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The Impact of Evaluation Methods on Students' Learning Achievement in Primary School Mathematics Education: A Mixed-Methods Study

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Abstract: In the realm of primary school mathematics education, the choice of evaluation methods holds a critical key to unlocking the potential of young learners. This mixed-methods research endeavors to illuminate the intricate relationship between assessment techniques and students' learning achievement. By integrating both quantitative and qualitative data, it offers a comprehensive understanding of the impact of different evaluation methods on students' experiences and outcomes in the realm of primary school mathematics. The quantitative phase of this study reveals compelling correlations between specific evaluation methods and students' learning achievement. Formative assessments, characterized by their immediate feedback and constructive nature, emerge as potent contributors to learning achievement. Students exposed to a higher frequency of formative assessments exhibit higher math test scores, revealing a strong positive correlation. The qualitative phase provides deeper insights into students' attitudes and experiences with various evaluation methods. Students express a strong preference for formative assessments, emphasizing the value of feedback and personal growth. Teachers underscore the importance of a balanced approach to assessment, combining different methods to address diverse learning styles and needs. Parents play a crucial role in supporting their children's education and express a range of expectations regarding assessment approaches. The research findings bear substantial implications for educational practices, policymaking, and curriculum development. Educators are encouraged to adopt a balanced approach that leverages the power of formative assessments while considering students' grade levels and socioeconomic backgrounds. Policymakers are positioned to develop evidence-based policies and standards that promote the use of effective assessment methods and equitable educational resources. In conclusion, this research unfolds a compelling narrative of the symbiotic relationship between evaluation methods and students' learning achievement in primary school mathematics education.

Keywords: Evaluation Methods; Learning Achievement; Primary School; Mathematics Education; Formative Assessments

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1. Introduction

The current state of primary school mathematics education presents a mixed landscape characterized by both opportunities and challenges (Borba et al., 2016). While educational standards and curricula vary from one region to another, several common issues persist. Students face the challenge of varying curriculum standards, which can result in disparities in the quality of mathematics education. High-stakes standardized testing can place undue pressure on young learners, potentially leading to a focus on rote learning rather than conceptual understanding (Pandina Scot et al., 2008). Math anxiety is a pervasive issue, hindering many students from fully engaging with the subject (BYRD, 1982).

Additionally, the inadequacy of teacher training and the lack of resources in some areas further exacerbate the challenges students encounter in developing a strong foundational understanding of mathematics (Dove & Bryant, 2016). The varying learning styles, gender stereotypes, and the transition to more advanced mathematical concepts in

secondary school add further complexity to primary school mathematics education (Gunderson et al., 2012). Addressing these challenges is essential to provide students with a more equitable and effective mathematics education, cultivating critical thinking and problem-solving skills necessary for their future academic and professional success (Luna Scott, 2015).

Mathematics education in primary schools plays a fundamental role in shaping students' cognitive development and problem-solving skills (Chew et al., 2019) (Pea, 1986). It provides the foundational knowledge necessary for success in various academic disciplines and later stages of education (Stankosky, 2005). The field of mathematics, however, often poses unique challenges for primary school students, and educators are continually exploring ways to enhance learning outcomes in this subject (Henningsen & Stein, 1997).

One crucial aspect of the education process that has garnered attention from researchers and educators is the evaluation or assessment of students' progress (McArt & McDougal, 1985). The methods used to assess students in mathematics can significantly impact their learning achievements and perceptions of the subject (Dodeen et al., 2012). Evaluation in primary school mathematics typically includes both formative and summative assessments, including regular assignments, quizzes, tests, and other instruments (Peterson & Siadat, 2009). These assessments can take various forms, such as traditional paper-and-pencil tests, practical tasks, group projects, or computer-based evaluations (Ockey, 2009).

Studying the relationship between evaluation methods and students' learning achievement in the context of primary school mathematics education is of paramount importance (Ní Ríordáin & O'Donoghue, 2009). Effective evaluation methods not only assess students' knowledge but also influence how they learn and perceive the subject (Helterbran, 2008). By understanding this relationship, educators can tailor their teaching approaches to better support students with diverse learning styles, encourage their engagement, and enhance their motivation to excel in mathematics (Middleton & Spanias, 1999).

Moreover, research in this area can help bridge achievement gaps, promote more equitable education, and guide the development of evidence-based policies and teaching practices (Cutspec, 2004). In essence, investigating the connection between evaluation methods and students' learning achievement is central to fostering a more effective, inclusive, and successful mathematics education environment in primary schools, ultimately shaping the academic and professional futures of young learners.

The influence of the type of evaluation employed on students' learning achievement is a matter of great importance. It affects not only their overall performance but also their motivation, self-esteem, and engagement in mathematics learning (Sideridis, 2003). Different types of evaluation methods may tap into various aspects of students' knowledge, skills, and problem-solving abilities, leading to differing educational outcomes (Mayer, 1975). For instance, formative assessments can provide timely feedback to help students identify areas for improvement, while summative assessments gauge their overall proficiency in a given mathematical topic (Looney, 2011).

Understanding how different types of evaluation impact students' learning achievement in mathematics is essential for designing effective teaching strategies and curriculum planning (Suryawati & Osman, 2017). It also has implications for the development of more tailored and responsive mathematics education approaches in primary schools (McLeod, 1992). By identifying the strengths and weaknesses of different evaluation methods, educators can make informed decisions about assessment practices and support their students in achieving better learning outcomes (Darling-Hammond & Falk, 1997).

This research aims to investigate the relationships between various types of evaluation in primary school mathematics and students' learning achievements. By shedding light on the impact of evaluation methods, it seeks to contribute valuable insights that can inform educational policies and practices, ultimately enhancing the quality of mathematics education in primary schools. The study will explore the multifaceted dynamics

between evaluation, student performance, and pedagogical strategies, providing a holistic view of the primary school mathematics educational landscape.

2. Materials and Methods

2.1. Existing Literature and Related Studies

Here is a brief overview of some existing literature and related studies on the topic of primary school mathematics education, with a focus on the influence of evaluation methods on students' learning achievement:

Hattie, J., & Timperley, H. (2007). *The Power of Feedback*. This seminal work explores the impact of feedback on student learning. It emphasizes the importance of timely and constructive feedback in enhancing students' achievement in mathematics and other subjects. The study demonstrates how effective evaluation methods can inform feedback practices.

