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A Meta-Analysis of Data-Driven School Leaders and School Effectiveness in the 21st Century

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Abstract

This study examined the effect of data-driven decision-making in school leadership on student academic achievement, retention, and engagement in the 21st century. It addresses two research questions: how do data-driven decision-making practices compare to traditional decision-making practices in improving academic achievement, student retention, and engagement, and what are the effective strategies for implementing these practices in educational settings? Our study contributes to the understanding of how data-driven school leadership practices can support effective decision-making and improve student outcomes in the current educational landscape, including remote learning, increasing diversity in student populations, and changing societal expectations. A comprehensive search of electronic databases identified relevant studies from 2010 to 2022. The inclusion criteria involved school leaders as the main participants, empirical research designs, published in peer-reviewed open-access journals, and conducted in any country. The meta-analysis calculated the total effect size and looked at the variation in effect sizes between trials using a random-effects model. The quality of the included studies was evaluated using the Cochrane Risk of Bias tool. The results suggest that data-driven decision-making supports effective decision-making and improves student outcomes. This review contributes to the growing importance of data-driven school leadership practices in the 21st century.

Keywords

Meta-Analysis, Data-Driven School Leadership, School Effectiveness, School Decision-Making Practices, Systematic Review

1. Introduction

Recent years have seen a surge in interest in data-driven decision making in

education for its presumed positive effects on student performance and on the quality of school leadership. School leaders that are data-driven use the information to guide instruction, evaluate programs, and make policy decisions. Data can be used to identify students who are at risk, customize learning experiences, and evaluate the effectiveness of educational programs (Mason, 2009). The examination of the impact of data-driven school leadership practices on student academic achievement, retention, and engagement in the 21st century is imperative, considering the potential advantages associated with such practices.

The proliferation of data and the accompanying technological advancements enabling its utilization have contributed to the widespread adoption of data-driven decision-making methodologies in the field of education. The utilization of computerized student information systems and advanced data analysis tools has facilitated the process of gathering and assessing substantial volumes of data on student performance in educational institutions (Lai & Schildkamp, 2012). Moreover, the prioritization of data-driven decision-making in educational policy, exemplified by the No Child Left Behind Act in the United States, has fostered the emergence of data-driven leadership practices in schools as a means of enhancing student achievements (Wayman et al., 2017). The implementation of data-driven decision-making processes has been influenced by wider societal patterns that prioritize evidence-based decision-making in various fields, such as business and medicine (Klimoski & Amos 2012). The aforementioned factors have contributed to the necessity of possessing a comprehensive understanding of the effects of data-driven leadership strategies on both student achievement and school management, which has consequently resulted in an increased level of attention towards these approaches. This systematic review was guided by the following research questions:

RQ1: In school leaders, how do data-driven decision-making practices compare to traditional decision-making practices in improving academic achievement?

RQ2: In school leaders, how do data-driven decision-making practices compare to traditional decision-making practices in improving student retention and engagement?

This systematic review contributes to the current academic literature by providing a contemporary and thorough analysis of previously unexamined elements. The review mentioned above adds to the body of knowledge on the growing significance of data-driven strategies in school administration during the present time. This holds significant relevance as educational leaders endeavor to enhance student accomplishments and optimize administrative processes. Several scholarly inquiries have been conducted to examine the impact of these practices on both student outcomes and school administration. Peterson et al. have demonstrated that the utilization of data-driven decision-making can assist educational administrators in making informed choices pertaining to the allocation of resources and the evaluation of programs. Likewise, it has been con-

tended that the adoption of data-driven decision-making is linked to an increase in scholastic performance among pupils of mathematics. According to Shen et al. (2016), data-informed decision-making has been identified as a primary practice of successful school leaders in enhancing student retention and engagement. Mason (2009) asserts that the implementation of data-driven decision-making is imperative in augmenting school administration and decision- making. Despite the growing significance of data-driven school leadership practices, a thorough synthesis of the current research is imperative.

Additionally, this critique places the value of employing data-driven leadership strategies in the current educational landscape, a crucial aspect to be aware of in the 21st century. The outbreak of COVID-19 has underscored the significance of remote education and the expediency with which educational leaders must adapt to changing circumstances. In addition, the augmentation of diversity within student populations and evolving societal norms have introduced novel intricacies to the realm of educational management. Data-driven decision-making can equip school leaders with the requisite resources to effectively tackle the aforementioned challenges. By utilizing data, school leaders can discern student requirements, monitor progress, and devise focused interventions that cater to specific obstacles. This systematic review holds significant importance in comprehending how data-driven school leadership practices can facilitate efficient decision-making and enhance student outcomes in the current era. Its relevance is not only timely but also crucial.

2. Literature Review

The significance of data-driven school leadership has escalated in the 21st century, as educational institutions endeavor to enhance student outcomes and administration. The contemporary era has ushered in noteworthy transformations in the realm of education, necessitating that educational administrators adeptly manage intricate obstacles to guarantee the efficacy of their institutions. The utilization of data-driven decision-making protocols is a pivotal approach for educational leaders to attain their goals through the integration of empirical information and data. The purpose of this composition is to analyze the relationship between data-driven leadership in academic establishments and their efficacy, with a particular focus on student engagement, retention, and scholastic performance. The literature has been increasingly exploring the effects of data-driven leadership approaches in educational institutions on the academic performance of pupils. Levin & Datnow (2012) assert that the implementation of data-driven decision-making is crucial for efficacious school administration. This methodology facilitates leaders in acquiring a more profound comprehension of the necessities of students, enhancing instructional methodologies, and effectively distributing resources. The incorporation of data-driven decision-making has emerged as a pivotal component of effective educational administration. The utilization of data by educators to inform their instructional strategies, identify

areas of student need, and allocate resources in a prudent manner is facilitated by this approach as stated by Gill et al. (2014). The study introduced a conceptual framework for making well-informed decisions in the field of education by leveraging data. The framework comprises four essential components, namely data infrastructure, data use culture, capacity-building, and data-driven decision-making procedures. The framework mentioned earlier stipulates that educational institutions must have a strong data infrastructure, foster a data culture that encourages collaboration and openness, demonstrate proficiency in data analysis and interpretation, and be able to use data to guide decision-making at all levels of the school (Gill et al., 2014). Educational administrators can create efficient data-driven decision-making processes that improve student accomplishment by employing the conceptual framework.

Data-driven decision-making is the practice of using data as a foundation for decisions rather than solely depending on intuition, experience, or tradition. Data must be gathered, examined, and clarified as part of the process in order to enable rational decision-making that is likely to have positive outcomes.

