Kognisi: Jurnal Ilmu Keguruan
ISSN (online): 2987-0240
Volume 3 Nomor 1 Tahun 2025
https://afeksi.id/journal3/index.php/kognisi/index

Differentiated Instruction as a Catalyst for Educational Transformation: A Meta-Analysis

Muchamad Rizki Eka Setiawan[1], Raissa Ariadna Putri Josephira[2], Desy Kumala Sari[3], Pri Ariadi Cahya Dinata[4], Nur Lailatul Rofiah[5]
[1]SMP YPPK Santo Mikael Merauke, Papua Selatan, Indonesia
[2]SMA Negeri 1 Merauke, Papua Selatan, Indonesia
[3]Physics Education, Faculty of Teacher Training and Education, Universitas Musamus, Papua Selatan, Indonesia
[4]Physics Education, Faculty of Teacher Training and Education, Universitas Palangka Raya, Kalimantan Tengah, Indonesia
[5] Walailak University, Thailand
Email: rizkimuchamad82@gmail.com

Abstract
Differentiated Instruction (DI) has long been implemented to address the diverse learning needs of students. However, exploring its impact on learning outcomes within the framework of modern education has become increasingly important in understanding its effectiveness in the context of 21st-century learning. This meta-analysis aims to investigate the effect of differentiated instruction on students' learning outcomes. The research method consisted of the stages of *identification*, *screening*, and *inclusion*. The research sample comprised 14 primary studies, producing a total of 41 effect sizes. The analysis revealed a significant effect (1.02; $p < 0.05$) of DI implementation on students' learning outcomes. No significant differences in effect size were found based on measured ability, subject, country, sample size, grade level, or Scopus indexing. In terms of contribution, the *country* variable accounted for a substantial portion of the "weak" and "small" effect size categories. Consequently, the implementation of DI in Asia has been shown to have a significant impact on improving learning outcomes. Furthermore, differentiated instruction exerts a similar influence across all educational levels, suggesting that it should be optimally applied in both primary and secondary schools. Nevertheless, evaluations of psychomotor learning outcomes within the context of differentiated instruction remain limited. This indicates the need for greater attention to the psychomotor domain in future studies, to ensure that the focus extends beyond cognitive and affective abilities.
Keywords: *Differentiated Instruction, Educational Transformation, Meta-Analysis*

INTRODUCTION

Educational transformation serves as a crucial foundation in preparing future generations to face global challenges. The UNESCO report highlights the importance of this transformation in shaping a better future. Several key aspects are emphasized, including risk anticipation, collaboration and professionalism, inclusion and equity, lifelong learning, and life relevance (UNESCO, 2021). Efforts toward educational transformation involve the design of inclusive curricula and the implementation of instructional approaches that accommodate the diverse learning needs of students (Kandiko Howson & Kingsbury, 2023). The main objective is to ensure that every learner can develop their potential optimally within a supportive learning environment. Therefore, educational transformation is not only

essential for shaping future generations capable of meeting global challenges but also for ensuring that each student learns in accordance with their individual learning needs.

DI focuses on addressing the diverse learning needs of students. DI is defined as an instructional approach that considers the most effective learning methods for each individual learner (Breaux & Magee, 2013; Coubergs et al., 2017; Eysink & Schildkamp, 2021; Huang, 2022; Tomlinson, 2017). This approach is particularly important in the current educational context, as every student possesses unique learning needs and styles (Paskevicius, 2021). Moreover, it assists teachers in making informed instructional decisions, enabling them to design learning experiences that align with varying levels of readiness, interests, and learner preferences (Lavrijsen et al., 2021; Puzio et al., 2020; Tomlinson & Moon, 2013). In its implementation, teachers need to consider several aspects, including learning content, learning process, learning products, and the learning environment, in order to accommodate the diverse needs of students (Brigandi et al., 2019; Kohnke, 2023). These aspects must also be aligned with global challenges and the current educational context (Paskevicius, 2021). Thus, DI is not merely a teaching approach, but also a strategic effort contributing to educational transformation.

In recent years, a number of studies have examined the various effects of DI on classroom learning. Several studies have demonstrated the effectiveness of DI in improving students' learning outcomes (Al-Shehri, 2020a; Anggoro, 2024a; Kamarulzaman, 2022; Yuen et al., 2023); however, other studies have failed to confirm its effectiveness (Aikaterini & Makrina, 2022; Peters, 2022; Shareefa, 2023). This inconsistency has raised doubts regarding the effectiveness of DI as an approach to educational transformation. Therefore, to address this gap, an in-depth investigation of recent research findings on DI is necessary. Such an analysis not only aims to provide a clearer understanding of the effectiveness of DI but also to reaffirm its relevance as a means of driving educational transformation.

This study employs a meta-analytic technique to synthesize findings from multiple studies on DI in order to produce a comprehensive summary of this instructional approach. While several studies have also explored DI using meta-analysis (Asriadi et al., 2023; Kahmann, 2022; Puzio et al., 2020), these works have not specifically examined its relevance to educational transformation. The present study seeks to address this limitation. Based on the discussion above, this research aims to conduct an in-depth analysis of the effectiveness of DI in enhancing students' learning outcomes and to examine its relevance as an effort toward educational transformation.

METHODS

This quantitative study focuses on the collection and analysis of numerical data on the DI approach, employing a meta-analytic technique based on a comparison of group contrast design. The purpose of the meta-analysis is to comprehensively assess the quantitative data collected. In this study, the required data include sample size, mean scores, and standard deviations from both the experimental and control groups.

