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Exploring IPAS through Learning Styles: An Analysis of the Influence of Learning Styles on Students' Conceptual Understanding at SD Alam Islami

Ega Januardi✉[1], Mohammad Syaifuddin[2], Yus Mochamad Cholily[3] & Eko Susetyarini[4]

[1,2,3,4] Doctoral Program in Education University of Muhammadiyah Malang, Malang, Indonesia

✉ egajanuardi650@gmail.com

Abstract. Accelerated rates of social and technological change require learning systems that develop scientific thinking, character, and problem-solving abilities beginning at the elementary school level. This research investigates the impact of learning styles, namely, visual, auditory and kinesthetic, on students' conceptual understanding in IPAS (Integrated Natiral and Social Sciences) at a primary school in Bekasi. In a classroom-based quantitative study, a validated learning style questionnaire and force-related multiple-choice tests were administered to gather data. The assumptions for the analyses were met and tested for normality, as well as homogeneity. The product-moment correlation was used to examine the relationships among the variables, and the significance and proportion of explained variance were also tested. There was a significant positive and useful effect between learning style and conceptual understanding as the findings indicated. Students who preferred visual learning obtained higher levels of understanding when learning was embalmed with visualizations; kinesthetic and auditory learners gained when the instructional strategies were similarly focused on their modality strengths. In total, learning styles explained about one-third of the variance in performance, the rest was related to teaching methods, learning environments and motivation. The research proposes that learner-centered differentiation techniques considering a variety of learning styles may enhance better engagement and depth of conceptual learning. Practical implications are related with what teacher professional development in multimodal pedagogical design and curriculum development should be that is based on the laboratory work with discussion and visual material in the direction of supporting learner diversity.

Keywords: Conceptual Understanding; Elementary School; IPAS; Learning Styles; Student-Centered Learning.

1. Introduction

The fast pace of the modern society changed almost all aspects of man's daily life especially education. In this day and age of globalization and digitalization, education is considered as the means that mould future generations which are knowledgeable, have a strong character, and able to compete in the global arena (Mertanen & Brunila, 2024; Sellami et al., 2025). Teaching is not simply a vehicle for imparting knowledge, but also a way of socialising and preparing young people with values, attitudes and competences needed to meet the challenges of an ever more difficult life (Miço & Cungu, 2023; Ng et al., 2023). In thisevent, the educational process's effectiveness is affected by numerous elements, one of which is the learning strategy utilized by instructors and how well the teaching strategies are able to conform to the learning styles of the students (Hernandez et al., 2020).

One of the core things that an IPAS—Natural and Social Sciences is that the subject needs to consider for promoting the scientific and logical thinking mind of the students. The emphasis of this course is on natural processes and on the ways in which humans have interacted with the environment (Marougkas et al., 2023; Surul & Septiliana, 2023). Teaching IPAS should be a learning process that students not only memorize concepts through cognitive process but also to think critically and solve problems as well as apply those concepts to their daily life. Unfortunately, in practice, IPAS learning in many elementary schools is still dominated by conventional and teacher-centered methods (Boroallo et al., 2025). Students often have no opportunity to explore, experiment, or develop their own understanding; they simply passively receive information in lectures and textbooks (Owens et al., 2020). This is the reason why the level of conceptual understanding and student's interest on IPAS is relatively low.

Already, the debate about learning preferences is becoming noisy in education. Each student processes and receives information in a unique way. The three most well-known learning styles are visual, auditory and kinesthetic (Bao & Yunus, 2024). Visual learners grasp information more readily from pictures, charts or some other form of visual presentation (Buckley & Nerantzi, 2020). Auditory learners, however, learn best by hearing – through group discussions, lectures, or listening to music (Islam, 2024) — while kinesthetic learners absorb information through movement, hands-on activities, and tangible experiences (Fang, 2025; Sutini et al., 2025). When the pedagogy is not adapted to students' learning styles, instruction is less impactful, concept mastery suffers, and this is especially true for IPAS, a content area that is high in conceptual demand (Ariswari et al., 2024; Durrani et al., 2023).

This is also the case at Alam Islami Elementary School, where IPAS teaching is still predominantly through lectures and textbook reading. Students are less engaged in experimental, observational, or participatory activities that enable them to generate their own knowledge. Because of this, IPAS teaching tends to be dull, uninspiring, and too examination-oriented. This situation calls for more diverse and creative solutions that relate to different styles of learning among students (Dhawan, 2020). Teachers must also understand that the diversity of learning styles is not a limitation but a capacity to be enhanced in the process of increasing learning effectiveness and student results (Jääskä & Aaltonen, 2022).