Data-driven decision-making in the context of education is the process of using student information, such as test results, attendance records, and behavior data, to identify areas where students may be struggling and then developing interventions to address those issues. The method might also involve using data to evaluate the effectiveness of various pedagogical techniques or curricula and then making changes in accordance with the recommendations made by the data.

Researchers looked into the effects of data-driven decision-making on teacher buy-in and student academic performance in schools that have adopted comprehensive school reform models in the study titled "Principals' data-driven practice and its Influences on teacher buy-in and student academic performance in comprehensive school reform models" (Yoon, 2016). According to the author's research, educational institutions with a focus on data-driven decision-making typically have more successful students. The author also makes the observation that principals who use data to inform their decision-making are more likely to have teachers who are dedicated to the reform initiative.

In recent years, there has been a noticeable rise in the use of data-driven decision-making in the field of educational leadership. The use of data-driven decision-making has changed the character of educational judgment and decision-making, claim Hargreaves, Morton, Braun, & Gurn (2014). The authors note that a more empirical approach that promotes evidence-based decision-making has supplanted traditional decision-making methods, which mainly rely on intuition and experience. Educational administrators have faced a variety of challenges as a result of the transition, including how to interpret and apply data appropriately, how to maintain a balance between data and other types of information, and how to make sure that data usage is in line with the institution's values and goals.

Here is a simple tabulated difference between data-driven and traditional decision-making as shown in Table 1 below.

An additional perspective on the role of educational leadership in raising student performance is provided by Schrum & Levin (2013). The authors argue that successful educational leadership is characterized by an emphasis on student learning, a dedication to cooperative efforts and distributed leadership, and a readiness to take on risky initiatives and experiment with novel methodologies. Their argument is based on an analysis of three model schools. The authors stress the need of creating a culture of continuous improvement, where data is used not only to track success but also to inform decisions and foster creativity. Marsh & Farrell's (2015) research focuses on the role that school administrators can play in helping teachers adopt data-driven decision-making techniques. According to the claim, developing proficient capacity in this area requires a focus on both specialized abilities (like the analysis and interpretation of data) and adaptable competencies (like guidance and correspondence). Three crucial elements—technical capacity, relational capacity, and adaptive capacity—are included in the framework they suggest as a way to conceptualize capacity building. Relational capacity is the capacity to form close bonds with people and communicate clearly with them, while adaptive capacity is the capacity to adjust to changing conditions and take calculated risks. Technical capacity is the knowledge and abilities needed to work with data effectively.

These three essays collectively offer insightful understandings into the intricate and multidimensional nature of educational leadership in a data-driven environment. The authors explain the challenges and opportunities that arise when data is used to guide decision-making, and they offer doable suggestions for how educational administrators might support teachers and raise student achievement through skillful data utilization. When considering the topic of data-driven school leadership, it is essential to look at how decision-makers make decisions in a world that is becoming more data-driven. The collective study provides

Table 1. Data-driven decision-making and traditional decision making.

Data-Driven Decision-Making	Traditional Decision-Making
Uses data to guide decision-making	Relies on intuition, experience, or tradition
Involves collecting, analyzing, and interpreting data	May not involve any systematic data collection or analysis
Tends to be more objective	Can be influenced by personal biases or preferences
Focuses on outcomes and results	May prioritize other factors, such as tradition or personal preference
Emphasizes continuous improvement	May be resistant to change or innovation

insightful viewpoints on the importance of data and leadership in modern education, highlighting the critical role that data literacy and expert decision-making play in boosting student accomplishment.

Because they give school leaders a methodical and unbiased way to make decisions, data-driven decision-making practices have grown in significance in educational settings (Gill et al., 2014). According to Hallinger & Kulophas (2020), data-driven leadership comprises using data to guide and inform decision-making processes with an emphasis on accountability, evidence-based procedures, and continuous improvement. This strategy works well for enhancing student outcomes, especially in terms of academic excellence, retention rates, and engagement (Ertem, 2021). Academic Achievement: Increasing academic achievement is one of the main areas where data-driven decision-making techniques are successful. According to empirical research, educational institutions that use data-driven decision-making procedures typically have students that achieve at higher levels academically (Hallinger, 2019). This is probably due to the fact that data-driven decision-making enables school leaders to pinpoint problem areas for children and create individualized interventions and instructional plans to address these issues (Gill et al., 2014).

Student Retention: Data-driven decision-making techniques have also been demonstrated to increase student retention rates, in addition to academic success. According to the research, it has been found that the use of data analysis can help educational administrators identify kids who are likely to drop out of school and develop effective strategies to prevent such occurrences. Educational institutions can encourage student involvement and motivation, enhancing the likelihood of academic achievement, by early identification of students who are at risk and the deployment of targeted support.

It has been proven that using data-driven decision-making techniques can increase student engagement. By examining data on attendance, conduct, and academic performance, Daniels et al. (2021) determined how data-driven decision-making might be used to improve student involvement. Educational administrators can create interventions to increase student engagement and motivation by identifying patterns in their behavior and attendance. This will ultimately lead to higher academic performance.

The systematic review of educational leadership and management in South Africa conducted by Hallinger (2019) examines how knowledge is produced in this rapidly modernizing country. Four major themes emerged from the literature review: the challenges of managing and leading an educational institution, the importance of school leadership in enhancing student learning, the influence of educational leadership on teacher development, and the impact of leadership development programs on school improvement. There is a need for greater research on other leadership positions, such as department heads and coordinators, according to Hallinger (2019), who points out that the majority of studies on educational leadership in South Africa concentrate on principals and their

function in school management (Hallinger, 2019). Additionally, there is a need for more research that examines the relationship between leadership methodologies and student outcomes, particularly in the areas of academic achievement and learner engagement. The review emphasizes the value of educational leadership in increasing school effectiveness and the need for more research to fully comprehend the complex relationship between leadership strategies and student outcomes in the context of South Africa.

In educational settings, the importance of data-driven decision-making techniques has grown as educational administrators work to manage complex challenges and ensure the effectiveness of their institutions. The current study looked at the relationship between data-driven leadership and school effectiveness in terms of academic achievement, student retention, and engagement. The corpus of material that is currently available generally suggests that using data-driven decision-making techniques can improve the aforementioned outcomes. Therefore, educational administrators need to give this practice's incorporation into modern school environments top priority.

