

META-ANALYSIS STUDY: IMPLEMENTATION OF DIFFERENTIATED LEARNING IN IMPROVING ELEMENTARY SCHOOL STUDENTS' LEARNING OUTCOMES

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Abstract

Differentiated instruction is a learner-centered approach that accommodates students' diverse readiness levels, interests, and learning profiles. Although it has been widely implemented across various educational settings, previous studies have reported inconsistent findings regarding its effectiveness in improving elementary school students' learning outcomes. Therefore, this study aimed to examine the effectiveness of differentiated instruction on elementary school students' learning outcomes through a meta-analysis. The study was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A total of 15 eligible studies involving 200 participants were included in the analysis. Data were analyzed using JASP version 0.18 under the random-effects model. Heterogeneity was assessed using Cochran's Q test, while publication bias was evaluated through funnel plot analysis, Egger's regression test, and Rosenthal's Fail-Safe N. The results revealed that differentiated instruction had a statistically significant and large positive effect on elementary school students' learning outcomes, with a pooled effect size of 1.561 (SE = 0.206; 95% CI = 1.157–1.966; Z = 7.576; $p < .001$). The heterogeneity analysis indicated significant variability among the included studies ($Q = 270.720$, $p < .001$), supporting the use of the random-effects model. Furthermore, the publication bias analyses demonstrated that the pooled effect estimate was stable and was not substantially influenced by publication bias, as indicated by the funnel plot, Egger's regression test, and Rosenthal's Fail-Safe N. In conclusion, differentiated instruction is an effective instructional approach for improving elementary school students' learning outcomes and is recommended as an adaptive, inclusive, and student-centered teaching strategy.

Keywords: *differentiated instruction; learning outcomes; elementary school; meta-analysis*

Abstrak

Pembelajaran berdiferensiasi merupakan pendekatan pembelajaran yang berpusat pada peserta didik dengan mengakomodasi keragaman kesiapan belajar, minat, dan profil belajar siswa. Meskipun telah banyak diterapkan pada berbagai jenjang pendidikan, hasil penelitian mengenai efektivitasnya terhadap hasil belajar siswa sekolah dasar masih menunjukkan temuan yang beragam. Penelitian ini bertujuan untuk menganalisis efektivitas pembelajaran berdiferensiasi terhadap hasil belajar siswa sekolah dasar melalui pendekatan meta-analisis. Penelitian dilaksanakan mengikuti pedoman *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA). Sebanyak 15 artikel yang memenuhi kriteria inklusi dianalisis dengan total sampel sebanyak 200 artikel. Analisis dilakukan menggunakan JASP 0.18 dengan model random-effects. Heterogenitas dianalisis menggunakan uji Cochran's Q, sedangkan bias publikasi dievaluasi melalui *funnel plot*, uji regresi Egger, dan Rosenthal's *Fail-Safe N*. Hasil penelitian menunjukkan bahwa pembelajaran berdiferensiasi memberikan pengaruh positif yang signifikan terhadap hasil belajar siswa sekolah dasar dengan ukuran efek gabungan (pooled effect size) sebesar 1,561 (SE = 0,206; 95% CI = 1,157–1,966; Z = 7,576; $p < 0,001$), yang termasuk kategori efek besar. Analisis heterogenitas menunjukkan adanya variasi yang signifikan antarpelitian ($Q = 270,720$; $p < 0,001$), sehingga model random-effects dinilai tepat digunakan. Sementara itu, hasil analisis bias publikasi menunjukkan bahwa estimasi ukuran efek relatif stabil dan tidak dipengaruhi secara signifikan oleh bias publikasi berdasarkan *funnel plot*, uji Egger, dan Rosenthal's *Fail-Safe N*. Dengan demikian, pembelajaran berdiferensiasi terbukti efektif dalam meningkatkan hasil belajar siswa sekolah dasar dan layak direkomendasikan sebagai pendekatan pembelajaran yang adaptif, inklusif, dan berpusat pada peserta didik.