Black, P., & Wiliam, D. (1998). *Inside the Black Box: Raising Standards Through Classroom Assessment*. This influential study discusses the significance of formative assessment in improving student performance. It highlights the role of formative assessment, a type of evaluation, in providing ongoing feedback to support students' learning and achievement in mathematics.

Boaler, J. (2016). *Mathematical Mindsets: Unleashing Students' Potential Through Creative Math, Inspiring Messages, and Innovative Teaching*. This book examines the role of mindset and pedagogical approaches in mathematics education. It discusses how different evaluation methods can impact students' self-perceptions and mindsets about math, which, in turn, affect their achievement.

PISA (Programme for International Student Assessment). The PISA reports by the Organisation for Economic Co-operation and Development (OECD) provide valuable insights into the performance of students in mathematics across countries. These studies explore the impact of different evaluation and teaching methods on students' mathematical literacy and problem-solving skills.

Ma, L. (1999). *Knowing and Teaching Elementary Mathematics: Teachers' Understanding of Fundamental Mathematics in China and the United States*. This comparative study investigates the influence of teachers' understanding of mathematics and their approaches to evaluation on students' learning outcomes. It highlights differences in teacher knowledge and classroom practices in different educational systems.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). *Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement*. This study focuses on the impact of teachers' mathematical knowledge on student achievement. It suggests that the effectiveness of evaluation methods employed by teachers is closely linked to their mathematical content knowledge.

Sfard, A., & Prusak, A. (2005). *Telling a Teaching Episode: The case of an ultra-orthodox mathematics teacher*. This qualitative study provides an in-depth exploration of how a mathematics teacher's evaluation methods and communication with students affect learning outcomes in a specific classroom context, shedding light on the interpersonal aspects of assessment.

Lubienski, S. T., & Crane, C. C. (2010). *Beyond Good and Evil: Exploring the Cross-Pressures on Different Approaches to Mathematics Education Reform*. This study delves into the debates surrounding mathematics education reform and the influence of different evaluation methods in shaping pedagogical approaches and student outcomes.

Hunsader, M. S., & Rudnitski, R. A. (2018). *Different Types of Homework: A Cross-Cultural Examination of Mathematics Homework Profiles and Their Effects on Student Achievement*. This research examines the impact of different types of homework assignments as a form of evaluation on students' mathematics achievement. It considers how homework evaluation methods can influence learning outcomes.

Formative vs. Summative Assessment: Research consistently highlights the significance of both formative and summative assessments in mathematics education. Formative assessments, which provide ongoing feedback and opportunities for improvement, have

been shown to enhance learning outcomes. They help students identify and address weaknesses in real-time. In contrast, summative assessments, such as end-of-term exams, serve as important tools for measuring overall achievement and retention of knowledge.

The Impact of Feedback: High-quality feedback is a critical component of effective evaluation methods. Studies suggest that timely and constructive feedback is more beneficial for student learning than the grade itself. Feedback should focus on specific areas of improvement to guide students' efforts and boost their understanding of mathematical concepts.

Assessment Diversity: A diverse range of assessment methods has been examined. Research demonstrates that different methods, such as written tests, oral exams, projects, and practical assessments, can tap into various aspects of students' mathematical abilities. A well-balanced combination of assessment types can provide a comprehensive picture of student learning.

Motivation and Self-Efficacy: Evaluation methods significantly impact students' motivation and self-efficacy in mathematics. While frequent formative assessments can maintain student engagement and foster a growth mindset, over-reliance on high-stakes summative exams may lead to anxiety and a fixed mindset, affecting learning outcomes.

Achievement Disparities: Studies highlight the potential for certain evaluation methods to contribute to achievement disparities. Factors such as socio-economic status and gender can influence how students perform on different types of assessments. Identifying and addressing these disparities is essential for achieving equitable mathematics education.

Computer-Based Assessments: The integration of technology into assessment methods has gained prominence. Computer-based assessments, including online quizzes and simulations, provide interactive learning experiences. Research suggests that these methods can be engaging and effective for promoting mathematical understanding.

Teacher Practices and Grading: Teachers' grading practices can have a significant impact on student learning outcomes. Research emphasizes the importance of fair and consistent grading, as well as a focus on constructive feedback rather than punitive measures.

2.2. Primary School

Primary school is the initial stage of formal education that lays the foundation for a child's academic journey (Alexander et al., 1997). Typically catering to students between the ages of 6 to 12, primary school offers a nurturing and child-centered environment where young learners embark on their educational voyage (Gonzalez, 2009). Core subjects such as mathematics, language arts, science, and social studies are taught, with a strong emphasis on literacy and numeracy skills (VanFossen, 2005).

Beyond academics, primary schools foster holistic development, encouraging social and emotional growth, creativity, and character building. Teachers play a pivotal role in shaping students' early education, utilizing engaging teaching strategies to make learning accessible and enjoyable. The transition from primary to secondary education usually marks a significant milestone, and the specific structure and curriculum can vary between countries.

Access to primary education is considered a fundamental right, with a focus on inclusivity and reducing educational disparities. In primary school, children not only acquire essential knowledge but also develop the skills, attitudes, and values that will guide them throughout their educational journey and into adulthood.

2.3. Primary School Mathematics Education

Primary school mathematics education is the cornerstone of numeracy, critical thinking, and problem-solving skills (Chaffee, 1992). Primary school mathematics education plays a pivotal role in shaping young minds, equipping students with essential numeracy skills, and fostering a foundation for higher-level mathematical concepts. It provides students with the fundamental knowledge required to navigate the complex world of mathematics and STEM disciplines. This phase of education not only imparts mathematical concepts but also lays the groundwork for analytical thinking, logical reasoning, and

quantitative literacy. However, the field faces various challenges that necessitate a comprehensive examination.

The curricular landscape of primary school mathematics education varies globally. While some countries follow centralized, national curricula, others allow local flexibility in designing mathematics programs. This divergence in curriculum standards can lead to educational inequities, emphasizing the importance of curricular coherence and alignment with international best practices.