Literature Search

The Publish or Perish (PoP) search engine and the ScienceDirect website were used to retrieve literature for this study. The search was limited to articles indexed in Scopus. The selected time range aimed to identify studies relevant to the theme of educational transformation. The search terms used were as follows: "differentiated instruction" OR "differentiated learning" OR "differentiated assessment" OR "differentiation education" OR "differentiated teaching." Literature searches were conducted in March and April 2024, resulting in a total of 542 articles, consisting of 97 articles retrieved through Publish or Perish (Scopus criteria applied) and 445 articles from ScienceDirect.

Inclusion of Studies

The inclusion criteria in this study were based on articles published between 2020 and April 2024. The articles obtained from the literature search were then screened according to the following inclusion criteria: (1) the article discusses the implementation of DI in classroom settings; (2) the article is written in English; (3) the article presents a quantitative analysis; (4) the study employs an experimental or quasi-experimental design; (5) the article provides data on sample size, mean values, and standard deviations; and (6) the article is published in a Scopus-indexed journal.

Articles that did not meet all six inclusion criteria were categorized as part of the exclusion group, meaning they could not be used as data for the meta-analysis. After the initial screening process, which involved the removal of duplicate articles (128 articles) and other exclusions for various reasons (337 articles), 41 articles remained for full screening.

The full screening phase aimed to thoroughly review each article to determine its alignment with the moderator variables being investigated and operationalized. First, studies had to examine the effects of DI implementation in both experimental and control groups; thus, studies that did not meet this requirement were excluded. Second, studies were required to explicitly report data on sample size, mean, and standard deviation—any studies lacking this information were excluded. Third, participant levels were limited to primary through secondary education; studies involving preschool or higher education participants were excluded. Finally, studies had to be published in Scopus-indexed journals; therefore, articles published in non-Scopus-indexed journals were removed from the dataset.

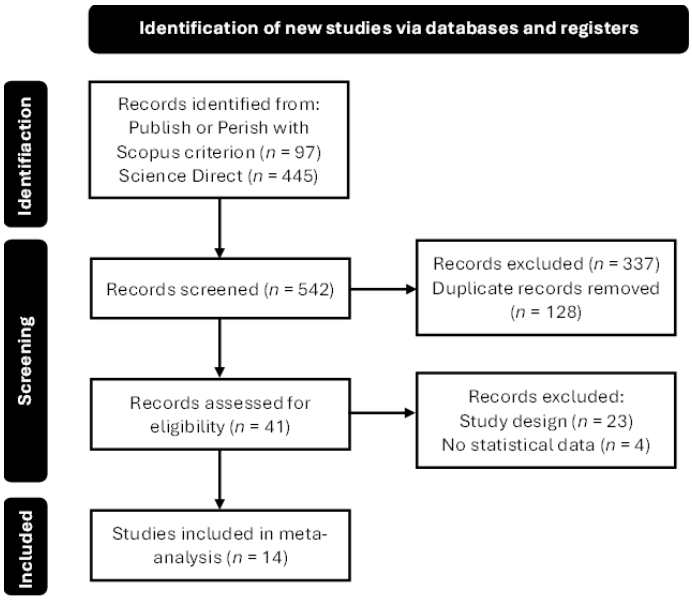

Figure 1. PRISMA Flowchart for Study Selection

A total of 14 articles met the inclusion criteria after completing the full screening stage (Figure 1). From these 14 primary studies, 41 independent samples were identified for analysis. The figure of 41 emerged as independent samples because several of the primary studies reported more than one aspect of learning outcomes, whereas others reported only a single aspect of learning outcomes.

Outcome Measures and Moderator Variable

The outcome measure of this study is the students' learning achievement, which refers to the acquisition of skills and knowledge assessed after the implementation of DI in the classroom. The learning outcomes examined in this study primarily focus on cognitive achievement, as most of the data analyzed report only cognitive learning results.

Based on the theoretical framework, several moderator variables were identified that may influence the effectiveness of differentiated instruction on students' learning outcomes. These moderator variables include the subject area, which identifies studies covering various academic disciplines, as well as sample size and educational level of the respondents involved in the studies—factors that may affect the variation in results obtained.

Analysis

The data from the 41 studies included in this research employed varying measurement scales for the dependent variable. Therefore, the effect size was calculated using the standardized mean difference (SMD) approach. This procedure involved analyzing the mean scores and standard deviations reported in each study, then standardizing the mean scores to a common scale to produce an overall measure of effect—referred to as the effect size for each study. The effect size was interpreted using Cohen's d coefficient, where values between 0–0.20 indicate a weak effect, 0.21–0.50 a small effect, 0.51–1.00 a medium effect, and greater than 1.00 a strong effect (Cohen et al., 2007, p. 521). After calculating the effect

sizes, a meta-analysis was conducted using the effect size and standard error data from each study.

Subsequently, a moderator variable analysis was performed using robust variance estimation, positioning the moderator variables as predictors. In this study, the Q-test for heterogeneity was used to examine variance among the study results (Borenstein et al., 2009; Dinçer, 2021; Suurmond et al., 2017). Given the relatively small number of studies (n = 41), descriptive statistical analysis was employed to calculate the effect size and the summary effect, adopting a p-value threshold of 0.05. To detect potential publication bias, the Funnel Plot and Fail-Safe N approaches were used, applying the criterion $N > 5K + 10$, where K represents the number of studies (Ahn & Kang, 2018). For computational purposes, the JASP (Jeffreys's Amazing Statistics Program) software was utilized to conduct the meta-analysis.

RESULTS AND DISCUSSION

This meta-analysis examined studies conducted over a five-year period (2020–2024) on the implementation of DI and its impact on students' learning outcomes. Following the literature screening process, 41 independent samples were obtained from 14 scholarly articles that met the established inclusion criteria. A summary of the studies included in the meta-analysis is presented in Table 1.

