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Impact of Implementation the Merdeka Curriculum on the Effectiveness of Children's Learning Styles: A Review Based on Gender and Subject

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Research Article

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Abstract

Background/purpose. The Merdeka Curriculum is an important aspect in the reform of Indonesian education in facing global challenges and industry 4.0. Its early implementation requires comprehensive analyses and evaluations to determine its effectiveness. This study aims to determine the effectiveness of elementary school students' learning styles (auditory, visual, and kinesthetic) in terms of gender and subjects.

Materials/methods. This study employed a mixed-methods research design using purposive sampling. Data were collected through teacher interviews and the compilation of students' daily test scores in Mathematics and Indonesian subjects.

Results. The analysis results with the general linear model (GLM) test show differences in average scores as a form of learning style effectiveness in terms of gender, specifically in mathematics. In detail, male students with visual learning styles have the most dominant average score (84 points) in math, and with kinesthetic learning styles in Indonesian (84.5 points). Through the ANOVA test, it was also obtained significant (>α 0.05) that there was no difference in the effectiveness of each learning style in terms of each subject. The N-gain score test results were also obtained (>55%) for the effectiveness of each learning style in terms of each subject, which was stated to be in the moderately effective category.

Conclusion. In general, the effectiveness of learning styles in terms of subjects fluctuates. Some of these results indicate that the implementation of the Merdeka curriculum at the primary school level has been able to encompass and equalize students' learning style preferences with the same learning outcomes or achievements.

1. Introduction

The world of Indonesian education is currently in a transformation phase through the Merdeka curriculum policy. The challenges of the era, increasingly rapid productivity of modern technology, and increasingly widespread intellectual development are the fundamental reasons why the Education curriculum is in the world spotlight today (Cuong et al., 2024). Indonesia, through the Merdeka curriculum, is expected to be a breakthrough in meeting the need for more flexible, adaptive, and practical education in facing the challenges of the times (Hamduuna et al., 2023; Suhandi & Robi'ah, 2022). As a form of business that realizes national goals, Indonesia has undergone several overhauls and changes in the curriculum. Several form curricula have been recorded that have applied as Indonesian Education guidelines, such as KTSP 2006 and K13, to the moment this Merdeka curriculum (F. Z. Aziz et al., 2022; Prayoga & Achadi, 2023).

The idea of the Merdeka curriculum by the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) is an effort to realize the profile of Pancasila learners (Kurniasih, 2022; Mery et al., 2022). The existence of this Merdeka curriculum is a tool in the development of the potential and formation of character for every Indonesian student (Fadhilah, 2022; Nugraheni & Siswanti, 2022; Sumilat & Geor, 2024). Teachers and students in this century must be able to integrate various skills in facing global challenges and the industrial revolution (Maimun & Bahtiar, 2023). Consequently, the implementation of the Merdeka Curriculum at the Elementary School level is also being carried out at this time. The implementation of the Merdeka curriculum in elementary schools is easily seen in a more flexible approach to learning management (Assidiq, 2024; F. Rahmawati, 2023). Placing the role of the teacher to guide students in exploring knowledge and skills through design of learning activities (Daga, 2022; Jannah & Rasyid, 2023; Pertiwi et al., 2022). The implementation of the education system, which is increasingly moving away from traditional education to contemporary education, needs further review. It is necessary to analyze the transformation in each school by the wider community (Avdiu, 2019) through research like this.

Previous studies have shown that the Merdeka Curriculum has the potential to increase student engagement in learning, primarily through approaches that are more contextual and relevant to students' lives (Kurniawan et al., 2024; Muktamar et al., 2023). Implementing the Merdeka curriculum will also be relevant to using modern technology in learning (Cholilah et al., 2023; Lubis et al., 2023). The use of this technology is a requirement to support the knowledge and skills possessed by students (Ahmed & Opoku, 2022; Seufert et al., 2021). The existence of modern technology will present an interactive learning approach (Castro, 2019; Gros & García-Peñalvo, 2023). This interactive-based learning will lead learners through different learning situations and learning styles.

According to Sunarsih et al. (2022), learning style generally consists of 3 three types: auditory, visual, and kinesthetic. Elementary school students are generally depicted with monotonous learning in which they hear and see only (audio-visual) (Nuraini & Evi, 2020; Puspitasari et al., 2021). Studies have shown that the learning style of students is often influenced by factors such as gender and the type of eye lessons taught (Husmann & O'Loughlin, 2019; Shamsuddin & Kaur, 2020). The existence of the Merdeka curriculum should be able to harmonize the effectiveness of student learning outcomes or knowledge despite these differences in learning styles (Dhera et al., 2024). Learning style preferences and approaches to materials and learning activities carried out are also determined by gender (Ariastuti & Wahyudin, 2022; El-Emadi et al., 2019). Some studies show that female students are more likely to have auditory and verbal learning styles (Fatmawati et al., 2020; Restianim et al., 2020). A study from Putri and Wathon (2021) shows that girls are more likely to be interested in activities that involve verbal and visual communication. In contrast, male students tend to have visual and kinesthetic learning styles (Fendrik et al., 2022; Fujiarti & Kurnia, 2021). Other research

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from Sabani (2019) revealed that boys more often show interest in activities that require physical movement and hands-on exploration.

Another factor that needs to be highlighted is the subjects. Subjects such as math and science tend to be more suitable for visual and kinesthetic learning styles. Compared to subjects such as Indonesian language and religion, which are more inclined to auditory and verbal learning styles (Sit et al., 2021; Wiguna et al., 2020). Reviewing the effectiveness of learning styles due to the implementation of the Merdeka curriculum needs to be done to determine the success of the Merdeka curriculum. In addition, knowledge is needed about conditions for implementing the Merdeka curriculum with differences in learning styles in terms of gender and subjects at the elementary school level. The results of this study illustrate the quality of the Merdeka curriculum in summarizing and harmonizing students' knowledge and skills from the elementary school level in responding to demands of the times and global developments.