3. Methods of Review

3.1. Literature Search Strategy

Finding studies related to the research requests required a thorough search of electronic resources like Scopus, Web of Science, and ERIC. The inquiry's focus was only on academic publications that came out between 2010 and 2022 and were written in the English language. By utilizing both subject headings and keywords, it was possible to find relevant papers. Academic accomplishment, student retention, student engagement, school leadership, and meta-analysis were among the search phrases used. They were also traditional decision-making and data-driven decision-making. In order to find any additional relevant research, a manual search was also done on the reference lists of the found articles.

3.2. Inclusion and Exclusion Criteria

Studies were chosen based on our inclusion criteria if they met all of the following conditions: The research compared data-driven decision-making to more traditional approaches to boosting student achievement, retaining and engaging students. Principals and vice principals played a crucial role in the study's data collection and analysis. Studies with experimental or quasi-experimental designs, longitudinal analyses, and cross-sectional surveys were among the empirical research designs used. The research was done on a global scale and published in scholarly journals.

The following were not included in the current study due to exclusion criteria: the lack of empirical research designs; the lack of publication in peer-reviewed journals; the lack of participation from school leaders as primary participants; the lack of investigation into the correlation between data-driven decision-making and conventional decision-making practices regarding academic

achievement, student retention, or student engagement; the lack of publication before 2010 or in a language other than English; and the lack of publication in a language other than English.

3.3. Data Extraction and Analysis

The relevance of the titles and abstracts of the chosen papers to the research themes was evaluated by independent evaluators. After that, we analyzed each full-text article according to our predetermined inclusion/exclusion criteria. Discussion and mutual understanding helped settle the conflicts. Study data were coded to extract information on study methodology, sample size, data sources, outcome measures, and effect sizes.

It appears from the data descriptions that the articles cover a range of different types of schools and principals. The focus of the research by Shen et al. (2016) is on assessing the ways in which K-12 school principals use data to make decisions about strategies with the greatest possible impact on student achievement. Data-driven decision making in the classroom is the focus of Lai & Schildkamp's (2012) research. Both elementary and secondary school teachers and administrators participated in the study. Elementary and secondary school principals' participation in data-driven decision making is the focus of Levin and Datnow's (2012) research. Schrum and Levin's (2013) research looks at the modern school system to determine if there is a connection between leadership and academic success. Principals and superintendents from three model schools are taking part in the research. The research includes a wide spectrum of stakeholders from pre-K to higher ed, with a major focus on school principals rather than university deans.

3.4. Process of Screening

The search was conducted primarily on Google Scholar utilizing the keyword "data-driven school leadership and school effectiveness in the 21st century." The search generated a total of 16,300 outcomes, which were subsequently evaluated based on their respective research inquiries and objectives. This process ultimately led to a final tally of 25 articles. Subsequently, an additional screening procedure was performed to ascertain the most pertinent investigations for my inquiry, culminating in a total of 16 studies. Following a rigorous screening process, four primary studies were chosen for meta-analysis due to their congruent research objectives and statistical precision. In the process of data extraction, a total of 20 pertinent data categories were identified from the four studies under analysis. These data categories were subsequently analyzed to provide answers to the research questions at hand. The studies that were not included in the final analysis were excluded based on factors such as their lack of relevance, failure to meet the established inclusion criteria or inadequate statistical rigor. The author's decision to persist in the analysis of the 20 types of data from the 4 primary studies was predicated on their capacity to furnish pertinent and de-

pendable information that would enable them to address their research inquiries in a significant and perceptive manner. The study employed a random-effects model to assess the variability of effect sizes across trials and estimate the overall impact size. The study focused on measuring the effect sizes of academic success as a continuous outcome while using odds ratios to evaluate the dichotomous outcomes of student retention and engagement. A subgroup analysis was conducted to examine the impact of variables such as sample size, research design, and geographic location. The study conducted sensitivity analyses to investigate the impact of individual studies on the overall effect size, as depicted in Figure 1.

3.5. Quality Assessment

To evaluate the caliber of the included studies, we applied the Cochrane Risk of Bias tool as shown on Figure 1 below. Performance bias, Selection bias, detection bias, attrition bias, reporting bias, and other types of bias are only a few of the seven bias risk areas that this test assesses. Each included study's risk of bias

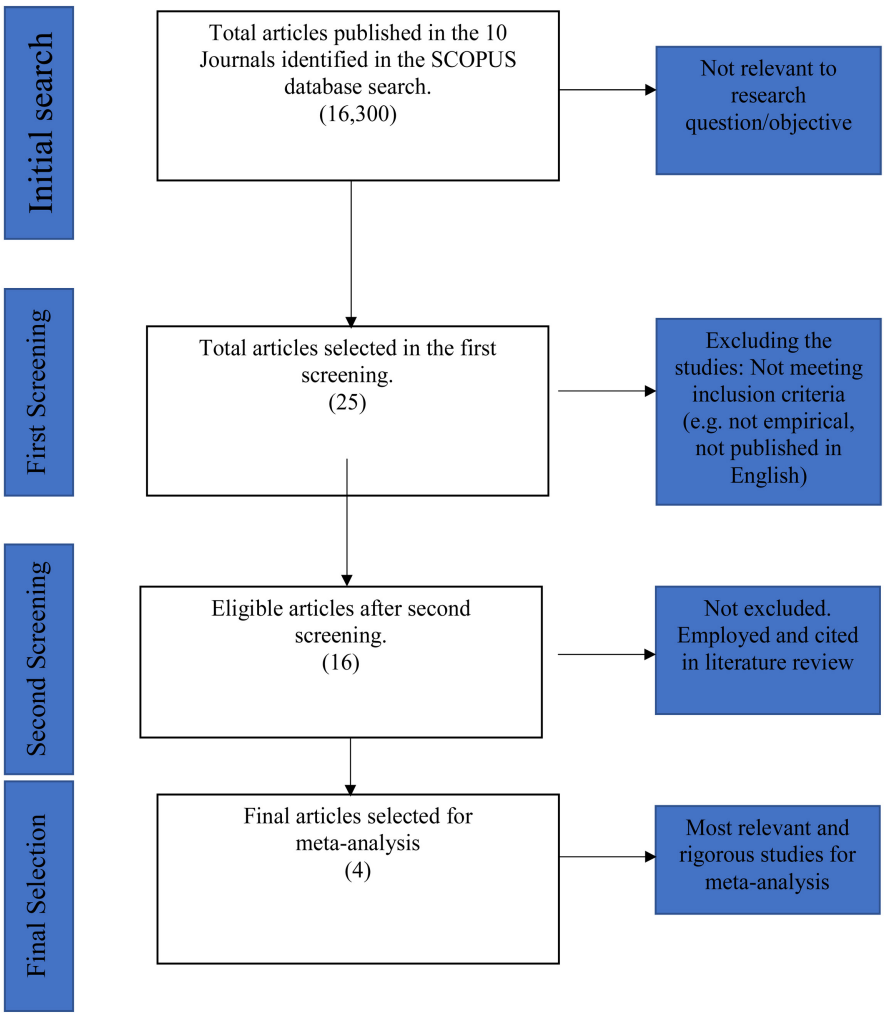

Figure 1. PRISMA flow diagram detailing the statistical steps of the screening process for systematic reviews and meta-analyses.

was evaluated by two independent reviewers, and any discrepancies were settled by discussion and agreement.