The table includes several key aspects: effect size (g), standard error (SE), measured ability (MA), subject (S), country, sample size (SS) categorized as *small (S)* or *large (L)*, grade level (GL) categorized as *primary (P)* or *secondary (S)*, and Scopus indexing (SI). The measured ability (MA) variable consists of two domains—*cognitive (C)* and *affective (A)*—while the subject (S) variable includes four categories: *science (Sci)*, *language (Lan)*, *social studies (Soc)*, and *not specified (Nos)*.

Table 1. Studies included and their properties

No	Study	Year	g	SE	MA	S	Country	SS	GL	SI
1	Al-Shehri (Study 1)	2020	1.39	0.31	C	Sci	Saudi Arabia	S	P	Q3
2	Al-Shehri (Study 2)	2020	0.50	0.29	C	Sci	Saudi Arabia	S	P	Q3
3	Alsalhi, et al.	2021	3.20	0.14	C	Sci	Jordan	L	S	Q1
4	Anggoro, et al. (Study 1)	2024	1.15	0.17	C	Sci	Indonesia	L	P	Q3
5	Anggoro, et al. (Study 2)	2024	0.64	0.16	C	Sci	Indonesia	L	P	Q3
6	Anggoro, et al. (Study 3)	2024	1.21	0.18	C	Sci	Indonesia	L	P	Q3
7	Anggoro, et al. (Study 4)	2024	-0.51	0.16	C	Sci	Indonesia	L	P	Q3
8	Magableh & Abdullah	2022	1.81	0.26	C	Nos	Jordan	L	S	Q3
9	Al-Makahleh, et al. (Study 1)	2023	1.88	0.31	C	Sci	Jordan	L	P	Q3
10	Al-Makahleh, et al. (Study 2)	2023	2.29	0.33	C	Sci	Jordan	L	P	Q3
11	Al-Makahleh, et al. (Study 3)	2023	2.10	0.32	C	Sci	Jordan	L	P	Q3
12	Aikaterini & Makrina	2022	0.69	0.34	C	Lan	Grecee	S	P	Q4
13	Magableh & Abdullah (Study 1)	2020	2.21	0.33	C	Lan	Jordan	L	P	Q3
14	Magableh & Abdullah (Study 2)	2020	2.61	0.35	C	Lan	Jordan	L	P	Q3
15	Magableh & Abdullah	2020	2.50	0.34	C	Lan	Jordan	L	S	Q2
16	Magableh & Abdullah	2021	0.96	0.29	C	Nos	Jordan	S	S	Q3
17	Yavuz (Study 1)	2020	1.06	0.46	C	Lan	Turkey	S	S	Q3
18	Yavuz (Study 2)	2020	0.85	0.45	C	Lan	Turkey	S	S	Q3
19	Yavuz (Study 3)	2020	1.28	0.48	C	Lan	Turkey	S	S	Q3
20	Yavuz (Study 4)	2020	2.31	0.56	C	Lan	Turkey	S	S	Q3
21	Yavuz (Study 5)	2020	0.74	0.45	C	Lan	Turkey	S	S	Q3
22	Ruhimat & Darmawan (Study 1)	2020	0.02	0.15	C	Soc	Indonesia	L	S	Q4

23	Ruhimat & Darmawan (Study 2)	2020	1.28	0.16	A	Soc	Indonesia	L	S	Q4
24	Ma'youf & Aburezzeq (Study 1)	2022	2.05	0.35	C	Nos	UEA	S	P	Q3
25	Ma'youf & Aburezzeq (Study 2)	2022	1.70	0.33	C	Nos	UEA	S	P	Q3
26	Ma'youf & Aburezzeq (Study 3)	2022	1.49	0.32	C	Nos	UEA	S	P	Q3
27	Ma'youf & Aburezzeq (Study 4)	2022	1.67	0.33	C	Nos	UEA	S	P	Q3
28	Ma'youf & Aburezzeq (Study 5)	2022	1.28	0.31	C	Nos	UEA	S	P	Q3
29	Haelermans (Study 1)	2022	0.09	0.10	A	Nos	Netherlands	L	S	Q1
30	Haelermans (Study 2)	2022	0.10	0.10	A	Nos	Netherlands	L	S	Q1
31	Haelermans (Study 3)	2022	0.31	0.31	A	Nos	Netherlands	L	S	Q1
32	Haelermans (Study 4)	2022	0.17	0.18	C	Nos	Netherlands	L	S	Q1
33	Haelermans (Study 5)	2022	0.10	0.11	C	Nos	Netherlands	L	S	Q1
34	Haelermans (Study 6)	2022	0.08	0.08	C	Nos	Netherlands	L	S	Q1
35	Haelermans (Study 7)	2022	0.00	0.08	C	Nos	Netherlands	L	S	Q1
36	Haelermans (Study 8)	2022	0.13	0.13	C	Nos	Netherlands	L	S	Q1
37	Haelermans (Study 9)	2022	0.12	0.12	C	Nos	Netherlands	L	S	Q1
38	Haelermans (Study 10)	2022	0.10	0.11	C	Nos	Netherlands	L	S	Q1
39	Sapan & Mede (Study 1)	2022	0.44	0.41	A	Lan	Turkey	S	S	Q2
40	Sapan & Mede (Study 2)	2022	0.17	0.40	C	Lan	Turkey	S	S	Q2
41	Sapan & Mede (Study 3)	2022	0.87	0.42	A	Lan	Turkey	S	S	Q2

The effect size (g) values presented in Table 1 vary across the studies. These differences are reflected in both positive and negative values, indicating variability in the direction and magnitude of the effects. Furthermore, it was observed that studies originating from the same research article also exhibited variations in their reported effect sizes, which consequently resulted in differing standard error (SE) values.