Kata kunci: pembelajaran berdiferensiasi; hasil belajar; sekolah dasar; meta-analisis.

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Introduction

Education is the main foundation in forming a competitive generation in the era of globalization. In this case, the world of education faces increasingly complex challenges, especially in efforts to accommodate the diversity of needs and potential of students. This is in line with Defi (2023); Lukman (2022) that education faces complex challenges in integrating educational principles and managing student diversity, as well as adapting methods to student needs. The needs of students at each level are different, especially elementary school students. The needs of elementary school students in learning include various academic and socio-emotional dimensions, effective teaching strategies, in order to create a conducive learning atmosphere. Therefore, uniform teaching strategies are often unable to optimally address students' individual needs.

In optimizing the needs of elementary school students who have unique learning styles, teachers are required to find the most effective teaching methods for each individual. For this reason, teachers must be able to design learning that is appropriate to the differences in students' learning needs. Sari (2018); Maulidiyah (2022) stated that professional teachers are teachers who are able to design learning that can accommodate all students' needs. One approach that can be used to adjust the needs, interests, and abilities of each student, so that the learning process becomes more inclusive and effective is differentiated learning.

Differentiated learning is learning designed by teachers to meet the learning needs of students in the classroom. Akmal et al., (2025); Wahyuni & Badarudin, (2024); Kononova, (2024); Sharshembieva, (2024) stated that Differentiated learning is an educational approach that adjusts instruction to meet the diverse needs of students, increasing engagement and academic performance. Differentiated learning emerged as an innovative approach that emphasizes adjusting the learning process to be more responsive to individual differences in students. Differentiated learning strategies include adaptations in aspects of content, process, product, and learning environment that are tailored to the needs, interests, and level of readiness of students. This aims to create an inclusive learning environment, where each student gets an equal opportunity to develop according to their respective potential. Rosalina (2024) stated that the implementation of differentiated learning adjusts with the individual needs of students, improving informative, social-communicative, self-awareness, and problem-solving competencies through personalized content, processes, and demonstration of results. In addition, differentiated learning is believed to be able to improve student learning outcomes (Yunita, 2023).

Learning outcomes are a form of whether or not a learning objective has been achieved. According to Sari (2022); Laumarang (2023) learning outcomes are the acquisition of learning values by students which include three knowledge, namely intellectual, skills, and attitudes that result in changes in behavior towards learning. Students will get high learning outcomes if in the learning process teachers and students can work together to achieve learning objectives. In addition, Rini (2023) stated that in differentiated learning, teachers are able to manage the class so that a conducive atmosphere is created and learning takes place effectively and pleasantly.

Akhiruddin (2024) stated that differentiated learning significantly improves student learning outcomes and encourages a more inclusive and effective learning environment.

Furthermore, Rohana (2024) stated that the application of differentiated learning using different learning methods can improve the learning outcomes of fifth grade students in science subjects, especially in science and science material. In line with Akmal et al., (2025) Differentiated learning in mathematics subjects that involve adjusting content, processes, and products supports the effectiveness of improving student learning outcomes. In addition, Kholidah (2023) stated that the application of differentiated learning has a positive effect on student learning outcomes and learning motivation. Although various studies have been conducted to evaluate the effectiveness of differentiated learning in improving student learning outcomes, the findings often vary. Some studies show that this approach is able to improve student learning outcomes, motivation, learning styles, and engagement, while other studies show minimal or insignificant impacts. These differences in results raise the need to conduct a meta-analysis study that can provide a comprehensive picture of the application of differentiated learning at the elementary school level.