2. Literature Review

2.1. Merdeka Curriculum

The issue of the quality of education is crucial in various developing countries. Many children are able to go to school but do not gain maximum knowledge (Ishii & Ogawa, 2024). This condition needs concrete solutions. In Indonesia, Innovation in the Education system that emphasizes competency-based learning, differentiation, and flexibility in the learning process is a short definition of the Merdeka curriculum (M. Aziz et al., 2024; Sigalingging, 2022; Sutrisno et al., 2023). The main goals are meaningful learning experiences through adjustment and consideration of student characteristics. As a result, the Merdeka curriculum has several principles, such as project-based learning with the aim of improving students' problem-solving skills and creativity skills (Ismuwardani et al., 2019; Nursalam et al., 2023; Rosa et al., 2024). The following principle is in the form of subjects that contain essential material so that it is more focused and obtains information or in-depth understanding (Sholihah Rosmana et al., 2023; Sulistyani et al., 2022). The last principle, for example, is a learning process that adapts to the needs and character of students, which is known for flexibility (Gusteti & Neviyarni, 2022; Sarnoto, 2024).

Based on the background of the definition and objectives, current lively research is being carried out to assess the effectiveness of the implementation of the Merdeka curriculum. These studies are critical to finding out the aspects or indicators that need to be improved or added to the concept of the Merdeka. Several theories were found related to the definition of learning styles. A theory states that learning style is the tendency of students to express how to learn or receive and understand information curriculum. One of the important research topics today is related to the impact of the Merdeka Curriculum on students' learning styles. Furthermore, the research is associated with gender factors, subjects, majors, and learning technology. This study focused on learning styles, gender, and subjects.

2.2. Children's learning style and gender

Several theories were found related to the definition of learning styles. A theory states that learning style is the tendency of students to express how to learn or receive and understand information (Huang et al., 2019; H. Rahmawati & Muhroji, 2022). Another theory states that students prefer to follow and grasp the subject matter delivered by the teacher, which is called a learning style (Huang et al., 2019; Stander et al., 2019). The researcher concluded that learning style is a way for students to understand, process, and remember learning materials with a sense of pleasure and comfort. In general, there are three main learning styles, namely, auditory, visual, and kinesthetic.

The auditory learning style is a way of learning for students who prefer to pay attention to the learning process with lecture methods, verbal/oral explanations, and voices (Atsari, 2020; Wahab et

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al., 2021). Students with this learning style tend to be focused on listening to explanations, having relatively more notes, and being active in discussions. Next is the visual learning style. Visual learning style is a way of learning for students who tend to pay attention to animations, pictures, diagrams, and graphs/tables (El-Sabagh, 2021). The character of students with this learning style will be easy in interpreting information in the form of narratives. Finally, there is the kinesthetic learning style. Kinesthetic students will have the comfort of learning through physical activity or practice as a way for them to receive and understand the learning material (Chairad et al., 2019). The character of students with kinesthetic learning style is their creativity and problem-solving ability.

Learning styles between men and women will have varying conditions (Malacapay, 2019; Vermote et al., 2020). Some studies state that male students tend to be dominant with a kinesthetic learning style (Farman, 2023; Hashem, 2022), while female students are dominant in using visual and auditory learning styles (Khan et al., 2019; Shanti Manipuspika & World English Journal wwwawejorg, 2020). The opposite or other conditions can occur. Against the background of these variations, this study is presented to determine the effectiveness of learning styles reviewed from gender in the implementation of the Merdeka curriculum.

2.3. Subjects on learning style

Each subject certainly has its own cluster of characteristics. These characteristics will affect students' ability and final understanding after the lesson. Subjects will also be adjusted to students' learning styles and genders. Simply put, the subject needs to be known for its effectiveness in implementing the Merdeka curriculum, such as this study. Some examples of subjects, such as mathematics, language and literature, and science/science, must have differences in character.

Mathematics lessons are familiar with numbers and symbols, so they are referred to as lessons by learning exact sciences (Clements & Sarama, 2020). According to some views, mathematics lessons will be more effective and efficient when taught with a visual and kinesthetic learning style approach (Farman, 2023; Wan Hussin & Mohd Matore, 2023). Unlike Indonesian lessons, it tends to be related to narratives, phrases, or sentences that are used to communicate well (Khair et al., 2022; Nurhayati, 2023). This lesson is also called the way students write, interpret, and convey information correctly. As a result, the tendency to learn with auditory and visual learning style approaches is more effective for this lesson (Kurniati et al., 2019; Wibowo et al., 2023). The last is the Science lesson, which has a character that can be said to be a combination of mathematics lessons. Science and mathematics are vital for advancing the world of education and, even more broadly, global development. These two lessons form superior students' cognition (Oulaydi et al., 2025). It tends to be about abstract science that needs to be represented, analyzed, and even predicted (Tshitoyan et al., 2019). This character causes it to be more effective when used in learning with a combination of auditory, visual, and kinesthetic approaches (Kamal et al., 2021; Shaidullina et al., 2023; Yusnanto & Rahayu, 2022).

The implementation of the Merdeka curriculum does not limit students in their learning style or even the subject group (major) they like. This freedom creates possibilities such as increased learning motivation due to suitability to their learning needs. Another possibility is in the form of increasing the effectiveness of learning based on each student's learning style. Finally, in the form of accommodating the ability or learning outcomes of male and female students.