In terms of the measured abilities, the majority of studies focused on the cognitive domain (85.37%), while only a small proportion examined the affective domain (14.63%). None of the analyzed studies investigated psychomotor learning outcomes in the context of DI.

Regarding subject distribution, a substantial portion of the studies (41.46%) did not specify the academic subject being examined. Among those that did, language subjects accounted for 29.27%, followed by science (24.39%), and social studies (4.88%).

The geographical distribution of the studies also varied, with research conducted in Saudi Arabia (4.88%), Jordan (21.95%), Indonesia (14.63%), Greece (2.44%), Turkey (19.51%), the United Arab Emirates (12.20%), and the Netherlands (24.39%). When grouped by continent, most studies were conducted in Asia (73.17%), while the remaining 26.83% were from Europe.

Based on sample size, studies with large samples comprised 58.54%, whereas small-sample studies represented 41.46%. In terms of grade level, secondary-level studies accounted for a higher proportion (58.54%) than primary-level studies (41.46%). Lastly, regarding Scopus indexing, most articles were published in Q3 journals (56.10%), followed by Q1 (26.83%), Q2 (9.76%), and Q4 (7.32%) journals.

Results

A Random-Effects Model was employed to estimate the overall effect of DI on students' learning outcomes. Prior to analysis, the assumption of heterogeneity was tested to ensure model suitability. The heterogeneity test using the I^2 statistic indicated substantial variability among the included studies ($I^2 = 95.95\%, > 25\%$), suggesting that the true effects

varied significantly across studies. Consequently, the Random-Effects Model was deemed appropriate for subsequent analysis.

The results of the meta-analysis are illustrated in Figure 2 (Forest Plot). The analysis revealed a mean effect size of $g = 1.02$ ($p < .001$), with a 95% confidence interval (CI) ranging from 0.74 to 1.30. These findings demonstrate a statistically significant and strong positive effect of differentiated instruction on students' learning outcomes when compared to traditional instructional approaches.

According to the interpretation criteria proposed by Cohen et al. (2007), an effect size greater than 1.00 indicates a *strong* effect. Therefore, the aggregated results from the 41 independent studies confirm that the application of DI exerts a strong and significant impact on improving students' learning performance.

As illustrated in Figure 2, the 41 studies included in the analysis fall into various effect size categories: 12 studies were classified as *weak*, 3 studies as *low*, 6 studies as *moderate*, and 20 studies as *strong*. Among them, the study with the smallest sample size was Study 4 (Yavuz, 2020). Despite its relatively small weight, this study was statistically significant, as evidenced by the effect size positioned far to the right of the overall criterion line. This indicates that the experimental group in Yavuz's (2020) study performed substantially better than the control group.

Conversely, Study 4 (Anggoro, 2024b) demonstrated a relatively large weight but an effect size located far to the left of the criterion line, suggesting that the implementation of DI in this study was not effective. In other words, the control group outperformed the experimental group. Despite the divergent findings of these two studies, the remaining 40 studies exhibited effect sizes positioned to the right of the criterion line, supporting the overall positive influence of DI.

The aggregated findings from all 41 studies indicate that the implementation of DI has a positive impact on students' learning outcomes compared to traditional instructional methods (Alsalhi, 2021; Al-Shehri, 2020b; Ma'youf, 2022). This positive impact is attributable to several factors related to the classroom implementation of DI, which significantly influence students' academic performance (Yavuz, 2020).

Differentiated instruction primarily aims to address the diverse learning needs of students (Coubergs et al., 2017; Rahman, 2018; Tomlinson & Moon, 2013). When these learning needs are effectively met, students' academic outcomes gradually improve (Sapan, 2022). Furthermore, DI provides varied learning experiences (Marks et al., 2021), which enhances student engagement and participation in the learning process (Magableh & Abdullah, 2020; Magee & Breaux, 2013). These findings are consistent with prior research (Cruzat, 2019; Haelermans, 2022; Whitley, 2021), which demonstrated that accommodating learners' individual needs through DI can increase motivation, engagement, comprehension, and skills, ultimately leading to improved learning outcomes.