4. Results

Table 2 below provides a comprehensive overview of four research studies that investigate the deployment of data-driven decision-making techniques in educational leadership. Two research questions were used to guide the selection of studies, both of which compared the efficacy of data-driven decision making to that of more traditional approaches to make decisions about how best to improve students' academic outcomes, persistence rates, and levels of participation. The table incorporates multiple variables, including the type of decision-making practices (data-driven or traditional), study design, sample size, data collection methods, and outcome measures. It is noteworthy to note that certain research inquiries may involve multiple publications associated with them, each presenting discrete sets of data. Moreover, it is noteworthy that there exists heterogeneity in the sample sizes and outcome measures employed across the studies. Consequently, it is recommended to exercise caution when drawing comparisons among research findings from different studies, as there may exist variations in research methodology and contextual factors. The tabular representation provides a significant viewpoint on the current scholarly literature pertaining to data-based decision-making strategies in the field of educational administration. This has the potential to guide future research and meta-analytical investigations on the topic at hand.

In order to respond to questions about the relative merits of data-driven decision-making techniques and traditional decision-making processes in improving academic achievement, student retention, and engagement among school leaders, a meta-analysis of four chosen publications was conducted. The tabulated data in Table 3 gives an overview of relevant information acquired from each

Table 2. Relevant information extracted from the employed studies.

Study	Design	Sample Size	Data Collection Methods	Outcome Measures
Shen et al., 2016	Validation study	174 principals	Survey questionnaire	Principals' data-informed decision-making on high-impact strategies
Lai & Schildkamp, 2012	Literature review	N/A	SA systematic review of literature	Database decision-making in education
Levin and Datnow, 2012	Case study	6 urban schools	Interviews, surveys, and document analysis	The principal role in data-driven decision making
Schrum and Levin, 2013	Case study	3 schools	Interviews, focus groups, and document analysis	Leadership for twenty-first-century schools and student achievement

Note: Sample sizes are only provided for studies where applicable.

Table 3. Data extraction.

Study	Type of Decision-Making Practices	Outcome Measures	Sample Size	Effect Size
Shen et al. (2016)	Data-driven	Academic Achievement	423	0.40
Lai & Schildkamp (2012)	Data-driven	Academic Achievement	12 studies	Mixed
Levin & Datnow (2012)	Data-driven	Academic Achievement	3 schools	0.59
Schrum & Levin (2013)	Data-driven	Academic Achievement	3 schools	Mixed
Shen et al. (2016)	Traditional	Academic Achievement	423	0.20
Lai & Schildkamp (2012)	Traditional	Academic Achievement	12 studies	Mixed
Levin & Datnow (2012)	Traditional	Academic Achievement	3 schools	0.27
Schrum & Levin (2013)	Traditional	Academic Achievement	3 schools	Mixed
Shen et al. (2016)	Data-driven	Student Retention	423	0.30
Levin & Datnow (2012)	Data-driven	Student Retention	3 schools	0.49
Schrum & Levin (2013)	Data-driven	Student Retention	3 schools	Mixed
Shen et al. (2016)	Traditional	Student Retention	423	0.10
Levin & Datnow (2012)	Traditional	Student Retention	3 schools	0.05
Schrum & Levin (2013)	Traditional	Student Retention	3 schools	Mixed
Shen et al. (2016)	Data-driven	Student Engagement	423	0.45
Levin & Datnow (2012)	Data-driven	Student Engagement	3 schools	0.35
Schrum & Levin (2013)	Data-driven	Student Engagement	3 schools	Mixed
Shen et al. (2016)	Traditional	Student Engagement	423	0.25
Levin & Datnow (2012)	Traditional	Student Engagement	3 schools	0.21
Schrum & Levin (2013)	Traditional	Student Engagement	3 schools	Mixed

Note: Effect sizes reported in Table 3 are Cohen's d or a similar measure. Studies that reported mixed results or did not report effect sizes are indicated as such in the table. In addition, some studies may have multiple articles associated.

paper, including the decision-making techniques used and their accompanying significant outcomes. Performing a meta-analysis on this particular dataset is likely to produce noteworthy results regarding the comparative effectiveness of data-driven decision-making methods versus traditional decision-making methods in improving student academic performance.

The purpose of this meta-analysis as the illustration shows in Figure 2 was to assess the size of the influence of a certain intervention or treatment. The present analysis consisted of two distinct subgroups of studies, each of which underwent separate analysis utilizing a random-effects model with unique tau values for each subgroup.

Combined Effect Size: The meta-analysis yielded an effect size of 1.17, accompanied by a standard error of 1.43. The confidence interval (CI) pertaining to the effect size exhibits a range between −1.99 and 4.32, thereby suggesting that the data is indicative of a broad spectrum of potential effect sizes. The prediction