Based on the background description, the researcher wants to analyze the experimental research on the application of differentiation learning in improving the learning outcomes of elementary school students using a meta-analysis approach. Meta-analysis is a study of statistical analysis techniques that combines the results of quantitative research reviews with the accuracy of several scientific studies (Borenstein et al., 2009). According to Retnawati (2018), meta-analysis aims to determine statistical power, the ability to generalize results, accuracy in estimating impacts, and reducing the risk of false negative results so as to produce new hypotheses for further research. Related to the meta-analysis research on the application of differentiation learning in improving the learning outcomes of elementary school students that has not been exploited, the researcher is interested in conducting this study. Therefore, the purpose of this study is to estimate and test the effect of the application of differentiation learning in improving the learning outcomes of elementary school students. The following research questions are directed at the objectives of this study, namely how big is the effect of implementing differentiated learning in improving elementary school students' learning outcomes?; Does the implementation of differentiated learning affect elementary school students' learning outcomes?

Research Methods

This study employed a quantitative meta-analysis to synthesize empirical evidence regarding the effectiveness of differentiated learning in improving elementary school students' learning outcomes. Meta-analysis was selected because it enables researchers to statistically integrate findings from multiple independent studies, thereby providing a more precise estimate of the overall intervention effect than individual studies alone (Borenstein et al., 2009; Retnawati et al., 2018). The steps of meta-analysis can be seen in Figure 1. To ensure transparency, reproducibility, and methodological rigor, this study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines throughout the identification, screening, eligibility assessment, and inclusion stages.

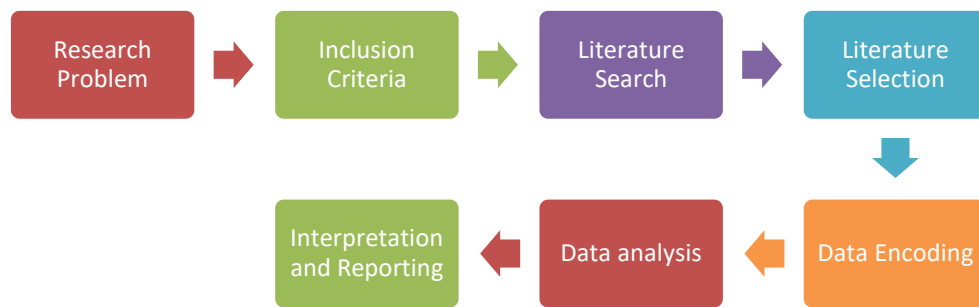


Figure 1. Steps of meta analysis (Retnawati, 2018)

The literature search was conducted in December 2024 using the Publish or Perish (PoP) software, which retrieved publications indexed in Google Scholar. The search strategy combined Boolean operators with the following keywords: ("differentiated learning" OR "differentiated instruction") AND ("elementary school" OR "primary school") AND ("learning outcomes"). The initial search identified 200 records. All retrieved references were exported and screened systematically to remove duplicate publications and studies unrelated to the research objectives before proceeding to the eligibility assessment. Eligible studies were selected according to predetermined inclusion and exclusion criteria, in Table 1.

Table 1. Inclusion and Exclusion Criteria established in this study.

Exclusion Criteria	1. Classroom Action Research (CAR/PTK). 2. Development research (R&D). 3. Review papers, conference abstracts, editorials, or incomplete manuscripts. 4. Studies involving secondary school or higher education students. 5. Studies with insufficient statistical data for effect size calculation.
Inclusion Criteria	1. Articles published between 2020 and 2024. 2. Empirical quantitative studies investigating differentiated learning in elementary schools. 3. Experimental or quasi-experimental research designs. 4. Studies reporting sufficient statistical information to calculate effect sizes. 5. Studies focusing on elementary school students' learning outcomes.

The study selection followed the four stages recommended in the PRISMA framework. During the identification stage, 200 articles were retrieved from the database search. Duplicate records and irrelevant publications were removed during the screening stage based on titles and abstracts. The remaining studies were evaluated through full-text assessment according to the established eligibility criteria. Finally, 15 empirical studies fulfilled all inclusion criteria and were included in the quantitative meta-analysis.