3. Methodology

3.1. Research Design

This research is a mixed-method type with the aim of measuring the effectiveness of student learning styles in terms of gender and subjects in the context of learning with the Merdeka curriculum. The learning styles referred to in this study are auditory, visual, and kinesthetic. The use of mixed methods is because the data in this study will contain quantitative data in the form of

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students' daily test scores and the distribution of their learning styles. Then, qualitative data in the form of teachers' perceptions of each school towards the current implementation of the Merdeka curriculum. In general, it is also due to the concept of the study of results and discussion in the research, which will refer to the results of quantitative data analysis and qualitative data description.

3.2. Population and Sample

The sample in this study consisted of fifth-grade (V) elementary school students at SDN 28 Melayu, SDN 29 Tanjung, and SDN 46 Lela in Bima City. The subjects reviewed were mathematics (science) and Indonesian Language (social studies). Sampling was based on a purposive sampling technique. A purposive sampling technique was preferred, considering the affordability of schools with research sites. Another consideration is the equivalent quality of each school based on the community assessment. Proximity to classroom teachers in each school so that they can be more flexible and maximize their ability to explore information or research data. The research data comprised qualitative data obtained through teacher interviews and student learning style questionnaires. Meanwhile, quantitative data is obtained by recapping students' daily test scores. Daily test data was taken 2 (two) data, namely test I (first month of meeting), and test II (last month of meeting). The research was conducted in April 2024 (even semester of the 2022-2023 school year).

3.3. Data Analysis

The qualitative data was analyzed descriptively to identify and summarize the main patterns of the results of teacher interviews and variations in students' learning styles. The analysis is based on the results of interviews with teachers in each of these schools. Quantitative data were analyzed by WinStep (Rasch model) to find out the difficulty level of the student's grades against the learning style questionnaire data of students with their daily test scores. Then, the general linear model (GLM), one-way ANOVA, and n-gain score with the help of SPSS 24, using the students' daily test data. GLM analysis to determine the difference in the average value of learning styles regarding gender. Oneway ANOVA test is used to determine the difference in the average value of learning styles in terms of subjects. Then, the n-gain score test was used to determine the effectiveness of each learning style for each subject.

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4. Results

4.1. Characteristics of Learning with the Merdeka Curriculum

Table 1. Summary of Interview with Classroom Teacher

Interview Question Indicator	SDN 28 Melayu Bima City	SDN 29 Tanjung Bima City	SDN 46 Lela Bima City
Teachers' knowledge of the implementation of Merdeka curriculum.	Has sufficient insight through training experience and seminars on learning tools in the Merdeka curriculum		
Use of modern technology to support learning.	Sometimes using modern technology that can be reached by students and schools, as a result, it is necessary to improve the school's facilities and infrastructure.	Adjusts to current subject matter, but rarely uses modern technology.	Using modern technology as an aid to students' (virtual) props, as well as teachers' own innovations.
Review of learning style, gender and subject factors.	Tend to pay attention to gender, and equality in terms of the division of study groups.	Encompasses learning for knowledge equality and student freedom.	Paying attention to the subject matter requires more focus and innovation.
Quality/achievement of learning with Merdeka curriculum	It is interesting and the teacher is more flexible and students are given full freedom to experiment with the lesson.	So far, it has been quite effective and has attracted students' attention in following the lesson.	Interactive but requires more effort and innovation, as well as the support of school infrastructure.

The results of the interviews above show that classroom teachers already have the ability or knowledge to implement learning with the Merdeka curriculum. Learning characteristics are based on modern technology or teaching aids as a form of learning innovation. This kind of learning will support scientific literacy, mathematics, and writing skills and improve student performance (Susanta et al., 2023). In this condition, improving the quality of educational facilities and infrastructure is still necessary. Relevant to the research, which states that in its implementation, the Merdeka curriculum poses challenges primarily related to the readiness of teachers and infrastructure needed (Gunawan & Bahari, 2024; Rofi'ah et al., 2024). Teachers are also able to apply learning approaches to equalize students' knowledge and skills. Other approaches by reviewing factors such as learning styles, gender, and subjects to adjust the learning process have been carried out. This condition is relevant to learning outcomes or results that are interesting, flexible, effective, and maximized.

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4.2. Frequency Sample Study

Table 2. Distribution of Research Samples

	Value Label	N
Learning Styles	Auditory	24
	Visual	25
	Kinesthetic	13
Gender	Male	23
	Female	39
School Origin	SDN 28 Melayu of Bima City	21
	SDN 29 Tanjung of Bima City	18
	SND 46 Lela of Bima City	23

As can be seen in Table 2, the number of samples in this study is 62 elementary school students of grade V (Five). The distribution is dominant with an auditory learning style (24 students), and is female (39 students). Based on the results of the daily test scores of 62 students with variations in learning styles in mathematics and Indonesian lessons, the level of difficulty of students' grades will be known first. The following will be shown in Figure 1 (the results of the Rasch model analysis).