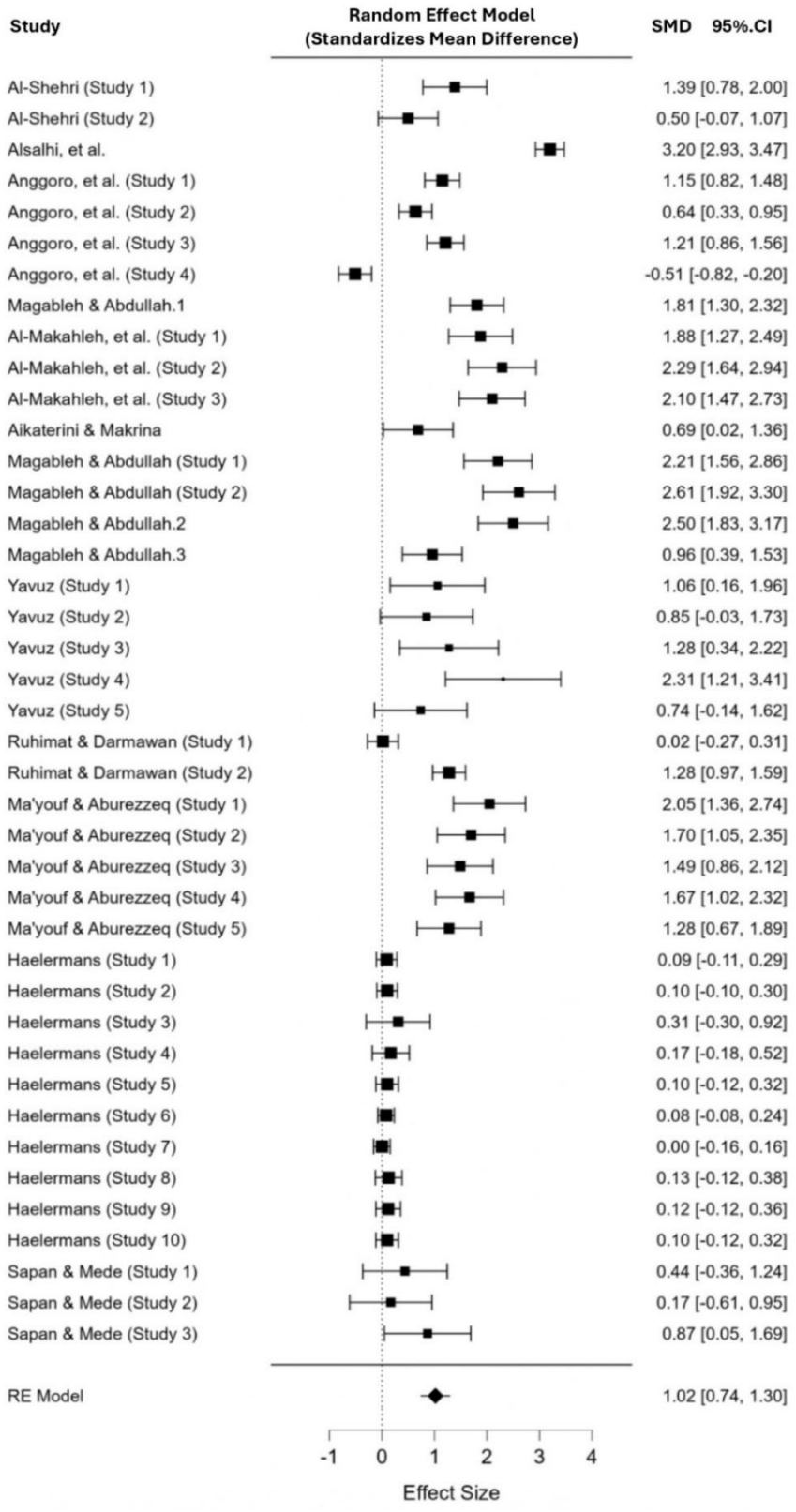

Figure 2. Forest Plot

The findings of this meta-analysis demonstrate that the implementation of DI has a significant and positive impact on students' learning outcomes across both primary and secondary school levels. Compared with traditional instructional approaches, DI yielded stronger learning gains, suggesting that instructional designs that accommodate students' individual differences are more effective in promoting academic achievement. This aligns with the broader vision of educational transformation, which emphasizes equity, personalization, and responsiveness to diverse learner needs in the 21st century.

The results also reinforce the argument that DI plays a pivotal role in supporting the transformation of contemporary education systems. As noted by Kandiko Howson and Kingsbury (2023), transformative education requires instructional approaches that recognize and respond to learner diversity. In this sense, DI serves as both a pedagogical strategy and a philosophical framework that embodies inclusivity, adaptability, and student-centeredness. By ensuring that instruction is responsive to students' readiness levels, interests, and learning preferences, DI fosters more meaningful engagement and deeper understanding—key competencies for success in modern learning contexts.

Moreover, the results suggest that DI contributes to inclusive and equitable education, a principle central to the UNESCO (2021) agenda for global educational transformation. Differentiated instruction enables teachers to design learning experiences that respect the unique learning trajectories of all students, including those with varied abilities and backgrounds. This approach ensures that no learner is left behind, thereby operationalizing inclusion not merely as access, but as genuine participation and growth within the learning process.

From a practical perspective, the findings underscore the importance of developing teachers' professional capacity to implement DI effectively. Teachers need to be equipped with skills in curriculum adaptation, formative assessment, and instructional flexibility to respond to classroom diversity. Professional development programs that integrate DI principles can therefore play a vital role in enhancing teaching quality and student outcomes.

Finally, in the context of 21st-century learning, DI aligns closely with the goals of fostering creativity, critical thinking, collaboration, and self-directed learning. When applied systematically, DI not only improves academic outcomes but also cultivates learners who are adaptive, motivated, and capable of lifelong learning—qualities essential for thriving in rapidly changing global environments.

In summary, the results of this meta-analysis confirm that Differentiated Instruction is not only an effective pedagogical approach for improving learning outcomes but also a strategic mechanism for advancing educational transformation. Its implementation across school levels reflects a shift toward more responsive, equitable, and student-centered education—an imperative for preparing learners to meet the complex challenges of the 21st century.

Analysis of Moderating Variables

This study examined six moderator variables: measured ability, subject, country, sample size, grade level, and Scopus index category. The results of the moderator analysis are summarized in Table 2. Since the *p*-values for all groups were less than 0.05, it can be concluded that the implementation of DI had a consistent and significant effect across all moderator variables. This indicates that the effectiveness of DI is not influenced by differences in ability domains, subject areas, geographical locations, sample sizes, educational levels, or journal index classifications.

The measured ability moderator encompassed three learning domains—cognitive, affective, and psychomotor. However, in this meta-analysis, the included studies assessed only the cognitive and affective domains. The analysis revealed that the mean effect sizes for cognitive and affective abilities did not differ significantly (Qb = 12.775; $p < .05$). This indicates that, compared with traditional instruction, the effectiveness of DI on students' learning outcomes is not influenced by a specific ability domain.