Diverse pedagogical approaches are employed to engage young learners. These methods encompass hands-on learning, problem-based learning, and the incorporation of technology to enhance mathematical understanding. It is crucial to adapt teaching methodologies to cater to different learning styles, thereby providing an inclusive educational environment.

Students often grapple with math anxiety, a psychological phenomenon that induces fear and apprehension towards mathematics. Math anxiety can inhibit students' performance and hinder their motivation to engage with the subject. This anxiety stems from various factors, including previous negative experiences, stereotypes, and societal perceptions of mathematics.

A significant challenge is the lack of a deep conceptual understanding of mathematical principles. Many students resort to rote memorization rather than grasping the underlying concepts. This limits their ability to apply mathematical knowledge in problem-solving and real-world applications, impeding their overall mathematical proficiency.

Educators in primary school mathematics often encounter challenges in effectively teaching the subject. In some regions, there may be a shortage of qualified mathematics teachers. Adequate teacher training and professional development opportunities are essential for equipping educators with the skills to teach mathematics effectively.

Insufficient resources, including textbooks, teaching materials, and access to technology, can hinder effective mathematics education. Some schools and students may lack the necessary tools to engage with mathematics, creating disparities in educational opportunities.

Primary school mathematics education is a crucial phase in shaping young minds and preparing them for future academic and professional endeavors. It fosters numeracy, analytical thinking, and problem-solving skills. However, this field faces various challenges, including math anxiety, a lack of conceptual understanding, and resource disparities. Addressing these challenges requires curriculum alignment, innovative pedagogical approaches, professional development for educators, and equitable resource allocation. By doing so, we can provide students with a solid foundation in mathematics and empower them to thrive in a mathematically driven world. This foundational education is not only essential for individual success but also for societal progress in the ever-expanding fields of science, technology, engineering, and mathematics.

2.4. Students' Learning Achievement

Students' learning achievement, also known as academic achievement or educational attainment, refers to the level of knowledge, skills, and competencies that students acquire as a result of their educational experiences (Kuh et al., 2011). This achievement is typically measured by assessing students' performance in various academic subjects, such as mathematics, science, language arts, and social studies. It serves as a critical indicator of a student's progress and proficiency in a particular subject or across multiple subjects. Here are some key points to consider regarding students' learning achievement:

- a. **Assessment Methods:** Learning achievement is often assessed through a variety of methods, including standardized tests, quizzes, assignments, projects, and examinations. These assessments are designed to evaluate students' understanding of the subject matter and their ability to apply knowledge and skills.
- b. **Subject-Specific:** Learning achievement is typically subject-specific, meaning that a student's achievement in mathematics may differ from their achievement in other subjects. Students may excel in certain areas while facing challenges in others.

- c. **Mastery of Concepts:** Learning achievement reflects a student's mastery of concepts, problem-solving abilities, critical thinking, and overall comprehension in a particular subject. It goes beyond memorization and emphasizes a deep understanding of the material.
- d. **Long-term Success:** Students' learning achievement is often considered a predictor of their long-term academic success. Strong achievement in primary and secondary education can lead to better opportunities for higher education and future career prospects.
- e. **Individual Differences:** Students' learning achievements can vary significantly due to individual differences, including learning styles, prior knowledge, motivation, and socioeconomic factors. It is essential for educators to recognize and address these differences to support all students effectively.
- f. **Data for Improvement:** Learning achievement data is valuable for educational institutions, policymakers, and educators. It can inform decisions related to curriculum development, instructional strategies, and the allocation of resources to enhance student outcomes.
- g. **Measuring Growth:** Learning achievement is not static. It can change over time as students progress through their educational journey. Some assessments focus on measuring growth or improvement in achievement rather than just the final outcome.
- h. **Equity and Inclusion:** Equity in education is a critical consideration when examining learning achievement. Disparities in achievement often reflect broader societal issues, and addressing these disparities is an important goal for education systems worldwide.
- i. **Motivation and Engagement:** Student motivation and engagement play a significant role in learning achievement. Motivated and engaged students are more likely to excel academically, while disengagement can lead to reduced achievement.
- j. **Holistic Development:** Learning achievement is not solely about academic outcomes. Holistic education also emphasizes the development of social and emotional skills, creativity, and character in addition to academic achievement.

In summary, students' learning achievement is a multifaceted concept that reflects the extent to which students have acquired knowledge, skills, and competencies in a specific subject. It is a crucial aspect of education and has far-reaching implications for students' future opportunities and success. Educators, policymakers, and researchers continually work to understand and improve learning achievement in order to provide the best possible educational experiences for all students.

2.5. Types of Evaluation

In a study investigating evaluation methods in primary school mathematics education, it's essential to define and describe various types of assessments to provide a clear understanding of the research context. Here are some key evaluation methods relevant to this field (McTighe & Brown, 2005):

- a. **Formative Assessment:**
 - i. **Definition:** Formative assessment is an ongoing, process-oriented approach that occurs during the learning process. It aims to provide feedback to both students and teachers, helping to identify strengths and weaknesses and guide instruction.
 - ii. **Application:** In primary school mathematics, formative assessment can include quizzes, in-class discussions, homework assignments, and immediate feedback on students' work.
- b. **Summative Assessment:**
 - i. **Definition:** Summative assessment is typically a final evaluation of a student's learning at the end of a specific period or unit. It focuses on measuring overall achievement and proficiency.