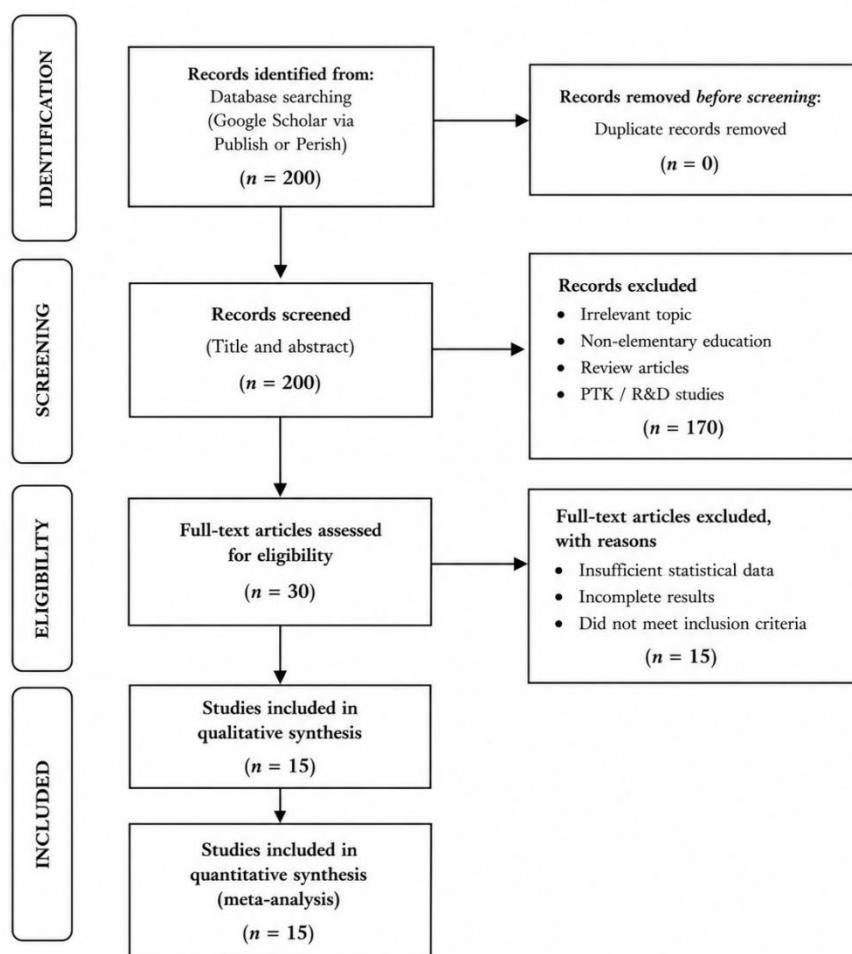


Figure 2. Presents The Prisma-Based Workflow Adopted In This Study.

A standardized data extraction form was developed to ensure consistency during data collection. The extracted information included authors, publication year, sample size, educational level, subject area, research design, pretest and posttest scores, and statistical information required for effect size calculation. Data extraction was performed systematically to minimize errors and maintain consistency across all included studies.

The statistical analysis focused on estimating the magnitude of the effect of differentiated learning on elementary school students' learning outcomes. Effect sizes were calculated using Cohen's standardized effect size criteria and interpreted as small (≤ 0.20), medium ($0.21-0.80$), and large (> 0.80). The average effect size across studies was estimated using a random-effects model because variability among studies was expected in terms of participants, learning contexts, instructional implementation, and research design. Heterogeneity among studies was evaluated using Cochran's Q statistic. Statistical significance of the pooled effect size was determined at a 95% confidence interval with a significance level of $\alpha = 0.05$. Publication bias was examined using three complementary approaches: Funnel Plot visualization, Egger's regression test, and Rosenthal's Fail-Safe N analysis. A symmetrical funnel plot, a non-significant Egger's test ($p > 0.05$), and a Fail-Safe N value exceeding the criterion of $5K + 10$ (where K represents the number of included studies) indicated that publication bias was unlikely to affect the robustness of the meta-analysis findings.