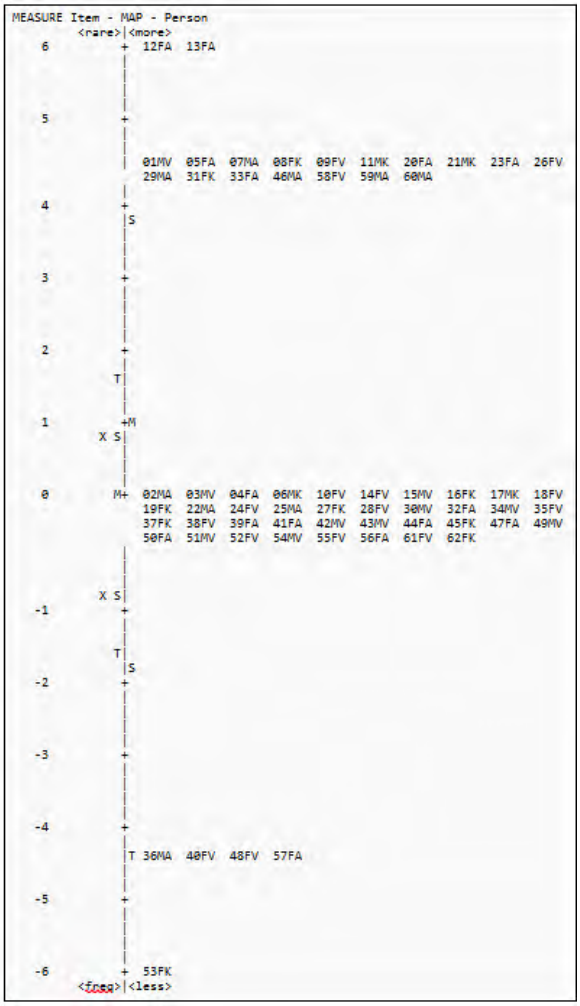

Figure 1. Difficulty Level of Students' Daily Test Scores

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Figure 1 shows female students with audio learning styles (12FA and 13FA) as the students with the highest test scores for both subjects. On the other hand, female students with kinesthetic learning styles (53FK) were students with the lowest test scores for both lessons. Furthermore, the results of the analysis of the average score of each student from the daily mathematics and Indonesian tests will be shown. This analysis is needed to find out in advance whether there is a difference in student scores due to gender and learning style.

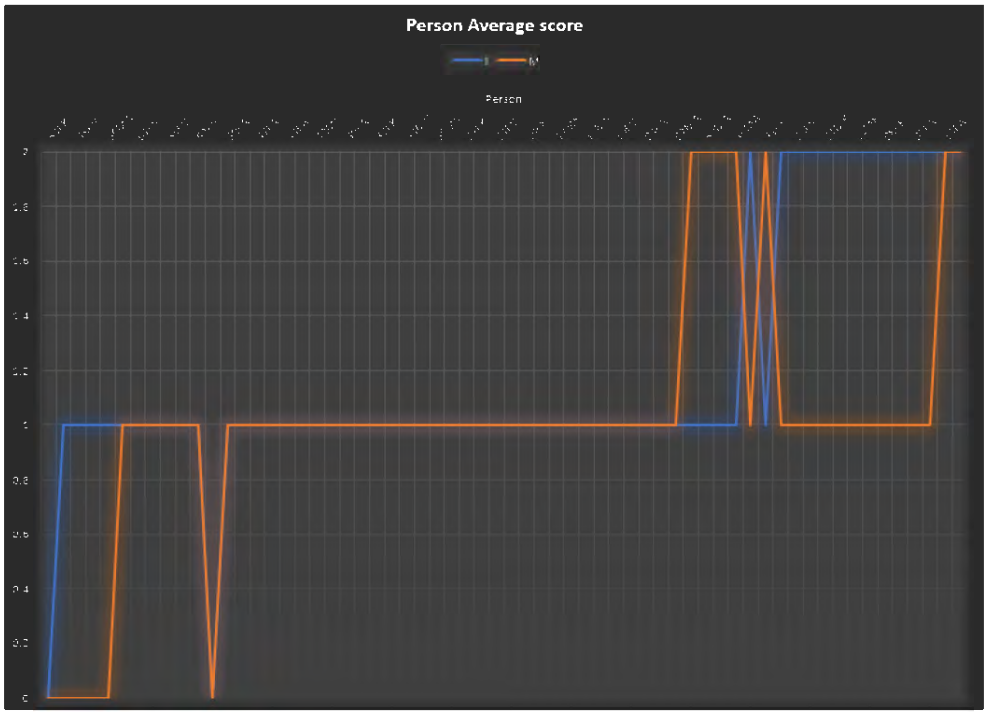

Figure 2. Average Score of Student Daily Test Scores

The orange curve line (M) shows that in mathematics lessons, there is no significant difference in students' daily test scores in terms of gender and learning style. The basis of the statement is the horizontal curve tendency of the line. On the other hand, the blue curve line (I) shows that there is a slight difference in students' daily test scores in Indonesian language lessons from the perspective of gender and learning style. Furthermore, Figure 2 supports the above statement (Figure 1) that students with women with an audio learning style (13FA) have the highest average daily test scores.

4.3. Learning Styles Reviewed in Math and Gender

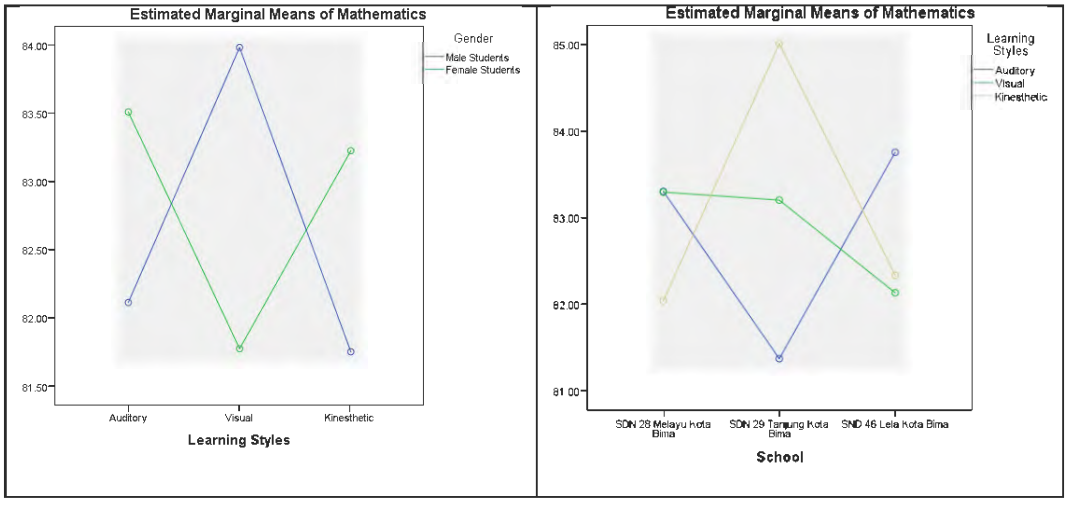

Figure 3. Learning Styles by Gender and Math Lesson

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Figure 3 shows that male students excel in visual learning styles and have the highest average score (84 points). Meanwhile, female students outperform auditory and kinesthetic learning styles.