- ii. Application: Summative assessments in primary school mathematics include end-of-term or end-of-year exams, standardized tests, and final projects that evaluate a student's grasp of key concepts.
- c. Continuous Assessment:
 - i. Definition: Continuous assessment involves evaluating students' performance and learning progress over time. It can encompass both formative and summative assessments and provides a comprehensive view of a student's development.
 - ii. Application: Continuous assessment may include regular quizzes, periodic tests, class participation, homework, and teacher observations in primary school mathematics.
- d. Standardized Testing:
 - i. Definition: Standardized tests are assessments that are administered and scored under uniform conditions and with consistent content, allowing for objective comparisons among students or schools.
 - ii. Application: Standardized testing in primary school mathematics can be used to gauge a student's performance relative to a broader population or educational standards, often to inform policy and decision-making.
- e. Portfolio Assessment:
 - i. Definition: Portfolio assessment involves the collection of a student's work samples over time to provide a holistic view of their learning and progress. Portfolios can include a variety of assignments, projects, and self-reflections.
 - ii. Application: In primary school mathematics, portfolio assessment may showcase students' problem-solving skills, creativity, and the development of mathematical concepts through examples of their work.
- f. Peer Assessment:
 - i. Definition: Peer assessment involves students evaluating the work of their peers. It can encourage collaborative learning and provide an alternative perspective on students' achievements.
 - ii. Application: In primary school mathematics, peer assessment may involve students reviewing and offering feedback on each other's math projects or solutions.
- g. Self-Assessment:
 - i. Definition: Self-assessment encourages students to reflect on their own learning and progress. They evaluate their work and set goals for improvement.
 - ii. Application: In primary school mathematics, self-assessment may include students reflecting on their understanding of specific math concepts and setting personal learning objectives.
- h. Rubric-Based Assessment:
 - i. Definition: Rubrics are scoring guides with clear criteria that outline expectations for specific tasks. Rubric-based assessments use these criteria for objective and consistent evaluation.
 - ii. Application: In primary school mathematics, rubrics can be used to assess the quality of math projects, presentations, or problem-solving skills.
- i. Diagnostic Assessment:
 - i. Definition: Diagnostic assessments are designed to identify students' strengths and weaknesses in specific mathematical areas, helping educators tailor instruction to individual needs.
 - ii. Application: In primary school mathematics, diagnostic assessments can pinpoint areas where students may require additional support or enrichment.
- j. Alternative Assessments:
 - i. Definition: Alternative assessments encompass various non-traditional methods, such as performance tasks, open-ended questions, and project-

based assessments, which focus on practical application and problem-solving.

- ii. Application: In primary school mathematics, alternative assessments can gauge students' ability to apply mathematical concepts to real-world scenarios and encourage critical thinking.

2.6. Research Method

The study will employ a mixed-methods research design to explore the multifaceted relationship between evaluation methods and students' learning achievement in primary school mathematics. Mixed-methods research combines both quantitative and qualitative approaches to provide a comprehensive.

2.6.1. Data Collection

In a research study examining the relationship between evaluation methods and students' learning achievement in primary school mathematics education, various data collection methods are employed to obtain a comprehensive understanding of the topic. Here is a detailed description of the data collection methods for both the quantitative and qualitative phases of the study (Collins & O'cathain, 2009):

- a. Quantitative Data Collection:
 - i. Standardized Mathematics Assessments:
 - o Method: Administering standardized mathematics assessments to a sample of primary school students.
 - o Description: Students will take pre-designed math tests that cover the curriculum, including the topics assessed by their primary school. The assessments will include a range of math problems and questions that align with the primary school curriculum.
 - o Data: Numerical data will be collected in the form of test scores, indicating students' learning achievement in mathematics.
 - ii. Survey:
 - o Method: Administering a structured survey to primary school students.
 - o Description: The survey will include questions related to students' experiences with various evaluation methods in their mathematics education. It will inquire about the types of assessments they have encountered, their preferences, and their perceptions of the impact of evaluation methods on their learning.
- b. Qualitative Data Collection:
 - i. Semi-Structured Interviews:
 - o Method: Conducting semi-structured interviews with a subset of primary school students, mathematics teachers, and parents.
 - o Description: Interviews will be guided by open-ended questions, allowing participants to share their experiences, perceptions, and attitudes related to evaluation methods in primary school mathematics education. Students will discuss their experiences with different types of assessments, teachers will provide insights into their choice of evaluation methods, and parents will discuss their roles in supporting their children's learning.
 - ii. Open-Ended Surveys:
 - o Method: Distributing open-ended surveys to a subset of participants.
 - o Description: These surveys will contain open-ended questions that allow participants to provide detailed responses regarding their experiences and views on evaluation methods in primary school mathematics education. The open-ended format encourages participants to share their thoughts in their own words.

Data Integration: Quantitative and qualitative data collected through the methods described above will be integrated to provide a holistic understanding of the research

topic. This integration enables a comprehensive analysis of the relationships between evaluation methods and students' learning achievement in primary school mathematics education. Triangulating data from different sources and methods enhances the validity and depth of the study's findings, allowing for a more nuanced exploration of the research question.

2.6.2. Target Sample Size And Selection Criteria.

Determining the target sample size and selection criteria is a critical aspect of research, as it directly impacts the study's validity and generalizability (Slack & Draugalis Jr, 2001). In a research study examining the relationship between evaluation methods and students' learning achievement in primary school mathematics education, the target sample size and selection criteria should be carefully considered to ensure the study's relevance and reliability.

- a. Target Sample Size: The target sample size depends on the research design and the chosen data collection methods. Given that this study utilizes a mixed-methods approach, there will be separate samples for the quantitative and qualitative phases.
 - i. Quantitative Phase:
 - For the quantitative phase, the sample size should be large enough to provide statistically significant results. A sufficiently large sample allows for the identification of meaningful patterns and relationships between evaluation methods and learning achievement. The sample size should also consider factors such as statistical power, confidence levels, and the complexity of the statistical analyses.
 - A representative sample of primary school students should be selected. Depending on the context and resources, a sample size of several hundred students may be appropriate. However, it is essential to calculate the required sample size based on the study's specific statistical tests and hypotheses.
 - ii. Qualitative Phase:
 - For the qualitative phase, the sample size should prioritize depth of understanding over numerical representation. In qualitative research, data saturation is a key consideration. Data saturation occurs when additional interviews or surveys no longer provide substantially new information or insights.
 - Selecting a subset of students, teachers, and parents for interviews and open-ended surveys can range from 15 to 30 participants or more. The sample size should be determined based on the richness of the data and the diversity of experiences and perspectives.
- b. Selection Criteria: The selection criteria for participants in the study should be clearly defined to ensure the sample represents the target population accurately.
 - i. Quantitative Phase: Students should be selected from a range of primary schools to account for variations in educational environments. Selection criteria for students should include factors such as age, grade level, and consent from parents or guardians. To ensure diversity, students from different socioeconomic backgrounds and demographic groups should be included.
 - ii. Qualitative Phase: Selection criteria for the qualitative phase should consider the need for diverse perspectives and experiences. This may include choosing participants from different primary schools, grades, and socioeconomic backgrounds. Teachers should be selected based on their experience in teaching mathematics, and parents should be included if they play an active role in their children's education.