To solve these problems, teachers must adopt student-centered learning that accommodates the learning styles of the students. In the case of IPAS, teachers may use demonstrations, experiments, group discussions, visual media and play-based learning activities tailored to the idiosyncrasies of students (Mystakidis, 2021). This contributes far more to making learning fun and meaningful, which helps students in having deeper conceptual understandings of the subject (Polman et al., 2021). These techniques have corollaries in the constructivist learning models of Piaget and Vygotsky where knowledge is constructed by the learners their selves through interaction with the environment and real relevant learning materials (Nurhasnah et al., 2024). Also, VAK Learning Styles Theory by Fleming is a key basis stating that teachers need to determine dominant learning styles of students to learn about their preferences and to consider these in instruction (Isma'il & Sodangi, 2025). The use of these theories in learning through IPAS at Alam Islami Elementary School is anticipated to have major impact on the students conceptual understanding and learning achievement (Rafia et al., 2025).

The research study is primarily focused on the effect of learning styles (visual, auditory, and kinesthetic) on the conceptual understanding of IPAS among class four students of Alam Islami Elementary School. This article investigates how learning styles influence students' comprehension of subject matter. With this knowledge, teachers will be able to create more engaging, interactive, and student-teaching strategies that cater to the needs of the learners. The benefit of this study goes beyond better student learning outcomes — it has implications for educators, particularly elementary school teachers as they develop differentiated teaching practices. Theoretically, the research adds value to prior studies on learning styles and conceptual understanding by confirming that the degree of learning success is highly dependent on the extent to which teachers can tailor their teaching styles to the characteristics of students. From a practical perspective, the results may be used as a guide in the development of curricula and teacher education programs that focus on the significance of considering individual differences in learning.

1.1. Problem Statement

The problem that will be investigated in this reserach is students' conceptual understanding In IPAS subject at Alam Islami Elementary School the students are very low. This problems occurs because the learning are still dominated by conventional method such lectures and textbooks so the learning become monotone and only have one way communication. As result, we end up with passive students, who aren't engaged in activities that make them curious or have them think critically. This teacher-centred teaching type prevent the students to gain a high level of conceptual understanding and make students apply the knowledge to the real life become difficult, even though this is the crux of IPAS learning.

Besides, another factor that leads to this issue is the fact that teachers are yet to be flexed in their teaching methods to suit the unique learning styles of each student. Every child learns differently—some are visual learners (looking at pictures, diagrams, or colors), some are audio learners (hearing explanations or participating in discussions), and some learn more through kinesthetic or tactile means (performing experiments or working with their hands). When learning styles are ignored, students often experience problems with focusing, motivation to learn, and their learning results are not satisfying.

1.2. Related Research

Some previous research has reported on the effect of learning styles on achievement or conceptual understanding in science learning at the elementary school level. This research is related to previous studies which states that learning styles is a significant factor that could contribute to the improving of learning achievement. For instance, similarly to the research of El-Sabagh (2021), this study concentrates on the effect of learning styles on learners' learning result, yet, within an adaptive e-learning environment as examined by El-Sabagh (2021), the present research is conducted in the IPAS learning context at an elementary school. There is also a parallel with the study of Huang et al. (2020) on the association between learning styles and learning outcomes, which concludes that both studies support the proposition that learning style diversity influences students' learning understanding. In line with this is the work of Almasri (2024) that is dedicated to investigating the enhancement of science learning through modern methods; however, in contrast to Almasri's that was integrative of AI-based learning this research design is grounded in learning-styles as guidance for the shape of instructional tactics.

The distinctions are in context, methodology, and the subject of investigation. El-Sabagh (2021) adopted an engagement-based approach in an adaptive e-learning environment, while the current research is the first to investigate the impact of learning styles on students' conceptual understanding of IPAS using a face-to-face approach. Huang et al. (2020) added new factors such as sense of presence and cognitive load, and used virtual reality technology; the current study focuses on traditional classroom teaching at the elementary school level. In contrast to this study's empirical methodology which directly engaged with young students, Almasri (2024) also investigated the application of AI in science education through a systematic review. However, the novelty of this study is insufficient if it is stated only in relation to the Indonesian IPAS context. Therefore, the study needs to articulate the research gap explicitly. First, there is a methodological gap because many previous studies have examined learning styles in technology-based learning environments—such as adaptive e-learning, virtual reality, or artificial intelligence—so evidence from regular face-to-face instruction in elementary schools remains limited. Second, there is a theoretical gap in the outcome variable: many studies emphasize general achievement, while evidence that specifically links visual, auditory, and kinesthetic learning styles to conceptual understanding in integrated science such as IPAS has not been adequately explained. Third, there is an operationalization gap because not all studies describe in detail how learning-style scores are grouped and then directly connected to concept-understanding test scores for specific content. Accordingly, this study contributes by addressing these gaps through measuring visual, auditory, and kinesthetic learning styles among fourth-grade students in face-to-face learning, assessing IPAS conceptual understanding through an objective test, and examining the quantitative relationship between the two. The novelty of this research lies in presenting empirical evidence from regular elementary school classrooms in Indonesia, with IPAS conceptual understanding positioned as the primary outcome variable, rather than general achievement or technology-based learning contexts.