All statistical analyses were performed using JASP 0.18 statistical software to estimate pooled effect sizes, heterogeneity statistics, confidence intervals, and publication bias indicators. The software was selected because it provides comprehensive procedures for conducting meta-analysis using both fixed-effect and random-effects models.

Result And Discussion

A total of 15 empirical studies met the predefined eligibility criteria and were included in the meta-analysis. The selected studies were published between 2022 and 2024 and investigated the effectiveness of differentiated learning in improving elementary school students' learning outcomes across various subject areas. The studies employed experimental or quasi-experimental designs and reported sufficient statistical information for calculating standardized effect sizes. These studies represented diverse educational contexts, thereby providing a comprehensive basis for estimating the overall effectiveness of differentiated learning in elementary education. The effect size and standard error of each included study were calculated to determine the magnitude of the intervention effect prior to estimating the pooled effect size. The results are presented in Table 2.

Table 2. Effect Sizes and Standard Errors of 15 studies

No.	Article Code	Publication Year	Effect Size	Standard Error
1	MA6	2022	2.04	0.24
2	MA2	2023	0.52	0.2
3	MA8	2023	2.36	0.24
4	MA10	2023	0.61	0.13
5	MA11	2023	0.66	0.2
6	MA1	2024	0.62	0.19
7	MA3	2024	0.92	0.22
8	MA4	2024	1.84	0.26
9	MA5	2024	1.39	0.23
10	MA7	2024	2.93	0.18
11	MA9	2024	0.83	0.19
12	MA12	2024	1.97	0.21
13	MA13	2024	1.71	0.21
14	MA14	2024	2.05	0.13
15	MA15	2024	3.09	0.27
Average			1,561	0.21

Table 3 shows that the individual effect sizes ranged from 0.52 to 3.09, with an overall mean effect size of 1.561. Based on Cohen's classification, eleven studies (73.3%) demonstrated large effect sizes, whereas four studies (26.7%) showed medium effect sizes. These findings indicate that differentiated learning consistently produced positive effects on elementary school students' learning outcomes, although the magnitude of the effects varied across studies. The results of the heterogeneity test and determination of the estimation using the random model and fixed model can be seen in table 4.

Table 4. Heterogeneous Results from Random and Fixed Models

	Q	df	P
Omnibus test of Model Coefficients	57,197	1	< .001
Test of Residual Heterogeneity	270,720	15	< .001

Before estimating the pooled effect size, a heterogeneity analysis was performed to determine whether the included studies shared a common underlying effect. Cochran's Q test indicated statistically significant heterogeneity among the studies ($Q = 270.720$, $p < .001$), suggesting that the observed variation in effect sizes exceeded that expected by sampling error alone. Therefore, the random-effects model was considered the most appropriate approach for estimating the overall intervention effect because it accounts for between-study variability. Furthermore, calculating the average value of the effect size to test the hypothesis. The results of the mean effect size test can be seen in Table 5.

Table 5. Overall Effect Size

	Estimate	Standard Error	z	P	95% Confidence Interval	
					Lower	Upper
Intercept	1,561	0.206	7,563	< .001	1.157	1.966

The pooled analysis using the random-effects model produced an overall effect size of 1.561 ($SE = 0.206$, $z = 7.563$, $p < .001$; 95% CI [1.157, 1.966]). This result indicates that differentiated learning has a statistically significant and substantial positive effect on elementary school students' learning outcomes. According to Cohen's effect size interpretation, the pooled effect falls within the large category, demonstrating that differentiated learning is highly effective in supporting academic achievement in elementary education. Publication bias check in meta-analysis using funnel plot and Egger's test (Bernard et al., 2014 ; Suryono et al., 2023 ; Li & Wang, 2023 ; Juandi et al., 2021) . The results of study bias can be seen in Figure3.