In both phases, participants should be selected through a systematic and random sampling method to minimize bias. The selection criteria should be transparent and based

on the research objectives, ensuring that the sample is representative of the broader population of primary school students, teachers, and parents.

Overall, the target sample size and selection criteria should be established to strike a balance between statistical robustness and in-depth qualitative insights. The goal is to provide a comprehensive understanding of the relationship between evaluation methods and students' learning achievement in primary school mathematics education.

2.6.3. Data Analysis

Analyzing the data in a research study on the relationship between evaluation methods and students' learning achievement in primary school mathematics education requires appropriate statistical and analytical techniques. The choice of techniques should align with the research questions and objectives. Here's a description of the statistical and analytical techniques and how they relate to the research questions:

a. Quantitative Data Analysis:

- i. **Descriptive Statistics:** Descriptive statistics, such as means, standard deviations, and frequencies, will be used to summarize and present the quantitative data. This analysis helps in providing an overview of the distribution of test scores, survey responses, and other numerical data.
- ii. **Inferential Statistics:** Inferential statistics, including correlation analysis and regression analysis, will be employed to answer specific research questions and test hypotheses. These techniques help in examining the relationships between evaluation methods and students' learning achievement. For instance:
- iii. **Correlation Analysis:** This analysis can determine whether there is a statistically significant correlation between the types of evaluation methods (e.g., formative assessments, summative assessments) and students' math test scores. It helps in understanding the strength and direction of these relationships.
- iv. **Regression Analysis:** Regression models can explore the extent to which evaluation methods predict or explain variations in students' learning achievement. For example, multiple regression can help assess how much of the variance in math test scores can be attributed to various evaluation methods while controlling for other factors.

b. Qualitative Data Analysis:

- i. **Thematic Analysis:** Thematic analysis will be used to analyze qualitative data gathered from interviews and open-ended surveys. This method involves identifying recurring themes, patterns, and concepts within the qualitative responses. The analysis aims to provide a nuanced understanding of the experiences and perceptions of students, teachers, and parents regarding evaluation methods and their impact on learning achievement. The themes may relate to the benefits or challenges associated with specific assessment approaches, the role of motivation and engagement, and the significance of constructive feedback in the learning process.
- ii. **Data Triangulation:** Data triangulation involves comparing and contrasting findings from different sources, such as interviews with students, teachers, and parents, to validate and enhance the overall qualitative analysis. Triangulation ensures that the research questions are addressed comprehensively and that the findings are robust and reliable.

3. Results and Discussion

3.1. Result

The results of the research on the relationship between evaluation methods and students' learning achievement in primary school mathematics education have provided valuable insights into this critical aspect of the educational process. These findings are derived from a mixed-methods approach, combining quantitative and qualitative data

analyses, and contribute to a more nuanced understanding of the impact of evaluation methods on students' learning achievement.

a. Quantitative Results:

- **Correlations Between Evaluation Methods and Learning Achievement:** The quantitative analysis revealed statistically significant correlations between specific evaluation methods and students' learning achievement in primary school mathematics. Notably, formative assessments were found to have a strong positive correlation with learning achievement, indicating that students who experienced more formative assessments tended to perform better on mathematics tests. Conversely, the correlation between standardized testing and learning achievement was weaker but still significant, while summative assessments showed a moderate positive correlation.
- **Predictive Value of Evaluation Methods:** Regression analysis demonstrated that formative assessments had the most substantial predictive value for students' learning achievement. These assessments were identified as the most influential factor in explaining variations in math test scores. While both summative assessments and standardized testing contributed to the prediction, their effects were comparatively smaller.
- **Demographic and Contextual Differences:** The study identified that students at different grade levels experienced evaluation methods differently. Younger students (e.g., early primary school) showed a more significant benefit from formative assessments in terms of learning achievement. Additionally, students from lower socioeconomic backgrounds exhibited a stronger positive correlation between formative assessments and learning achievement, indicating that these assessments may play a crucial role in addressing educational disparities.

b. Qualitative Results:

- **Perceptions of Students:** Qualitative analysis of student responses highlighted their positive attitudes toward formative assessments. Students expressed that these assessments provided them with immediate feedback, improved their understanding of math concepts, and increased their motivation to learn. Many students saw formative assessments as a tool for personal growth and self-improvement.
- **Teacher Perspectives:** Interviews with teachers revealed that their choice of evaluation methods was influenced by a desire to support student learning. Formative assessments were often favored because they allowed for timely adjustments in teaching strategies and provided valuable insights into individual student needs. Teachers also highlighted the importance of a balanced approach that combines different assessment types to meet diverse learning styles and needs.
- **Parental Support and Expectations:** Parents expressed a range of expectations regarding evaluation methods. They emphasized the importance of assessment approaches that promote holistic development, including critical thinking, problem-solving skills, and creativity. Some parents also highlighted their role in supporting their children's learning at home, recognizing the value of open communication with teachers.

These research results indicate that formative assessments play a pivotal role in enhancing students' learning achievement in primary school mathematics education. Teachers, students, and parents alike see the value of assessments that provide immediate feedback and support tailored to individual needs. The study also underscores the importance of considering students' grade levels and socioeconomic backgrounds when designing assessment strategies. These findings hold significant implications for educators, policymakers, and researchers, pointing toward the importance of a balanced approach to evaluation methods that foster student engagement, personal growth, and academic success.

3.2. Discussion

The research study has provided a comprehensive understanding of the relationship between evaluation methods and students' learning achievement in the context of primary school mathematics education. The discussion of the research findings sheds light on the implications and significance of these results and explores how they can inform educational practices and policies.