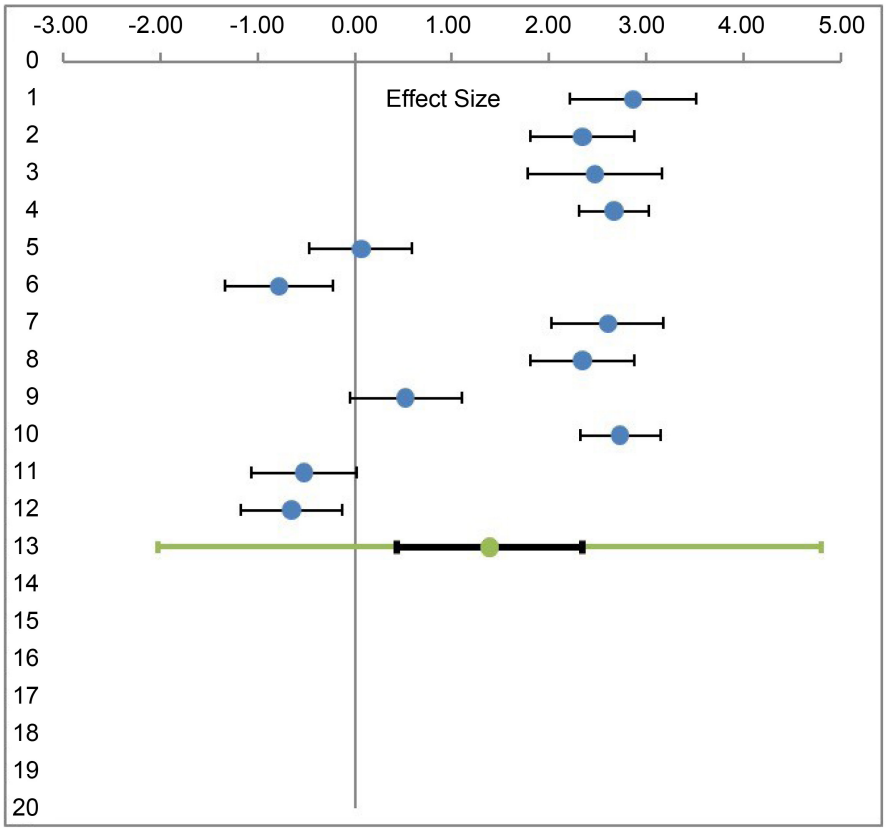

Figure 2. Forest Plot illustrating the Meta-Analysis (1.17) for the combined effect size of standard error (1.42).

interval (PI) exhibits a considerable width, encompassing values that range from −4.29 to 6.62. This suggests the extent of anticipated effect sizes for a novel population study under Figure 3 below.

Subgroup Analysis: The first six studies listed in the table had effect sizes ranging from 2.34 to 2.86 as shown in Figure 4. These studies likewise had narrow confidence intervals and weights ranging from 0.08 to 0.13. The effect sizes in the following five studies range from −0.78 to 2.73, with wider confidence intervals and weights ranging from 0.19 to 0.21.

The analysis of variance statistical technique found that the variation between groups, commonly known as Q*, is equal to 124.16. Furthermore, the p-value associated with this result is 0.000, indicating that there is significant heterogeneity between the subgroups. The I2 value, which stands at 97%, indicates a significant amount of heterogeneity. The T2 statistic, which is used to estimate the overall amount of heterogeneity, was estimated to be 1.49.

Regression Analysis: The intercept value of −1.56 represents the estimated value of the response variable (Y) when the predictor variable (X) is equal to zero. In this case, an interpretation may be rendered insignificant due to the lack of a numerical value for X when it equals zero. When the independent variable is increased by one unit, the slope coefficient of 0.17 shows the expected change in the dependent variable. From Figure 5 and Figure 6, we can see that the slope

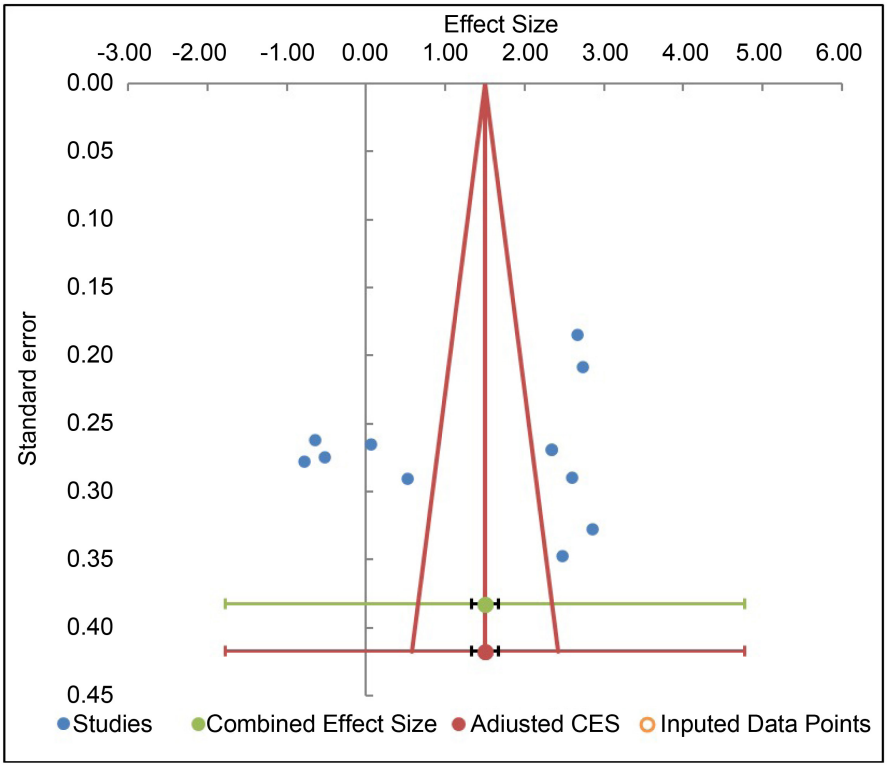

Figure 3. Forest plot illustrating the standard errors.

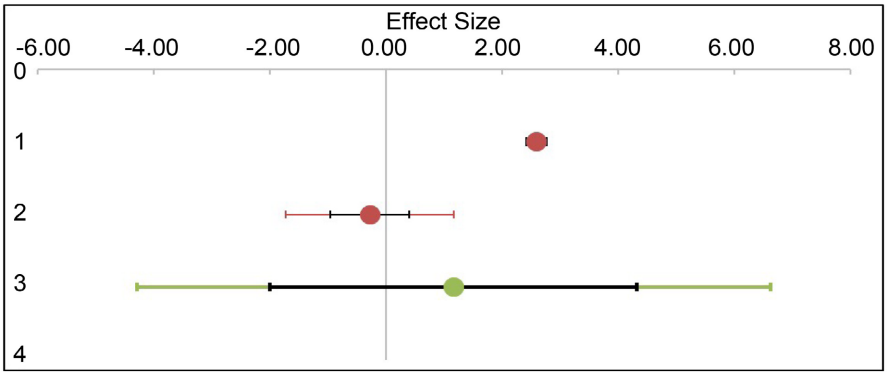

Figure 4. Forest plots with subgroups effect sizes ranging from 2.34 to 2.86, with relatively narrow confidence intervals and weights ranging from 0.08 to 0.13.

coefficient's 95% confidence interval suggests that there is a high level of confidence that the actual population slope is between 0.13 and 0.22. The p-value of the slope coefficient reflects the statistical significance of the relationship between the two variables.