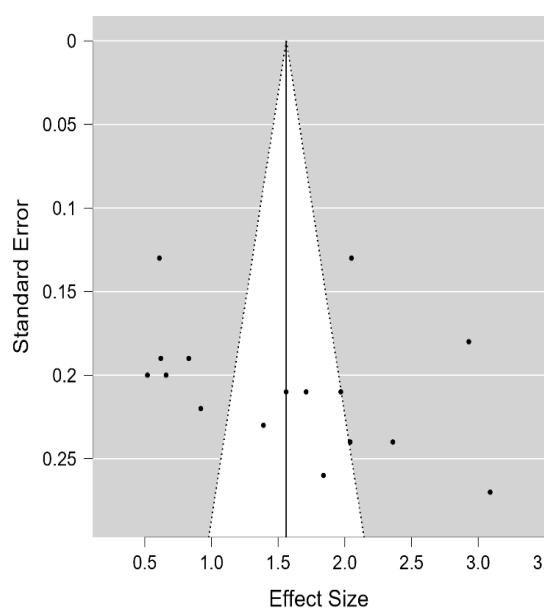


Figure 3. Standard Error of Funnel Plot

Publication bias was evaluated using Funnel Plot inspection, Egger's regression test, and Rosenthal's Fail-Safe N analysis. The funnel plot exhibited a symmetrical distribution of studies, indicating no apparent publication bias. This finding was supported by Egger's regression test ($z = 1.475$, $p = 0.140$), which was not statistically significant. Furthermore, the Rosenthal Fail-Safe N value (5513) substantially exceeded the recommended threshold of $5K + 10$, confirming that the meta-analysis findings were robust and unlikely to be influenced by publication bias.

The present meta-analysis demonstrated that differentiated instruction exerts a statistically significant and substantial positive effect on elementary school students' learning outcomes, with a pooled effect size of 1.561 under the random-effects model. According to Cohen's interpretation, this value represents a large educational effect, indicating that differentiated instruction consistently improves academic achievement across diverse elementary school contexts. The magnitude of the pooled effect is greater than that reported by Asriadi et al. (2023), who synthesized 49 primary studies and obtained a random-effects estimate (Hedges' g) of 1.109. Although direct numerical comparisons should be interpreted cautiously because of differences in study characteristics and inclusion criteria, both meta-analyses consistently demonstrate that differentiated instruction is an effective learner-centred approach for improving students' academic achievement. Furthermore, Asriadi et al. (2023) reported that contextual differences among countries contributed significantly to variations in effect size, highlighting that the effectiveness of differentiated instruction is influenced not only by instructional design but also by educational context. These findings reinforce the growing international evidence that differentiated instruction represents an evidence-based pedagogical approach for addressing learner diversity while improving educational outcomes.

The positive effect identified in this study can be interpreted through Tomlinson's framework of differentiated instruction, which proposes that effective teaching should adapt instructional content, learning processes, learning products, and learning environments according to students' readiness, interests, and learning profiles. Within this framework, differentiation is not merely the modification of classroom activities but a systematic process of designing equitable learning opportunities that allow every learner to achieve common educational goals through different instructional pathways. Recent systematic evidence further demonstrates that differentiated instruction is most effective when teachers continuously assess students' learning needs, implement flexible grouping strategies, and integrate formative assessment into classroom practice. These instructional characteristics enable teachers to respond proactively to learner diversity, thereby increasing students' engagement, conceptual understanding, and academic achievement. The systematic review conducted by Hu (2024) similarly concluded that differentiated instruction is most successful when implemented as a comprehensive instructional model rather than as isolated teaching techniques.

The present findings are equally supported by constructivist learning theory. Vygotsky's concept of the Zone of Proximal Development explains that learning becomes more effective when instructional support is aligned with students' developmental readiness, whereas Bruner's scaffolding theory emphasizes the gradual transfer of learning responsibility from teacher to learner through structured guidance. Differentiated instruction operationalizes these constructivist principles by enabling teachers to provide adaptive instructional support that corresponds to learners' cognitive readiness and learning progress. Consequently, students become active participants in constructing knowledge rather than passive recipients of information. Such instructional experiences strengthen conceptual understanding, increase learning motivation, and foster meaningful engagement throughout the learning process. Recent

literature reviews likewise indicate that differentiated instruction promotes inclusive learning environments, strengthens higher-order thinking skills, and supports sustained student participation across K–12 educational settings.