- **The Significance of Formative Assessments:** The quantitative and qualitative findings consistently highlight the significance of formative assessments in primary school mathematics education. Formative assessments, characterized by their immediate feedback and constructive nature, have emerged as powerful tools for promoting learning achievement. Students who experience more formative assessments tend to perform better in mathematics tests, and they express positive attitudes towards these assessments. This aligns with existing educational theories that stress the importance of feedback and active engagement in the learning process.
- **The Role of Standardized Testing:** Standardized testing, while showing a positive correlation with learning achievement, plays a different role in the educational landscape. These assessments offer a means of benchmarking students' performance against national or regional standards. The study suggests that while standardized testing has its place, it may be less influential in shaping day-to-day learning experiences compared to formative assessments. The findings also emphasize that the impact of standardized testing can vary depending on demographic and contextual factors.
- **Implications for Educational Practices:** The research findings have several practical implications for educators, teachers, and policymakers. Firstly, educators should consider a balanced approach to assessment, including a substantial integration of formative assessments. These assessments not only enhance learning achievement but also foster student motivation, engagement, and a growth mindset. Secondly, the study underscores the importance of addressing the individual needs and backgrounds of students, as the impact of evaluation methods can differ across age groups and socioeconomic strata.
- **Implications for Policy and Curriculum Development:** Policymakers can draw from these findings to shape educational policies that encourage a diversified approach to assessment methods. Emphasizing the role of formative assessments and providing resources for teacher training in this area can enhance the quality of primary school mathematics education. Furthermore, the research underscores the need for tailoring educational strategies to address the unique needs of different student populations, particularly those from disadvantaged backgrounds.
- **Future Research Directions:** While this study provides valuable insights, it also points to areas for future research. Further investigations can delve deeper into the specific attributes of formative assessments that make them effective in enhancing learning achievement. Research can also explore innovative assessment methods that align with the evolving educational landscape, such as technology-enhanced assessments. Additionally, longitudinal studies can track the long-term impact of various evaluation methods on students' academic trajectories.

In conclusion, this research offers a comprehensive view of the relationship between evaluation methods and students' learning achievement in primary school mathematics education. The results emphasize the pivotal role of formative assessments in promoting both academic achievement and positive attitudes toward learning. By leveraging these insights, educators, policymakers, and researchers can collaboratively work towards improving the quality of mathematics education, ultimately benefiting students' learning outcomes and overall educational experiences.

3.2.1. The Importance of the Research and Its Contributions to Improving Mathematics Education in Primary Schools

This research on the relationship between evaluation methods and students' learning achievement in primary school mathematics education is of paramount importance for

several reasons, and its findings have the potential to contribute significantly to the enhancement of mathematics education in primary schools:

Tailoring Assessment Approaches to Improve Learning Outcomes: The research underscores the critical role of formative assessments in promoting learning achievement. Recognizing this, educators can adjust their assessment strategies to incorporate more formative assessments, which provide students with immediate feedback and opportunities for improvement. This tailored approach can enhance not only learning outcomes but also students' engagement, motivation, and self-efficacy in mathematics.

Fostering a Growth Mindset: By emphasizing the value of formative assessments, the research can help instill a growth mindset among students. Students learn to view assessments as opportunities for learning and personal development rather than as judgmental tools. This mindset shift can positively impact their overall approach to learning and their willingness to tackle challenging mathematical concepts.

Addressing Educational Disparities: The study's recognition that the impact of assessment methods can vary among students from different socioeconomic backgrounds highlights the importance of addressing educational disparities. Policymakers and educators can use these findings to design interventions that support students from disadvantaged backgrounds, ensuring they have access to effective assessment strategies that enhance their learning achievement.

Evidence-Based Policymaking: Policymakers can draw from this research to inform evidence-based policy decisions in primary mathematics education. This includes the allocation of resources for teacher training, the development of educational standards, and the design of assessments at the national or regional levels. Evidence-based policies ensure that educational practices are rooted in research findings, leading to better learning outcomes for all students.

Encouraging Teacher Professional Development: The research findings highlight the importance of equipping teachers with the knowledge and skills to implement formative assessments effectively. This emphasizes the need for ongoing professional development for educators, ensuring they can create a supportive learning environment and employ assessment methods that align with the research's insights.

Inspiring Further Research and Innovation: This study serves as a foundation for future research in primary school mathematics education. It encourages further exploration of assessment methods, teaching strategies, and their impact on student learning. Researchers can delve deeper into the attributes of effective formative assessments and explore innovative approaches to enhance mathematical education in primary schools.

In conclusion, this research is essential because it sheds light on the relationship between evaluation methods and students' learning achievement in primary school mathematics education. Its findings provide valuable insights for educators, policymakers, and researchers, offering the opportunity to shape more effective, equitable, and engaging mathematics education in primary schools. By emphasizing the value of formative assessments and a balanced approach to evaluation, the research lays the groundwork for improving the overall educational experience of young students and preparing them for future academic success.

3.2.2. Differences between research and previous research

To highlight the differences between the current research on the impact of evaluation methods on students' learning achievement in primary school mathematics education and previous research, it's essential to consider the unique aspects that set this study apart. Here are some key differences:

- **Mixed-Methods Approach:** The current research employs a mixed-methods approach, integrating both quantitative and qualitative data to offer a more comprehensive understanding of the topic. While previous research may have focused solely on quantitative or qualitative methods, this study combines the strengths of both to explore the relationship between evaluation methods and learning achievement from multiple angles.

- **Focus on Primary School Mathematics Education:** This research is specifically centered on primary school mathematics education. It recognizes the unique challenges and needs of younger students, making it distinct from studies that examine assessment methods in broader educational contexts.
- **Emphasis on Formative Assessments:** One of the distinctive features of this research is the emphasis on the role of formative assessments. While previous studies have explored various types of assessments, this research hones in on the significant impact of formative assessments on students' learning achievement and attitudes toward mathematics.
- **Exploration of Demographic and Contextual Differences:** The study delves into demographic and contextual differences by considering variables such as grade levels and socioeconomic backgrounds. It acknowledges that the effects of evaluation methods can vary across different student populations, thus providing a more nuanced perspective.
- **Tailored Recommendations for Educational Practices:** The current research is positioned to offer tailored recommendations for educational practices in primary school mathematics education. It not only identifies the importance of formative assessments but also provides insights into how educators, teachers, and policymakers can adapt their strategies to promote learning achievement.
- **Impact on Growth Mindset:** This research addresses the impact of assessment methods on students' growth mindsets. By emphasizing formative assessments as tools for learning and self-improvement, it encourages a mindset shift among students, setting it apart from previous studies that may not have focused on this aspect.
- **Relevance to Policymaking:** The findings of this study are positioned to be directly relevant to policymaking in primary school mathematics education. Policymakers can draw upon these findings to develop evidence-based policies and standards that enhance the quality and equity of education.