Between the two domains, DI was found to be more effective when applied to cognitive abilities (g = 1.11; $p < .05$). This result contrasts with the findings of Asriadi et al. (2023), who reported that DI was more effective in improving affective outcomes than cognitive ones. This discrepancy highlights the need for further research to clarify the impact of DI on the affective domain.

Overall, conclusions regarding the affective and psychomotor domains remain tentative due to limitations in the available literature. The current meta-analysis included only open-access studies, meaning that subscription-based publications were not accessible and thus excluded from analysis. Consequently, generalizations about DI's effects on affective and psychomotor learning outcomes should be made with caution.

Based on the results of the analysis, the mean effect sizes across the four subject groups—Science, Social Studies, Language, and Non-Specific—did not differ significantly (Qb = 310.232; $p < .05$). This finding indicates that the effectiveness of DI is not influenced by the type of subject taught. In other words, DI demonstrates a comparable level of effectiveness regardless of disciplinary content, supporting the notion that its pedagogical principles are universally applicable across subject areas.

Among the four subject categories, DI was found to be most effective in Science subjects (g = 1.38; $p < .05$). This may be attributed to the inquiry-based and exploratory nature of science learning, which aligns closely with the core tenets of DI—namely, addressing learners' readiness levels, interests, and preferred learning modalities through flexible instructional design.

The analysis revealed that the mean effect sizes of studies conducted in Asia and Europe did not differ significantly (Qb = 410.882; $p < .01$). This finding indicates that the implementation of DI produced comparable outcomes across both continents, suggesting that the approach maintains its overall effectiveness in diverse educational contexts.

However, when comparing regional performance, DI was found to be most effective in Asian countries ($g = 1.37$; $p < .01$). As illustrated in Figure 2, most studies originating from European countries contributed to the *weak* and *small* effect size categories, implying that the application of DI in Europe has been less effective than in Asia. This disparity may stem from contextual differences such as variations in curriculum flexibility, pedagogical culture, teacher readiness, and institutional support for differentiated practices.

Table 2. Results of Moderator Variable Analysis

Variabel	g	95% CI	Q	Qb	df	p-value
Measured Ability				12.775	1	0.00
Cognitive	1.11	[0.80, 1.43]	850.549			
Affective	0.49	[0.06, 0.92]	47.877			
Subject				310.232	3	0.00
Science	1.38	[0.71, 2.04]	356.455			
Social	0.65	[-0.59, 1.88]	33.006			
Language	1.32	[0.82, 1.82]	56.218			
Not Specific	0.66	[0.31, 1.02]	155.29			
Country				410.882	1	0.00
Asia	1.37	[1.05, 1.68]	495.041			
Eropa	0.09	[-0.12, 0.32]	5.278			
Sample Size				58.208	1	0.00
Small	1.14	[0.87, 1.40]	36.172			
Large	0.96	[0.53, 1.38]	816.821			
Grade Level				107.882	1	0.00
Primary School	1.40	[1.02, 1.79]	190.864			
Secondary School	0.75	[0.38, 1.11]	612.455			
Scopus Indexed				181.014	3	0.00
Q1	0.40	[-0.15, 0.95]	468.938			
Q2	1.04	[-0.03, 2.06]	25.209			
Q3	1.40	[1.09, 1.70]	202.983			
Q4	0.66	[-0.10, 1.42]	33.057			

The moderator variable sample size—categorized as *small* and *large*—showed no significant difference in mean effect size between the two groups ($Qb = 58.208$; $p < .05$). This indicates that the effectiveness of DI is not influenced by the size of the sample. Nonetheless, DI was found to be more effective in studies with smaller sample sizes ($g = 1.37$; $p < .05$). This may suggest that DI is implemented more intensively or closely monitored in smaller classroom or participant settings, allowing for more individualized attention and adaptation.

The grade level moderator, which included two categories—primary school and secondary school—also showed no significant difference in mean effect size ($Qb = 107.882$; $p < .05$). This finding implies that DI is equally effective across educational levels. However, DI demonstrated slightly greater effectiveness in primary school settings ($g = 1.40$; $p < .05$), possibly due to younger learners' greater responsiveness to flexible and engaging instructional strategies.

Finally, regarding the Scopus index category of the journals in which the studies were published, the analysis revealed no significant differences among the quartile levels ($Qb = 181.014$; $p < .05$). This suggests that the observed effectiveness of DI is consistent regardless of journal quality or index classification. Most of the analyzed studies were published in Q3-indexed journals, which also reported the highest average effect size ($g = 1.40$; $p < .05$). This

trend indicates that DI research has been more frequently disseminated through mid-tier international journals that focus on applied educational practice.

Evaluatin of Publication Bias

The evaluation of **publication bias** in this study was conducted using both the **Funnel Plot analysis** and the calculation of the **Fail-Safe N** value across the 41 studies included in the meta-analysis. As shown in **Figure 3**, the funnel plot illustrates that the sample of studies encompassed both large and small sample sizes. The **symmetrical distribution** of effect sizes in the plot indicates that there is **no evidence of publication bias** within this meta-analysis. This symmetry suggests that the results are stable and that the findings are unlikely to have been influenced by selective reporting or the omission of non-significant studies.