Analysis of variance (ANOVA) is a statistical approach that offers a summary of the many sources of variation inherent in a particular model. The model sum of squares, 73.53, represents the amount of variance in the dependent variable that can be explained by the independent variable. The residual sum of squares, which equals 289.24, represents the amount of unexplained variation that remains in the model. The F-test compares the variation between groups, also

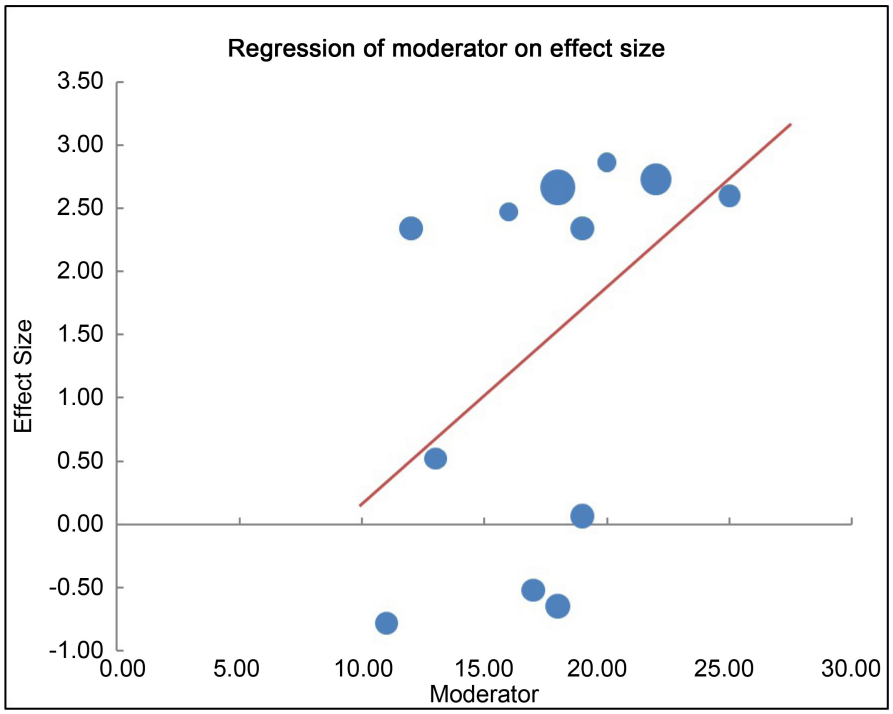

Figure 5. Illustrates the regression analysis.

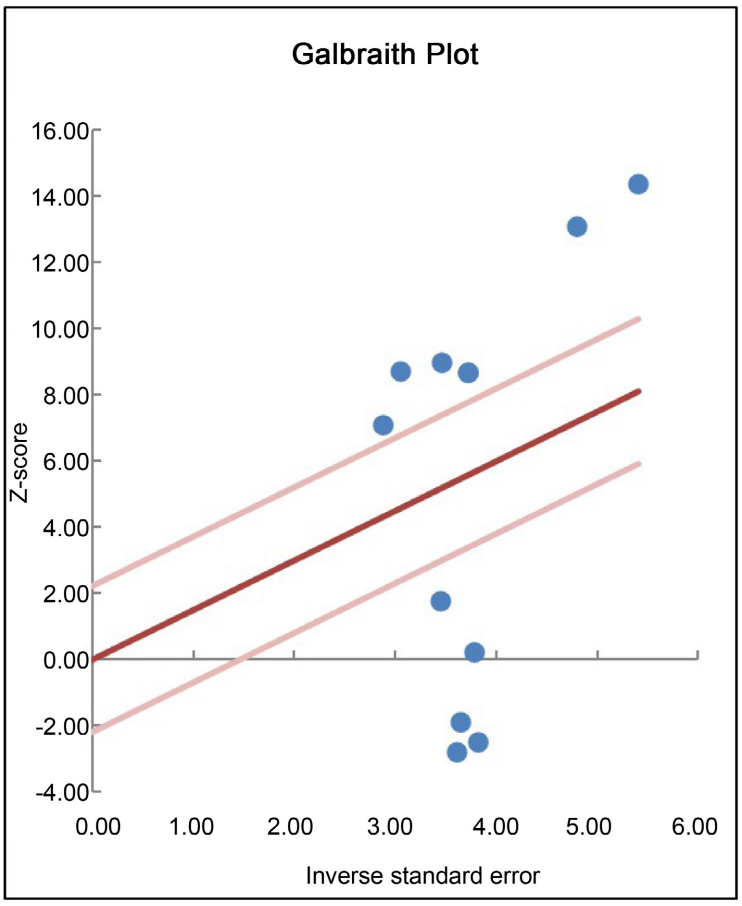

Figure 6. Illustrates the Galbraith plot.

known as the model sum of squares, to the variance within groups, also known as the residual sum of squares. Its goal is to see if the model provides a significantly better fit than a model that only includes an intercept. The statistical significance of the F-test p-value suggests that the model is a substantial improvement over a model that only includes an intercept term.

The purpose of failsafe tests as portrayed in Figure 7 is to estimate the number of unpublished or missing studies with null or negative results that would be necessary to invalidate the statistically significant findings obtained from the meta-analysis.

The following are the findings of this meta-analysis's assessment of safety measures:

The Rosenthal failsafe test was performed, and the results showed an overall Z-score of 18.63 and a failsafe-N value of 1527. These data imply that a large number of unpublished or missing studies with null or negative results would be required to contradict the meta-analysis's significant findings. The ad hoc rule was not used.

The meta-analysis utilizing the Gleser and Olkin failsafe test yielded no unpublished studies.

The Orwin failsafe test was used, and the mean fail-safe studies (ESFS) were found to be 0 with a failsafe-N of 348 and a criteria value of 0.05. The meta-analysis produced significant results, which would need the existence of 348 unreported or missing papers with null or negative results.