4.4. Learning Styles Reviewed in Indonesian and Gender

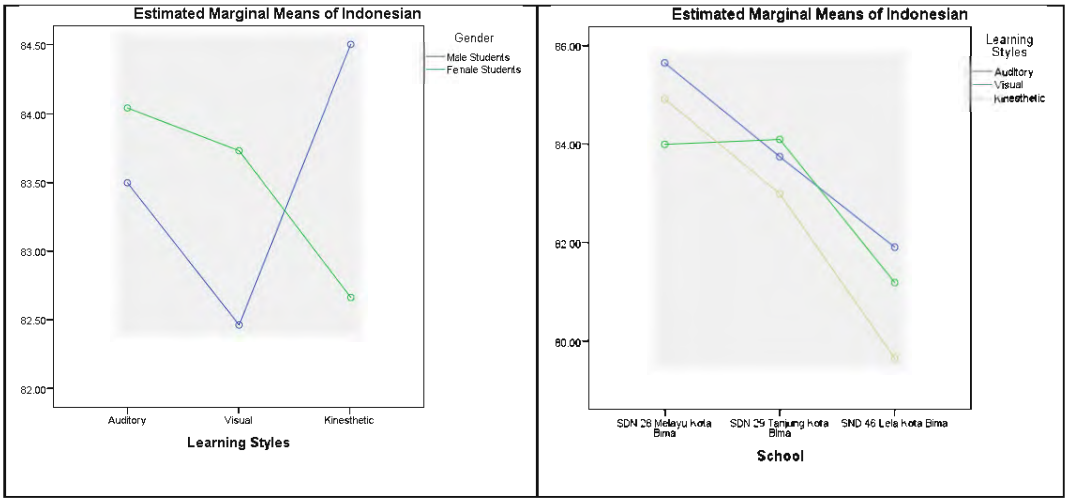

Figure 4. Learning Styles Based on Gender and Indonesian Language Lessons

Figure 4 shows that female students excel in auditory and visual learning styles. Meanwhile, male students outperformed and had the highest average score (84.5 points) in the kinesthetic learning style. More specifically, the auditory learning style in Indonesian language lessons had a more dominant mean score in 2 schools (SDN 28 Melayu and 46 Lela in Bima City).

4.5. GLM Test Result

Previously, the students' daily test scores were tested for normality. The results are shown in Table 3.

Table 3. Results of the Normality Test of Students' Daily Test Score Data

Tests of Normality

		Shapiro-Wilk		
	School	Statistic	df	Sig.
Mathematics	SDN 28 Melayu Kota Bima	.935	21	.177
	SDN 29 Tanjung Kota Bima	.891	18	.061
	SND 46 Lela Kota Bima	.872	23	.070
Indonesian	SDN 28 Melayu Kota Bima	.974	21	.815
	SDN 29 Tanjung Kota Bima	.871	18	.069
	SND 46 Lela Kota Bima	.935	23	.141

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of the normality test (Table 3), each student's daily test score in each subject and each school has been distributed normally (sig.> 0.05). The use of the Shapiro-Wilk test is due to the number of samples that are less than 50 students. As a result, the data of this daily repetition score can be continued for the general linear model (GLM) and one-way ANOVA test. The general

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linear model (GLM) test is intended to existence difference effectiveness learning style reviewed from gender refers to values eye lesson.

Table 4. Results of the General Linear Learning Style Model Test Against Gender

Tests of Between-Subjects Effects							
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Learning Styles	Mathematics	1,486	2	.743	.183	.833	.008
	Indonesian	10,564	2	5.282	1,486	.237	.061
Gender	Mathematics	2.144	1	2.144	.528	.471	.011
	Indonesian	8.275	1	8.275	2,329	.134	.048
Learning Styles * Gender	Mathematics	35,080	2	17,540	4.322	.019	.158
	Indonesian	1,540	2	.770	.217	.806	.009

a. R Squared =.478 (Adjusted R Squared =.308)

b. R Squared =.540 (Adjusted R Squared =.390)

Table 4 shows differences in the value of learning styles in terms of gender in mathematics subjects. Proven by significant 0.019 (< α 0.05), while for Indonesian language lessons there is no difference (significant 0.806).

4.6. Oneway ANOVA Test Results

The ANOVA test is used to determine differences in the effectiveness of learning styles in terms of subjects. Previously, a prerequisite test of homogeneity will be carried out.

Table 5. Homogeneity Test Results

	Levene Statistics	df1	df2	Sig.
Mathematics	.434	2	59	.650
Indonesian	.703	2	59	.499

The data on math and Indonesian language scores are homogeneous, as shown in Table 5. Then, the ANOVA test was conducted.