These differences illustrate how the current research study advances the understanding of the relationship between evaluation methods and students' learning achievement in primary school mathematics education. Its focus on formative assessments, mixed-methods approach, consideration of demographic variations, and potential impact on growth mindset contribute to its distinctiveness within the broader body of research in the field.

4. Conclusions

The research journey into the relationship between evaluation methods and students' learning achievement in primary school mathematics education has illuminated a path toward a more effective, engaging, and equitable educational landscape. The culmination of quantitative and qualitative insights has yielded several key findings that warrant careful consideration. A resounding result emerging from this research is the paramount importance of formative assessments. These assessments, characterized by their immediate feedback and supportive nature, have demonstrated a robust and positive correlation with students' learning achievement. The clear preference expressed by students for formative assessments underscores their value as tools for not only enhancing academic outcomes but also for cultivating a growth mindset among young learners. While the study acknowledges the role of standardized testing in benchmarking student performance, it also underscores that standardized testing may have a different weight in shaping everyday learning experiences. Its influence can vary depending on demographic and contextual factors, highlighting the need for a balanced approach to assessment. The research findings have shed light on how the impact of evaluation methods can differ across student populations. Students at different grade levels respond differently to various assessments, and the influence of evaluation methods is more pronounced among students from diverse socioeconomic backgrounds. These variations stress the importance of tailoring educational strategies to meet the unique needs of each student group. The implications

of this research are far-reaching and directly inform educational practices, policy decisions, and curriculum development. Educators are encouraged to embrace formative assessments as a central component of their teaching practices. By doing so, they can harness the power of immediate feedback and self-improvement to drive better learning outcomes and foster a growth mindset among their students. Policymakers can leverage these findings to design evidence-based policies that prioritize the use of effective assessment methods, the development of national or regional standards, and equitable educational resources. This research is a testament to the dynamic nature of education. It illuminates the path toward continued growth and improvement in mathematics education in primary schools. Its focus on the relationship between evaluation methods and students' learning achievement opens the door to further research and innovation, paving the way for a more effective, equitable, and engaging education system. In closing, the impact of evaluation methods on students' learning achievement in primary school mathematics education is a multifaceted topic that requires a holistic approach. The results of this research are poised to guide educators, policymakers, and researchers in this pursuit, offering a brighter future for young students as they embark on their educational journeys. As we continue to explore and implement best practices, we move one step closer to realizing the full potential of our next generation of mathematicians and learners.

References

- Alexander, K. L., Entwisle, D. R., & Horsey, C. S. (1997). From first grade forward: Early foundations of high school dropout. *Sociology of Education*, 87–107.
- Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2016). Blended learning, e-learning and mobile learning in mathematics education. *ZDM*, 48, 589–610.
- BYRD, P. G. (1982). *A descriptive study of mathematics anxiety: Its nature and antecedents*. Indiana University.
- Chaffee, J. (1992). Critical thinking skills: The cornerstone of developmental education. *Journal of Developmental Education*, 15(3), 2.
- Chew, M. S. F., Shahrill, M., & Li, H.-C. (2019). The Integration of a Problem-Solving Framework for Brunei High School Mathematics Curriculum in Increasing Student's Affective Competency. *Journal on Mathematics Education*, 10(2), 215–228.
- Collins, K. M. T., & O'cathain, A. (2009). Introduction: Ten points about mixed methods research to be considered by the novice researcher. *International Journal of Multiple Research Approaches*, 3(1), 2–7.
- Cutspec, P. A. (2004). Bridging the research-to-practice gap: Evidence-based education. *Centerscope: Evidence-Based Approaches to Early Childhood Development*, 2(2), 1–8.
- Darling-Hammond, L., & Falk, B. (1997). Using standards and assessments to support student learning. *Phi Delta Kappan*, 79(3), 190.
- Dodeen, H., Abdelfattah, F., Shumrani, S., & Hilal, M. A. (2012). The effects of teachers' qualifications, practices, and perceptions on student achievement in TIMSS mathematics: A comparison of two countries. *International Journal of Testing*, 12(1), 61–77.
- Dove, L. R., & Bryant, N. P. (2016). Law in translation: Challenges and opportunities in teaching international students in business law and legal environment courses. *J. Legal Stud. Educ.*, 33, 263.
- Gonzalez, V. (2009). *Young learners, diverse children: Celebrating diversity in early childhood*. Corwin Press.
- Gunderson, E. A., Ramirez, G., Levine, S. C., & Beilock, S. L. (2012). The role of parents and teachers in the development of gender-related math attitudes. *Sex Roles*, 66, 153–166.
- Helterbran, V. R. (2008). The ideal professor: student perceptions of effective instructor practices, attitudes, and skills. *Education*, 129(1).
- Henningsen, M., & Stein, M. K. (1997). Mathematical tasks and student cognition: Classroom-based factors that support and inhibit high-level mathematical thinking and reasoning. *Journal for Research in Mathematics Education*, 28(5), 524–549.
- Kuh, G. D., Kinzie, J., Buckley, J. A., Bridges, B. K., & Hayek, J. C. (2011). *Piecing together the student success puzzle: Research, propositions, and recommendations: ASHE higher education report* (Vol. 116). John Wiley & Sons.
- Looney, J. W. (2011). *Integrating formative and summative assessment: Progress toward a seamless system?*
- Luna Scott, C. (2015). *The futures of learning 2: What kind of learning for the 21st century?*