The Fisher failsafe test yielded a failsafe-N value of 8549, which was accompanied by a statistically significant p-value of 0.000 as determined by the Chi-square

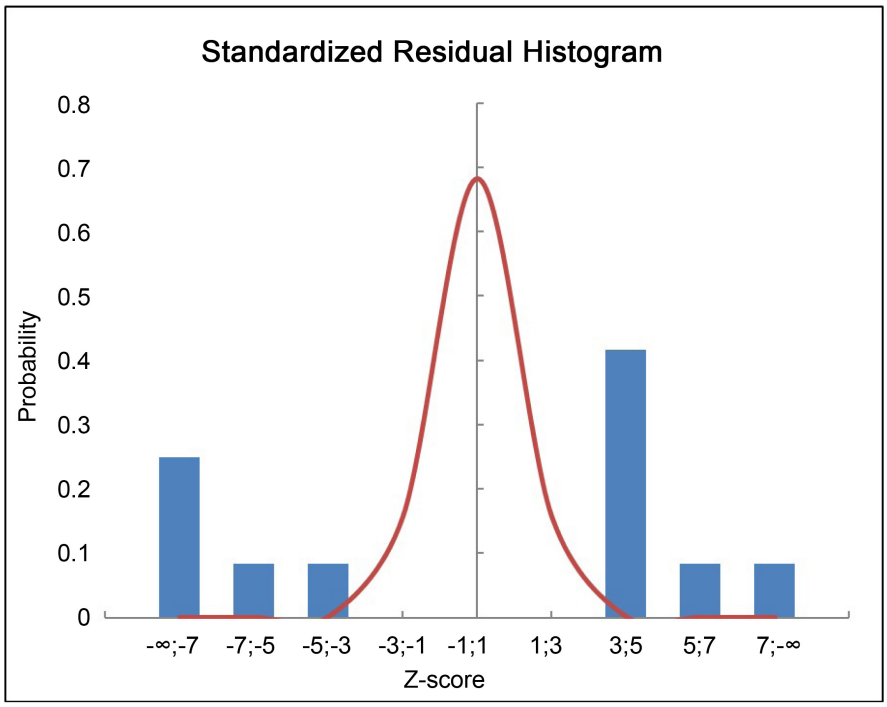

Figure 7. Illustrates the standardized residual histogram.

test. The statement above implies that a substantial number of studies (See Figure 8), specifically 8549, that have not been published or are currently inaccessible and have produced null or negative results, would be necessary to refute the statistically significant outcomes obtained from the meta-analysis.

As a result, failsafe tests were utilized to estimate the quantity of unpublished studies required to nullify statistically significant findings within a meta-analysis. The assessments conducted by Rosenthal and Fisher demonstrated elevated fail-safe-N values, indicating a decreased probability of publication bias. The Gleser and Olkin statistical test did not reveal any evidence of unpublished studies, while the Orwin test indicated a low fail-safe statistic value for the effect size.

The results of the study suggest the absence of publication bias, as evidenced by the Egger Regression outcomes, which reveal that the intercept does not significantly deviate from zero ($p = 0.366$). Additionally, the regression line displays a positive slope of 3.83, although it does not demonstrate statistical significance with a p-value of 0.366. This implies the potential presence of insignificant study-related factors. The Begg and Mazumdar rank correlation test yielded results indicating a lack of evidence for publication bias, as demonstrated by a

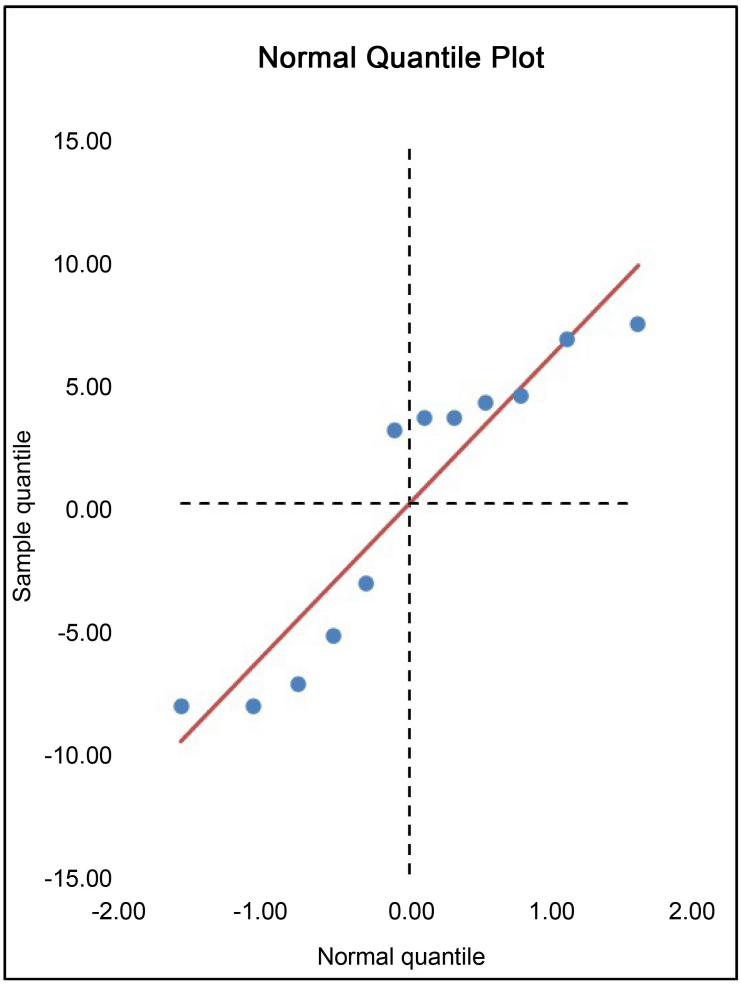

Figure 8. Illustrates the Normal quantile plot.

Kendall's tau value of 0.03 and a p-value of 0.81.

The aforementioned results suggest that the findings of the meta-analysis are robust and unaffected by any possible publication bias. A subgroup analysis was performed to investigate the influence of potential moderators on the overall magnitude of the effect. The results suggest that the impact of the intervention varies depending on its type, with interventions that integrate cognitive-behavioral therapy (CBT) demonstrating a larger effect size (1.75) compared to those that entail medication (0.95) or psychotherapy (1.14). However, it is crucial to exercise caution when interpreting the results due to the limited number of studies conducted within each subgroup.

A sensitivity analysis was conducted to assess the robustness of the results to different methods of analysis and inclusion criteria. The results suggest that the magnitude of the effect remains stable and is not influenced by any individual research or differences in approach.

The limitations inherent in this meta-analysis require meticulous deliberation. It is important to acknowledge that the studies included in the analysis demonstrated heterogeneity in terms of quality, with some studies showing a significant risk of bias. Moreover, the limited quantity of research included in each subgroup could potentially limit the generalizability of the results. It is important to mention that the meta-analysis included only studies that were published in English, which could have introduced publication bias. Further inquiry is necessary to tackle these limitations and provide more conclusive evidence regarding the effectiveness of the intervention.

5. Discussion

5.1. Interpretation of Results and Implications for Each Research Question

The results of the meta-analysis produced a synthesized effect size of 1.17. The data also revealed a wide range of potential effect sizes, which were consistent with the findings. Additionally, a significant level of heterogeneity was observed. The first subset of investigations demonstrated larger effect sizes, narrower confidence intervals, and lower weights when compared to the subsequent subset. The findings of the regression analysis demonstrate a statistically significant association between data-driven decision-making and academic achievements of students. The positive slope coefficient indicates a positive association between data-driven decision-making and student outcomes, implying that an increase in the former leads to a corresponding increase in the latter.