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Table 6. Results of Oneway ANOVA Test

Bonferroni							
Dependent Variable	(I) Learning Style	(J) Learning Style	Mean Difference (IJ)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Mathematics	Auditory	Visual	.31167	.70247	1,000	-1.4193	2.0427
		Kinesthetic	.02244	.84651	1,000	-2.0635	2.1084
	Visual	Auditory	-.31167	.70247	1,000	-2.0427	1.4193
		Kinesthetic	-.28923	.84054	1,000	-2.3604	1.7820
	Kinesthetic	Auditory	-.02244	.84651	1,000	-2.1084	2.0635
		Visual	.28923	.84054	1,000	-1.7820	2.3604
Indonesian	Auditory	Visual	.74500	.69461	.864	-.9666	2.4566
		Kinesthetic	.39423	.83704	1,000	-1.6684	2.4568
	Visual	Auditory	-.74500	.69461	.864	-2.4566	.9666
		Kinesthetic	-.35077	.83113	1,000	-2.3988	1.6973
	Kinesthetic	Auditory	-.39423	.83704	1,000	-2.4568	1.6684
		Visual	.35077	.83113	1,000	-1.6973	2.3988

Based on Table 6, using the Bonferroni further test type, it is found that for three types of learning styles, when reviewed in two subjects, there is no difference in average scores when reviewed in two subjects for three types of learning styles. This statement is evidenced by a significant value> α 0,05. So, it can be stated that with the implementation of the Merdeka curriculum, the effectiveness of learning styles in terms of subjects is the same.

Specifically, the Bonferroni test shows that there is a difference in the average scores of mathematics and Indonesian based on the effectiveness of learning styles. This difference in value can be ignored because it is relatively small, thus supporting the test statement that there is no difference in the average score due to the effectiveness of learning styles in mathematics and Indonesian lessons. The difference in the intended values is 0,311 and 0,022 for auditory learning styles with visual and kinesthetic learning in mathematics lessons. Then, a difference of 0,745 and 0,394 was obtained for auditory learning styles with visual and kinesthetic in Indonesian lessons. Based on the difference in average scores, overall, each subject is outperformed by students with an auditory learning style.

4.7. Test Results N-Gain Score

The n-gain score test is intended to determine the specific level of effectiveness of each learning style in each subject. The results are shown in the following table.

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Table 7. Test Results of N-Gain Score Learning Styles Based on Subjects

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain Score AM	24	25.00	77.78	59.3278	14.45932
N-Gain Score VM	25	30.00	73.68	55.2303	12.75439
N-Gain Score KM	13	40.00	76.47	60.2937	9.06952
N-Gain Score AI	24	50.00	83.33	63.9933	9.76558
N-Gain Score VI	25	44.44	93.33	57.9475	10.96893
N-Gain Score KI	13	35.00	95.00	62.9086	16.52243

Based on Table 7, the effect of auditory learning style on mathematics and Indonesian language learning (AM & AI) is in the moderately effective category (59% and 64%). Likewise, the effect of visual learning styles on math and Indonesian language learning (VM and VI) is in the moderately effective category (55.2% and 58%). Finally, the effect of the kinesthetic learning style on math and Indonesian language learning (KM and KI) is in the moderately effective category (60% and 63%). This same effectiveness category supports the results of the previous ANOVA test, which states that there is no difference in the average value of each learning style on each subject. Final effectiveness of learning styles in each gender and subject. Shown in the following figure.

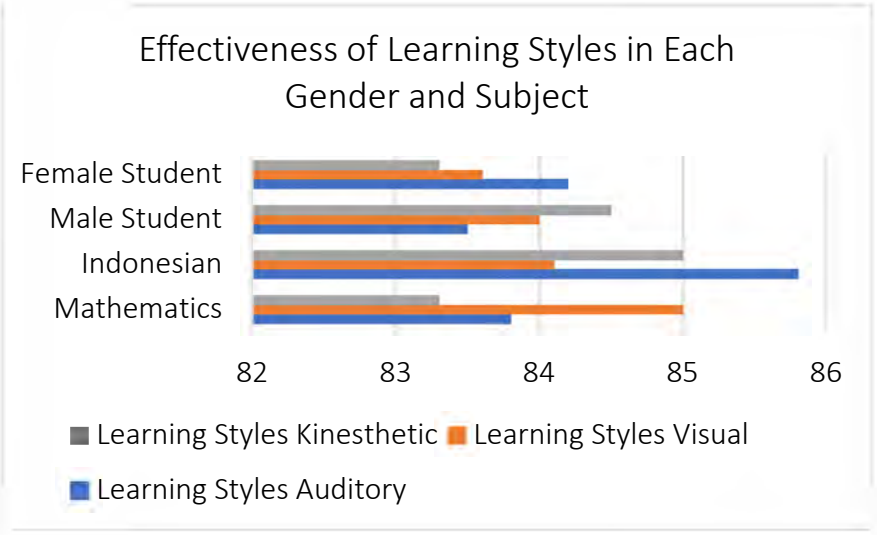

Figure 5. Effectiveness of Learning Styles by Gender and Subject

Based on Figure 5, it is clear that male and female students have their own best learning style preferences. Female students are most effective with the auditory learning style (84.2 points), while male students are most effective with the kinesthetic learning style (84.5 points). Likewise, the subject Indonesian lessons are most effective with auditory learning styles (85.8 points), while math is most effective with visual learning styles (85 points).

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5. Discussion

(The results should be discussed and interpreted from the perspective of previous studies and the working hypotheses in the broadest context possible).

5.1. Learning Styles Reviewed from Gender

Implementation of the Merdeka Curriculum, which provides freedom in choosing learning methods, allows students to adapt their learning styles to the teaching methods provided. Furthermore, the Merdeka curriculum also provides an opportunity for teachers to adapt teaching methods to suit students' needs and preferences. This study has a sample distribution of elementary school students in 3 (three) types of learning styles, namely 23 auditory, 25 visual, and 13 kinesthetic.