Although all included studies reported positive intervention effects, considerable variability was observed among individual effect sizes, ranging from 0.52 to 3.09. This finding is consistent with the significant heterogeneity identified in the present meta-analysis ($Q = 270.720$, $p < .001$), suggesting that differences among studies cannot be attributed solely to sampling error. Instead, the variability most likely reflects differences in instructional duration, subject domains, implementation fidelity, teacher expertise, assessment strategies, class characteristics, and students' prior achievement. Hu (2024) reported that differentiated instruction varies considerably according to educational level, subject area, grouping strategies, instructional technology, and assessment approaches, while Asriadi et al. (2023) identified contextual differences among countries as a significant moderator of instructional effectiveness. Collectively, these findings indicate that differentiated instruction should be viewed as a flexible pedagogical framework whose effectiveness depends on the quality and consistency of classroom implementation rather than as a universally standardized instructional model.

The credibility of the present findings is strengthened by the publication bias analysis. The symmetrical funnel plot, non-significant Egger's regression test, and large Rosenthal's Fail-Safe N collectively indicate that the pooled effect size is unlikely to have been substantially influenced by publication bias. Therefore, the estimated overall effect can be interpreted with greater confidence as representing genuine educational benefits rather than selective publication of statistically significant findings. The adoption of a random-effects model further enhances the robustness of the analysis because it explicitly accommodates between-study variability while producing a more generalizable estimate of the effectiveness of differentiated instruction across diverse educational contexts. These methodological strengths increase confidence in the validity and reliability of the conclusions drawn from this meta-analysis.

The findings of this study have important implications for educational practice, teacher professional development, and curriculum implementation. Elementary school teachers should incorporate differentiated instruction into instructional planning by systematically considering students' readiness, interests, and learning profiles when designing learning objectives, instructional activities, learning resources, and assessment procedures. Schools should provide institutional support through collaborative planning, instructional coaching, and continuous professional development to strengthen teachers' competence in implementing differentiated instruction effectively. At the policy level, differentiated instruction should become an integral component of curriculum implementation and teacher education because it aligns with inclusive, student-centred, and equitable educational principles. Future meta-analyses should investigate moderator variables such as digital learning environments, instructional duration, teacher professional competence, subject-specific implementation, and socioeconomic context to explain the substantial heterogeneity identified in the present study and further strengthen the evidence base supporting differentiated instruction in elementary education.

Conclusion

This meta-analysis demonstrates that differentiated instruction has a statistically significant and substantial positive effect on elementary school students' learning outcomes. The pooled effect size of 1.561 obtained under the random-effects model indicates that differentiated instruction is a highly effective learner-centred approach for improving academic achievement across diverse elementary school contexts. The significant heterogeneity identified among the

included studies suggests that the effectiveness of differentiated instruction is influenced by contextual factors, including implementation quality, instructional duration, teacher competence, and learning environments. Nevertheless, the publication bias analyses indicate that the pooled estimate is robust and unlikely to be substantially affected by selective publication.

The findings contribute to the growing body of evidence supporting differentiated instruction as an evidence-based pedagogical approach that accommodates learner diversity while improving educational outcomes. For educational practice, teachers are encouraged to integrate differentiated instruction into instructional planning by considering students' readiness, interests, and learning profiles. Schools and policymakers should also strengthen teacher professional development to support the effective implementation of differentiated instruction in inclusive classrooms.

This study has several limitations. The meta-analysis included only studies published between 2020 and 2024 and focused exclusively on elementary school education. In addition, moderator analyses based on instructional duration, subject domains, and teacher characteristics were not conducted because of limited reporting in the primary studies. Therefore, future meta-analyses should include broader international databases, investigate additional moderator variables, and examine differentiated instruction across different educational levels and learning environments to provide a more comprehensive understanding of its effectiveness.

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