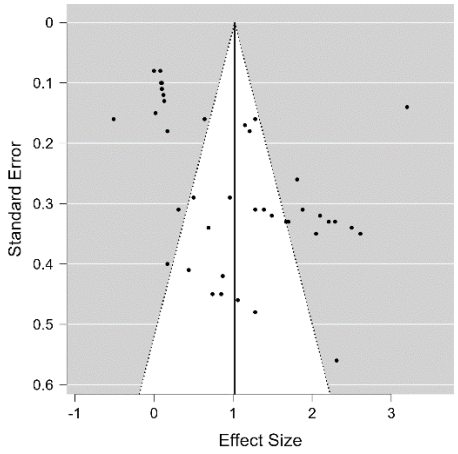

Figure 3. Funnel Plot

The Fail-Safe N value was calculated using the criterion $N > 5K + 10$ (Ahn & Kang, 2018), where K represents the number of studies included in the meta-analysis ($K = 41$). Based on this criterion, the threshold value for N was 215. The analysis produced a Fail-Safe N of 8792, which is substantially higher than the required threshold.

This result indicates that more than 8792 additional studies with null results would be needed to reduce the overall effect of DI to a non-significant level. Therefore, it can be concluded that no publication bias was present in this meta-analysis, confirming that the findings are robust and free from bias-related distortion.

CONCLUSION

The influence of DI on students' learning outcomes over the past five years (2020–2024) indicates that DI can play a crucial role in supporting the ongoing educational transformation. As an instructional approach, DI can be effectively utilized to address the diverse learning needs of students, thereby enabling each learner to develop their full potential within an inclusive and responsive learning environment.

The findings of this meta-analysis emphasize the positive impact of DI on students' learning outcomes, particularly in enhancing both cognitive and affective domains. The results also revealed variations in effect sizes across studies, ranging from *weak* to *strong*.

Studies originating from European countries contributed more frequently to the *weak* and *small* effect size categories, while the majority of studies overall—particularly those from Asian contexts—demonstrated strong effect sizes, confirming the high effectiveness of DI in improving learning outcomes in Asia.

Furthermore, the results suggest that DI exerts a consistent positive influence across educational levels, making it equally effective in both primary and secondary school settings. Accordingly, it is recommended that DI be systematically integrated into classroom practices at these levels to maximize student achievement.

Finally, this study highlights a notable research gap: psychomotor learning outcomes have been largely underexplored within DI research. Future studies should give greater attention to this domain to ensure a more comprehensive understanding of DI's impact, moving beyond cognitive and affective measures toward a more holistic evaluation of student learning.

REFERENCES

Ahn, E., & Kang, H. (2018). Introduction to systematic review and meta-analysis. *Korean Journal of Anesthesiology*, *71*(2), 103–112. https://doi.org/10.4097/kjae.2018.71.2.103

Aikaterini, T. A., & Makrina, Z. (2022). Differentiated instruction and portfolio assessment: Motivating young Greek-Romani students in the English class. *World*, *Query date: 2024-02-17 13:24:56*.

Alsalhi, N. R. (2021). Impact of Using the Differentiated Instruction (DI) Strategy on Student Achievement in an Intermediate Stage Science Course. *International Journal of Emerging Technologies in Learning*, *16*(11), 25–45. https://doi.org/10.3991/ijet.v16i11.22303

Al-Shehri, M. S. (2020a). Effect of differentiated instruction on the achievement and development of critical thinking skills among sixth-grade science students. *International Journal of Learning, Teaching and Educational Research*, *19*(10), 77–99. https://doi.org/10.26803/IJLTER.19.10.5

Al-Shehri, M. S. (2020b). Effect of differentiated instruction on the achievement and development of critical thinking skills among sixth-grade science students. *International Journal of Learning, Teaching and Educational Research*, *19*(10), 77–99. https://doi.org/10.26803/IJLTER.19.10.5

Anggoro, S. (2024a). Differentiated instruction based on multiple intelligences as promising joyful and meaningful learning. *International Journal of Evaluation and Research in Education*, *13*(2), 1194–1204. https://doi.org/10.11591/ijere.v13i2.24791

Anggoro, S. (2024b). Differentiated instruction based on multiple intelligences as promising joyful and meaningful learning. *International Journal of Evaluation and Research in Education*, *13*(2), 1194–1204. https://doi.org/10.11591/ijere.v13i2.24791

Asriadi, M., Hadi, S., & Retnawati, H. (2023). Does differentiated instruction affect learning outcome? Systematic review and meta-analysis. *Journal of Pedagogical Research*, *7*(5). https://doi.org/10.33902/JPR.202322021

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). Introduction to Meta-Analysis. In *Principles and Practice of Clinical Trials*. https://doi.org/10.1007/978-3-319-52636-2_287

Breaux, E., & Magee, M. B. (2013). How the best teachers differentiate instruction. In *How the Best Teachers Differentiate Instruction*. Routledge. https://doi.org/10.4324/9781315855257

Brigandi, C. B., Gilson, C. M., & Miller, M. (2019). Professional Development and Differentiated Instruction in an Elementary School Pullout Program: A Gifted Education Case Study. In *Journal for the Education of the Gifted* (Vol. 42, Issue 4). https://doi.org/10.1177/0162353219874418

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. Routledge.

Coubergs, C., Struyven, K., Vanthournout, G., & Engels, N. (2017). Measuring teachers' perceptions about differentiated instruction: The DI-Quest instrument and model. *Studies in Educational Evaluation*, *53*, 41–54. https://doi.org/10.1016/j.stueduc.2017.02.004

Cruzat, D. (2019). The Extent of Utilization of Differentiated Instruction in Teaching Science for Grade Six at San Teodoro Elementary School. *Ascendens Asia Journal of Multidisciplinary …*, *Query date: 2024-02-17 13:24:56*.