In implementing the Merdeka curriculum, diverse learning styles based on gender can be accommodated properly. The distribution of samples by gender is 23 male students and 39 female students. The results show that females excel in auditory and kinesthetic learning styles in mathematics. Females have better communication and collaboration skills. As a result, they can more easily understand mathematical concepts when explained verbally (Sabirin & Sulistiyarini, 2021; Sulistyaningrum et al., 2019). Females will also like teaching direct or based on discussion group (Linneman, 2018). Another factor is that math lessons require emotional and sensory involvement. This factor will tend to be liked and owned by women, for example, in hand movements to calculate or understand mathematical concepts (Haase et al., 2019; Mansor & Amran, 2023). This confidence arises due to their ability to listen to explanations while performing physical movements for concepts of material, and they are listening to process information better.

Meanwhile, males excel in visual learning and have the most dominant average score. This condition states that mathematics is more effectively learned with a visual learning style. Visual learning style is very effective in learning mathematics because mathematics often involves abstract concepts that can be more easily understood if visualized (Madyaratri & Wardono Dan Priyono, 2019; Mainali, 2021). Some examples of materials are symbols, graphs, diagrams, and geometric shapes. This aligns with Saman's (2023) view that visualizations such as graphs, diagrams, and images help students remember information better. Visual patterns such as multiplication tables or function graphs help students remember and connect concepts in mathematics.

The condition differs from the Indonesian language lesson, where women excel in auditory and visual learning styles. The first factor is neurological differences; the female brain has better connectivity between the right and left hemispheres. The right hemisphere is usually associated with visual and spatial abilities, while the left hemisphere is associated with language and logical abilities (Tejavibulya et al., 2022). Another factor, according to Mubarkah and Masriyah (2023), is that female students are better able to master auditory elements in the learning process, such as listening to reasoning, teacher explanations, discussions, or stories.

Meanwhile, male students excel in kinesthetic learning styles and have the most dominant average score. A study states that male students with kinesthetic learning styles in Indonesian lessons are superior in doing assignments (L. O. Sari, 2020). Referring to the results of this study, Indonesian language lessons will be more effective with the adjustment of kinesthetic learning styles. Kinesthetic learning styles tend to prioritize physical activity. Movement or action to understand and remember knowledge information will be more in sync with aspects of Indonesian language learning (Fhonna & Yusuf, 2020; Sulaeha et al., 2024). One example is in the aspect of narrative text material, stories or fairy tales, students will easily understand material through drama or role playing.

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Some of the research facts above are further proven by the n-gain score test, which shows the improvement and effectiveness of learning styles in supporting subjects. The test results show that the visual learning style for math lessons (VM) has a percentage increase in the moderately effective category. Meanwhile, the kinesthetic learning style for Indonesian language lessons (KB) has a percentage increase in the moderately effective category. The moderately effective category means that each learning style is quite effective in improving learning outcomes or achievements (grades) in mathematics and Indonesian language subjects. In accordance with several studies, there is a positive relationship between learning styles and learning outcomes in Indonesian language lessons. Another statement is that auditory, visual, and combination learning styles can increase the level of knowledge, skills, or general learning outcomes of Indonesian language lessons (Aswar, 2020; Sinaga, 2022). The follow-up is for teachers to make references when conducting learning in mathematics and Indonesian language materials. The details are visual learning styles for math lessons and kinesthetic learning styles for Indonesian language lessons.

5.2. Learning Styles in Terms of Subjects

As a result, each subject has different characteristics and demands, so a learning style that is effective for one subject may not be equally effective for another. This research looks at mathematics and the Indonesian language. Mathematics is one of the exact subjects. This type of learning tends to be more effective for students with visual and kinesthetic learning styles (Andriliani et al., 2022; B. P. Sari, 2023). Students with visual learning styles can understand abstract concepts through diagrams, graphs, tables, and symbols. Then, students with kinesthetic learning styles will be enthusiastic about experimental activities and the use of science laboratories. In contrast to Indonesian language lessons, it is a type of social and humanities lesson. Humanities-type lessons will be more effective for students who have an auditory learning style (Kurniawati et al., 2021). Students with auditory learning styles will be dominant in learning activities such as discussions, lectures, listening, reading, writing, or memorizing material. The results of this study show that the effectiveness of the learning style is fluctuating for both subjects.

Specifically, in math lessons at SDN 28 Melayu, visual learning styles were superior. At SDN 29 Tanjung, the kinesthetic learning style was superior. Finally, at SDN 46 Lale, the auditory learning style was superior. So, it can be seen that kinesthetic learning styles are superior in math lessons. This is in line with the results of a study which showed that kinesthetic learning styles were 1,9 times superior to auditory and 4,3 times superior to visual in math lessons. Other results state that kinesthetic learning styles are superior in absorbing and understanding math concepts compared to other learning styles (Riyadi et al., 2020; Zahra Amalia & Hadi, 2021).

Based on the distribution of scores, it also shows that SDN 29 Tanjung is superior in math learning outcomes/values. This achievement can be attributed to the results of interviews with the school's class teachers. The explanation from a teacher of SDN 29 Tanjung is that in reviewing learning style factors and subjects, namely encompassing learning for equal knowledge and student freedom. This statement is in accordance with theories of learning independence. The freedom given to students is a form of learning independence so that students will choose the learning method that suits them best (Alamri et al., 2020; Nurhayati et al., 2022). Ultimately, it helps them develop a sense of responsibility for their own learning, which can improve the quality of learning and learning outcomes. Another theory is about the differentiation approach, that the Merdeka curriculum will support knowledge equality by providing opportunities for each student to apply their learning strategies and support their needs and potential (Abdul & Suja', 2023; Anggraeni & Susanti, 2024).