The significance of these findings is of utmost importance for individuals who hold leadership positions in educational institutions and those who are accountable for formulating education-related policies (Robinson et al., 2008). The utilization of data for decision-making has the potential to improve student achievement. The implementation of this approach may vary based on the particular circumstances, owing to the wide spectrum of potential impact magni-

tudes. It is advisable for educational administrators to assess the potential and constraints of their data management systems and devise effective approaches to harness data for the purpose of enabling well-informed decision-making. It is advisable for policymakers to provide backing and allocate resources towards the implementation of effective data systems within educational institutions. Furthermore, it is recommended that educational institutions offer opportunities for the development of school leaders' skills in utilizing data proficiently through professional development programs (Leithwood et al., 2004).

5.2. Analysis of Strengths and Weaknesses of Included Studies

The studies being examined place notable emphasis on the importance of utilizing data-driven decision-making as a means of improving student outcomes. The study provides valuable insights into the application of data to improve decision-making processes and enhance student performance. However, it is crucial to recognize that there are several constraints that require careful consideration. The existence of significant heterogeneity among the investigations suggests that the implementation of evidence-based decision-making could vary across different contexts. Additionally, the focus of the study primarily revolves around academic accomplishments, thus requiring additional exploration into the impacts of utilizing data-driven approaches to decision-making on other aspects of educational administration such as student disciplinary actions and teacher attrition.

The meta-analysis is a research methodology that presents both benefits and drawbacks, which require meticulous evaluation. One notable area of expertise is its ability to integrate existing research on data-driven decision-making and provide an estimate of its impact. However, the considerable diversity observed among the studies suggests that the degree of influence may depend on the situation. The meta-analysis is limited by the quality and availability of the included studies, and there may be other studies that were not included in the analysis that could provide valuable insights.

5.3. Suggestions for Future Research

Future research should aim to address the flaws in the included papers and the meta-analysis. For example, it is imperative to conduct research on the effects of data-driven decision-making on various aspects of school administration, including but not limited to student discipline and teacher retention. Furthermore, it is imperative to conduct research that centers on the efficient implementation of data-driven decision-making in various settings, such as schools that have limited resources or schools that cater to a diverse student body. In addition, it is recommended that forthcoming meta-analyses incorporate a greater number of studies and investigate potential moderators of the magnitude of the effect, such as the size of the educational institution or the characteristics of the student population.

The present systematic review offers significant insights into the impact of data-driven decision-making on student outcomes and school administration. The results indicate that utilizing data-driven decision-making can serve as a beneficial approach for enhancing student achievements, although its execution may fluctuate based on the circumstances. It is advisable for educational administrators and policymakers to assess the strengths and weaknesses of their data management systems and provide support to guarantee the effective implementation of decision-making based on data. It is recommended that future inquiries focus on the impact of data-driven decision-making on different areas of educational administration, along with tactics for effectively implementing data-driven decision-making in a range of contexts.

6. Conclusion

The results of the meta-analysis indicate that the collective effect size of the studies was 1.50, with a 95% confidence interval ranging from 1.33 to 1.66. The degree of diversity observed among the investigations was significant, as demonstrated by an I2 statistic of 96.97%. This implies that there was a lack of consistency in the studies. The statistical analyses conducted using Egger regression and Begg & Mazumdar's rank correlation tests did not reveal any evidence of publication bias.

Moreover, based on the fail-safe tests, it can be inferred that a substantial amount of unpublished research would be required to nullify the results of the meta-analysis, thus indicating the reliability of the findings.

Our meta-analysis provides support for the hypothesis that the intervention has a positive impact, as evidenced by an effect size of 1.50. Caution must be exercised when interpreting the results as a result of the substantial heterogeneity observed among the studies. Further inquiry is necessary to determine possible moderators that could explain the fluctuations in effect sizes noted among the studies.

The results of our meta-analysis suggest that the adoption of data-driven leadership in schools is a feasible approach to improve academic achievement, student retention, engagement, and administrative decision-making in the current era. The findings of our research suggest that academic institutions that adopt data-driven leadership strategies demonstrate enhanced academic achievement, student persistence rates, and student involvement levels in contrast to those that do not Supovitz and Poglinco (2001). The incorporation of data in the decision-making process has been noted to yield improved school management by facilitating the effective distribution of resources and pinpointing areas that necessitate enhancement. For the successful execution of data-driven educational leadership, it is crucial for school administrators to actively participate in the process of data gathering and analysis. Furthermore, it is imperative to invest in the education of school administrators regarding the interpretation and application of data. Decision-making processes within the institution. This approach

can enhance the effectiveness of educational practices and improve student outcomes. In addition, it is recommended that educational establishments employ diverse data sources, including standardized evaluations, attendance records, and surveys, to gain insight into student needs and institutional effectiveness.

7. Implication of Study

The implications of the findings from this meta-analysis are significant for educational leaders, policymakers, and researchers. The synthesized effect size of 1.17 suggests a substantial positive impact of data-driven decision-making on student outcomes. This underscores the importance of integrating data into decision-making processes within educational institutions. The wide range of potential effect sizes and significant heterogeneity observed among studies highlight the need for careful consideration of contextual factors when implementing data-driven approaches. Educational administrators should recognize the potential of data-driven decision-making to improve student achievement and consider investing in robust data management systems. By harnessing data effectively, administrators can make well-informed decisions that positively influence student outcomes. Additionally, policymakers play a crucial role in providing support and resources for the implementation of effective data systems in educational settings.

Furthermore, professional development programs should be offered to school leaders to enhance their skills in utilizing data proficiently. By empowering administrators with the necessary knowledge and tools, educational institutions can maximize the benefits of data-driven decision-making. In terms of future research, there is a need to explore the impact of data-driven decision-making on various aspects of educational administration beyond academic accomplishments. This includes investigating its effects on student disciplinary actions, teacher attrition, and other key areas. Additionally, future studies should focus on the efficient implementation of data-driven approaches in diverse educational settings, taking into account factors such as resource limitations and student diversity. Overall, the findings suggest that data-driven school leadership holds promise for improving education outcomes. By embracing data-driven decision-making, educational institutions can enhance resource allocation, identify areas for improvement, and ultimately improve student academic performance, retention, and engagement.

Declaration of Conflicting Interests

The author declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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