Dinçer, S. (2021). *Applied meta-analysis in educational science* (3rd ed.). Pegem Akademi.

Eysink, T. H. S., & Schildkamp, K. (2021). A conceptual framework for Assessment-Informed Differentiation (AID) in the classroom. *Educational Research*, *63*(3), 261–278. https://doi.org/10.1080/00131881.2021.1942118

Haelermans, C. (2022). The Effects of Group differentiation by students' learning strategies. *Instructional Science*, *50*(2), 223–250. https://doi.org/10.1007/s11251-021-09575-0

Huang, Y. (2022). Effectiveness of inquiry-based science laboratories for improving teamwork and problem solving skills and attitudes. *Journal of Research in Science Teaching*, *59*(3). https://doi.org/10.1002/tea.21729 Jo

Kahmann, R. (2022). Meta-analysis of professional development programs in differentiated instruction. *International Journal of Educational Research*, *116*(Query date: 2024-02-17 12:30:19). https://doi.org/10.1016/j.ijer.2022.102072

Kamarulzaman, M. H. (2022). Impact of Differentiated Instruction on the Mathematical Thinking Processes of Gifted and Talented Students. *Journal of Education and E-Learning Research*, *9*(4), 269–277. https://doi.org/10.20448/jeelr.v9i4.4253

Kandiko Howson, C., & Kingsbury, M. (2023). Curriculum change as transformational learning. *Teaching in Higher Education*, *28*(8), 1847–1866. https://doi.org/10.1080/13562517.2021.1940923

Kohnke, L. (2023). A Pedagogical Chatbot: A Supplemental Language Learning Tool. *RELC Journal*, *54*(3), 828–838. https://doi.org/10.1177/00336882211067054

Lavrijsen, J., Dockx, J., Struyf, E., & Verschueren, K. (2021). Class composition, student achivement, and the role of the learning environmental. *Journal of Educational Psychology*, *114*(3). https://doi.org/10.1037/edu0000709

Magableh, I., & Abdullah, A. (2020). The effect of differentiated instruction on EFL learners: Teachers' perspective. *International Journal of …*, *Query date: 2024-02-17 13:22:34*.

Magee, M., & Breaux, E. (2013). *How the Best Teachers Differentiate Instruction* (0 ed.). Routledge.

Marks, A., Woolcott, G., & Markopoulos, C. (2021). Differentiating Instruction: Development of a Practice Framework for and with Secondary Mathematics Classroom Teachers. *International Electronic Journal of Mathematics Education*, *16*(3), em0657. https://doi.org/10.29333/iejme/11198

Ma'youf, N. A. (2022). The Effectiveness of Differentiated Teaching Strategy in Developing Reading Comprehension Skills of Fourth Grade Students in the United Arab Emirates. *Theory and Practice in Language Studies*, *12*(1), 17–27. https://doi.org/10.17507/tpls.1201.03

Paskevicius, M. (2021). Educators as Content Creators in a Diverse Digital Media Landscape. *Journal of Interactive Media in Education*, *2021*(1), 1–10. https://doi.org/10.5334/JIME.675

Peters, M. T. (2022). Effects of Providing Teachers With Tools for Implementing Assessment-Based Differentiated Reading Instruction in Second Grade. *Assessment for Effective Intervention*, *47*(3), 157–169. https://doi.org/10.1177/15345084211014926

Puzio, K., Colby, G. T., & Algeo-Nichols, D. (2020). Differentated Literacy Instruction: Boondoggle or Best Practice? *Review of Educational Research*, *XX*(X). https://doi.org/10.3102/0034654320933536

Rahman, R. A. (2018). Differentiated instruction: Is it in place? *International Journal of Social Research & …*, *Query date: 2024-02-17 13:24:56*.

Sapan, M. (2022). The Effects of Differentiated Instruction (DI) on Achievement, Motivation, and Autonomy among English Learners. *Iranian Journal of Language Teaching Research*, *10*(1), 127–144. https://doi.org/10.30466/ijltr.2022.121125

Shareefa, M. (2023). Demystifying the Impact of Teachers' Qualification and Experience on Implementation of Differentiated Instruction. *International Journal of Instruction*, *16*(1), 393–416. https://doi.org/10.29333/iji.2023.16122a

Suurmond, R., van Rhee, H., & Hak, T. (2017). Introduction, comparison, and validation of Meta-Essentials: A free and simple tool for meta-analysis. *Research Synthesis Methods*, *8*(4), 537–553. https://doi.org/10.1002/jrsm.1260

Tomlinson, C. A. (2017). How to Differentiate Instruction in Academically Diverse Classrooms. In *ASCD* (3rd ed., Vol. 44, Issue 1). ASCD.

Tomlinson, C. A., & Moon, T. R. (2013). *Assessment and Student Success in a Differentiated Classroom*. ASCD.

UNESCO. (2021). *Reimagining a new social our features contract for together education*.

Whitley, J. (2021). Implementation of a differentiated instruction initiative: Perspectives of leaders. *Canadian Journal of Educational Administration and Policy*, *196*, 49–64. https://doi.org/10.7202/1078517AR

Yavuz, A. C. (2020). The effects of differentiated instruction on turkish students' l2 achievement, and student and teacher perceptions. *Eurasian Journal of Applied Linguistics*, *6*(2), 313–335. https://doi.org/10.32601/ejal.776002

Yuen, S. Y., Luo, Z., & Wan, S. W. yan. (2023). Challenges and Opportunities of Implementing Differentiated Instruction amid the COVID-19 Pandemic: Insights from a Qualitative Exploration. *Education Sciences*, *13*(10). https://doi.org/10.3390/educsci13100989