The subsequent distribution is from the Indonesian language lesson, showing that at SDN 28 Melayu, the auditory learning style was superior. At SDN 29 Tanjung, the visual learning style was superior. Finally, at SDN 46 Lela, the auditory learning style was superior. This distribution shows that

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auditory learning styles are superior in Indonesian language lessons. This aligns with the previous theory that humanities-type lessons will be more effective for students with auditory learning styles. Another condition shown from score distribution is that SDN 28 Melayu is superior in Indonesian language learning outcomes/scores. The SDN 28 Melayu class teacher said that in reviewing the learning style and subject factors, she was more likely to pay attention to equality in terms of the division of student study groups. This is in line with the theory that equal division of groups encourages more dynamic interaction between students. Then students can help each other and learn from each other's experiences and understanding, ultimately improving their understanding of the materials and learning outcomes (Webb et al., 2019). Another theory that is more aligned with Indonesian language subjects is the development of social skills. Equal division of groups can also help students develop social skills such as cooperation, communication, and empathy (Wahyuningrum, 2022).

5.3. Effectiveness of Learning Styles by Gender and Subject

The reference is the result of statistical analysis through the general linear model (GLM) test, one-way ANOVA further test, and n-gain score. In general, the results of the analysis of these statistical tests will show levels and differences in the effectiveness of learning styles in terms of gender and subject. The first gain is shown by the GLM test results, which indicate that there are differences in the effectiveness of learning styles when viewed based on gender, namely in mathematics lessons. Supported by the results of research through the significant ANOVA test, it states that there are differences in learning outcomes between male students and female students (Rahayuny et al., 2024).

A theory states that men are often more interested in solving problems that involve logic and abstraction. In contrast, women may focus more on details and practical application. This can affect the way they understand and work on math problems (Charlesworth & Banaji, 2019; Prasetyo, 2022). Another theory suggests that men may be more likely to use active learning strategies that involve experimentation and hands-on practice, while females tend to use reflective learning strategies, such as reading and contemplation (Erdogan, 2019; Ješková et al., 2022). Another fact is obtained from the results of the one-way ANOVA further test with the Bonferroni test type. The result is no difference in the effectiveness value of learning styles when reviewed in each subject. These results are relevant to the research conducted by Silva Putri et al. (2019) demonstrating that there are no differences in mathematics learning outcomes in the form of critical thinking skills when viewed from each learning style (auditory, visual, and kinesthetic). Finally, there is research from Finundi et al., (2024) suggesting that there is no difference in students' Indonesian language achievement or learning outcomes due to differences in learning styles because all learning styles are the same and according to student preferences.

Finally, based on the n-gain score test, the effectiveness of each learning style in terms of each subject was obtained. The fact is that each learning style (auditory, visual, and kinesthetic) has a reasonably adequate level of effectiveness in mathematics and Indonesian language subjects. In detail, it was found that each learning style was more than 55% effective in supporting learning in mathematics and Indonesian. This result is supported by several studies, such as Widyasari (2023), who found that auditory, visual, and kinesthetic learning styles were able to improve the mathematical communication skills of fifth-grade students of Min 2 Ponorogo by 59,8%. This percentage places the learning style as quite effective in supporting students' results or abilities in learning mathematics. Another study stated that there was a positive effectiveness of differences in students' learning styles on students' ability to write in Indonesian language lessons (Yusuf, 2024).

6. Conclusion

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Based on the results of data analysis and discussion, in this study, there are several outline points as conclusions. The first point is that there are differences in the value of learning styles in terms of gender in mathematics subjects. This fact shows that the effectiveness of learning styles in terms of gender has a form of influence, especially in mathematics subjects. Specifically, male students with a visual learning style are superior in math subjects. Likewise, in Indonesian language subjects, male students with kinesthetic learning styles were the most superior.

The second point is that the three types of learning styles can be stated that with the application of the Merdeka curriculum, the effectiveness of learning styles in terms of subjects has the same effect. This condition shows that learning with the Merdeka curriculum can encompass equalizing the knowledge and needs of students and teachers. The last point is that the level of effectiveness of each learning style on each subject is in a moderately effective category. This condition supports previous results that show that the effectiveness of increasing students' average scores based on learning styles in terms of subjects is the same.

7. Suggestion

Referring to the research results and discussion points, the researcher wrote several recommendations as a form of follow-up to this research. The implementation of the Merdeka curriculum needs to be of particular concern to teachers regarding gender variations in study groups and discussions. Learning in each subject with the implementation of the Merdeka curriculum also needs to use modern technology to support students' maximum learning outcomes or achievements. The existence of the Merdeka curriculum has been able to encompass and equalize the effectiveness of students' learning styles. However, it must still be reviewed and adjusted to the subject matter. Finally, the future research should be carried out more precisely by reviewing the effectiveness of learning styles on the 21st-century skills (4C) item response.

Declarations

Author Contributions. U.U: Researchers (compilers, designers, and collection of research data), recapitulation and analysis of research data, preparation of articles, and construction of writing. M.I: Verification or method, reviewer of article content, and construction of writing. Tabulation, analysis, and processing of research statistical data. A.K, A.Y.F, H, R & M.I.J: Reviewer of content construction, discussion, and related references.

Conflicts of Interest. The authors declare no conflict of interest.

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Ethical Approval. This study was conducted in accordance with ethical guidelines.

Data Availability Statement. The data supporting this study are available from the corresponding author upon reasonable request.

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Appendix I.

Interview Indicator Grid for Class Teachers regarding the implementation of the Merdeka curriculum.

1. Teachers' knowledge.
2. Use of modern technology,
3. Review of learning style, gender and subject factors.
4. Quality/achievement of learning.