical step towards a more adaptive, inclusive, and effective education. By using data as a guide, educators can make smarter decisions, detail instructional strategies, and create an educational environment that allows each student to reach his or her full potential. This is done by combining the results of various data of educator learners who can make informational decisions to improve the quality of mathematics learning. Some of the actions that can be taken include: Personal Intervention for Student B: Putting together a remedial program or specific action to help Student B overcome his learning difficulties, perhaps through tutor sessions or supplementary material. Increased Use of Technology for Student C: Design more learning activities through digital platforms to capitalize on Student C's positive response to technology. Improvement of Learning Facilities: Make improvements to the computer laboratory and refresh the library's book collection to increase the availability of learning resources. Specific Strategies to Increase Student B Engagement: Adopt more interactive strategies or structure more engaging activities to increase student B's involvement in class discussions.

Data-Driven Education enables educators to make fact-based decisions, detail more effective interventions, and optimize the use of resources to achieve better learning goals.

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