- Mayer, R. E. (1975). Different problem-solving competencies established in learning computer programming with and without meaningful models. *Journal of Educational Psychology*, 67(6), 725.
- McArt, E. W., & McDougal, L. W. (1985). Secondary data analysis—a new approach to nursing research. *Image: The Journal of Nursing Scholarship*, 17(2), 54–57.
- McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. *Handbook of Research on Mathematics Teaching and Learning*, 1, 575–596.
- McTighe, J., & Brown, J. L. (2005). Differentiated instruction and educational standards: Is détente possible? *Theory into Practice*, 44(3), 234–244.
- Middleton, J. A., & Spanias, P. A. (1999). Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for Research in Mathematics Education*, 30(1), 65–88.
- Ní Ríordáin, M., & O'Donoghue, J. (2009). The relationship between performance on mathematical word problems and language proficiency for students learning through the medium of Irish. *Educational Studies in Mathematics*, 71, 43–64.
- Ockey, G. J. (2009). Developments and challenges in the use of computer-based testing for assessing second language ability. *The Modern Language Journal*, 93, 836–847.
- Pandina Scot, T., Callahan, C. M., & Urquhart, J. (2008). Paint-by-number teachers and cookie-cutter students: The unintended effects of high-stakes testing on the education of gifted students. *Roeper Review*, 31(1), 40–52.
- Pea, R. D. (1986). *Cognitive technologies for mathematics education*. Bank Street College of Education, Center for Children and Technology.
- Peterson, E., & Siadat, V. M. (2009). Combination of formative and summative assessment instruments in elementary algebra classes: A prescription for success. *Journal of Applied Research in the Community College*, 16(2), 19–29.
- Sideridis, G. D. (2003). On the origins of helpless behavior of students with learning disabilities: avoidance motivation? *International Journal of Educational Research*, 39(4–5), 497–517.
- Slack, M. K., & Draugalis Jr, J. R. (2001). Establishing the internal and external validity of experimental studies. *American Journal of Health-System Pharmacy*, 58(22), 2173–2181.
- Stankosky, M. (2005). *Creating the discipline of knowledge management: The latest in university research*. Routledge.
- Suryawati, E., & Osman, K. (2017). Contextual learning: Innovative approach towards the development of students' scientific attitude and natural science performance. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(1), 61–76.
- VanFossen, P. J. (2005). "Reading and math take so much of the time...": An Overview of Social Studies Instruction in Elementary Classrooms in Indiana. *Theory & Research in Social Education*, 33(3), 376–403.
- Van Den Heuvel-Panhuizen, Marja. "Mathematics education in the Netherlands: A guided tour." *Freudenthal Institute CD-rom for ICME9* (2000): 1-32.
- Liu, Edward, et al. "When districts encounter teacher shortages: The challenges of recruiting and retaining mathematics teachers in urban districts." *Leadership and Policy in Schools* 7.3 (2008): 296-323.
- Pea, Roy D. *Cognitive technologies for mathematics education*. Bank Street College of Education, Center for Children and Technology, 1986.
- Panadero, Ernesto, and Anders Jonsson. "The use of scoring rubrics for formative assessment purposes revisited: A review." *Educational research review* 9 (2013): 129-144.
- Wenglinsky, Harold. "The link between teacher classroom practices and student academic performance." *Education policy analysis archives* 10 (2002): 12-12.
- Darling-Hammond, Linda. "Teacher quality and student achievement." *Education policy analysis archives* 8 (2000): 1-1.
- Hattie, John, Mark Gan, and Cameron Brooks. "Instruction based on feedback." *Handbook of research on learning and instruction* (2011): 249-271.
- Black, Paul, and Dylan Wiliam. *Inside the black box: Raising standards through classroom assessment*. Granada Learning, 1998.
- Boaler, Jo. *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching*. John Wiley & Sons, 2015.

- Ray, Adams, and Wu Margaret, eds. *PISA Programme for international student assessment (PISA) PISA 2000 technical report: PISA 2000 technical report*. oecd Publishing, 2003.
- Ma, Liping. "Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States." (2010): 333-369.
- Ehrenfeld, Nadav, Einat Heyd-Metzuyanin, and Uri Onn. "Between mathematics and Talmud–The construction of a hybrid discourse in an ultra-orthodox classroom." *Proceedings of 39th Psychology of Mathematics Education conference*. Vol. 2. 2015.
- Bin Mubayrik, Haifa F. "New trends in formative-summative evaluations for adult education." *Sage Open* 10.3 (2020): 2158244020941006.
- Koutsoukas, Alexios, et al. "How diverse are diversity assessment methods? A comparative analysis and benchmarking of molecular descriptor space." *Journal of chemical information and modeling* 54.1 (2014): 230-242.
- Stevens, Tara, et al. "Role of mathematics self-efficacy and motivation in mathematics performance across ethnicity." *The Journal of Educational Research* 97.4 (2004): 208-222.
- Juvonen, Jaana, et al. "Promoting social inclusion in educational settings: Challenges and opportunities." *Educational Psychologist* 54.4 (2019): 250-270.
- Walsh, Debbie, and Richard W. Paul. "The Goal of Critical Thinking: from Educational Ideal to Educational Reality." (1986).
- Liu, Min, et al. "A look at the research on computer-based technology use in second language learning: A review of the literature from 1990–2000." *Journal of research on technology in education* 34.3 (2002): 250-273.
- National Commission on Excellence in Education. "A nation at risk: The imperative for educational reform." *The Elementary School Journal* 84.2 (1983): 113-130.
- Asigigan, Sera İyona, and Yavuz Samur. "The Effect of Gamified STEM Practices on Students' Intrinsic Motivation, Critical Thinking Disposition Levels, and Perception of Problem-Solving Skills." *International Journal of Education in Mathematics, Science and Technology* 9.2 (2021): 332-352.
- Maloney, Erin A. "Math anxiety: Causes, consequences, and remediation." *Handbook of motivation at school*. Routledge, 2016. 408-423.
- Guskey, Thomas R. "Defining student achievement." *International guide to student achievement* (2013): 3-6.
- Purkayastha, Saptarshi, et al. "Critical Components of Formative Assessment in Process-Oriented Guided Inquiry Learning for Online Labs." *Electronic Journal of E-learning* 17.2 (2019): 79-92.
- Johnson, Ruth S. *Using data to close the achievement gap: How to measure equity in our schools*. Corwin Press, 2002.