1.3. Research Objectives

The focus of this study is to analyze the influence of learning styles (visual, auditory, and kinesthetic) on fourth-grade students' ability to understand IPAS concepts. The results of this research are expected to answer the question: *How do learning styles affect the conceptual* *understanding of IPAS among fourth-grade students at Alam Islami Elementary School?* Thus, this study is expected to contribute to improving the overall quality of IPAS learning and student learning outcome.

2. Theoretical Framework

This theoretical framework explains the key concepts that form the foundation of the study, namely learning styles and conceptual understanding in the subject of IPAS (*Integrated Natural and Social Sciences*). The framework is organized based on the research variables and focuses on how students' learning styles influence their conceptual understanding of IPAS.

2.1. Conceptual Understanding in IPAS Learning

A concept is an object of thought, the result of processing information, something that is generally understood and is used to facilitate human thinking due to some characteristics. A conceptual understanding is when students are able to make meaningful connections among different concepts and principles related to a particular domain (Altmeyer et al., 2020; Fries et al., 2021). Therefore, understanding the concept is more than memorizing procedures, it is understanding the meaning of the procedures and the ideas and principles on which the procedures are based (Götze & Baiker, 2021; Sigit et al., 2022). Students with conceptual understanding can connect new knowledge to prior understanding, and have the ability to transfer their knowledge to novel situations. Within the IPAS, conceptual understanding is defined as students' ability to link scientific ideas, recognize cause-and-effect relations in nature, and situate the basic scientific ideas that underlie technology (Nasri et al., 2023; Wee & Andoh, 2022).

2.2. Definition and Importance of IPAS

IPAS (Integrated Physical and Social Sciences) is a domain of inquiry that investigates the natural and social worlds in which we live using systematic observation, experimentation, and logical deduction. IPAS, in the opinion of Shutaleva et al. (2021), is an analytical, cautious, and holistic observation of nature in which one phenomenon is linked to others that brings us together in a new frame of reference. IPAS is vital because: (1) It is the basis for technological innovation—a country's wealth is largely determined by its scientific know-how, and science serves as the pillar of advancement (Ubaidillah et al., 2025). (2) It promotes critical thinking—students can acquire the ability of scientific thinking by experiments and activities of discovering by themselves (Rafia et al., 2025). (3) It promotes scientific attitudes: IPAS learning promotes curiosity, accuracy and objectivity to natural phenomenon (Surul & Septiliana, 2023). (4) It facilitates positive character shaping: Among the others, IPAS promotes not only cognitive aspects but affective and psychomotor ones in activities of observing, experimenting and reflecting (Guslinda et al., 2025). Therefore, learning of IPAS at elementary school level is encouraged to be delivered in a creative and interactive way to capture the imagination of learners so as to prepare them engaging in real life application of concepts and not dreading memorization of facts only.

2.3. Definition of Learning and Learning Styles

Learning is an operation of behavior that results in the stable changes due to experience and environmental interaction. This could be in the form of knowledge, attitude or skills (Liao et al., 2022; Seufert et al., 2021). Prominent educationists have opined that attainment of educational objectives is based on the process of learning, as sub-terms of process are equally applicable in the students role performance, including at school and in their surrounding environments. Learning is more than memorization; it's an active process through which learners come to understand, transform, and apply new information to real-world contexts (Asad et al., 2021). A learning style refers to the manner in which an individual processes, receives, and interprets information from the environment (El-Sabagh, 2021). It represents one's unique approach to learning and handling information, whether through a deep approach (involving understanding and reflection) or a surface approach (focused mainly on memorization and reproduction). Meanwhile, Yotta (2023) state that learning style is a modal pattern which is preferred by learners in learning, whether they are dissimilar or equate in classroom or out of class. A good learning style can make it easier for students to retain and understand what they have learned.

2.4. Types of Learning Styles (VAK Model)

Visual, Auditory and Kinesthetic (VAK) are three widely recognized learning styles for users. (a) Visual Learning Style Learners who have a visual learning style can be said to learn by seeing. In this study, VAK is treated as a descriptive learning preference used to help map students' tendencies and to design more multimodal instruction, not to label students permanently or to make it the sole basis for choosing teaching methods. Therefore, VAK is positioned as a tendency in learning preferences that can help teachers vary their strategies, rather than as fixed categories that automatically determine learning outcomes (Jones et al., 2020). They have a preference for images, charts, videos and any other type of visual material. Characteristics of students with a visual learning style include: (1) Neat and orderly, (2) Prefer reading to listening. (3) Remember information based on what is seen. (4) Lack of focus if only listening to verbal explanations (Rogowsky et al., 2020; Wang & Han, 2021). These characteristics reflect tendencies and may not appear in every student, so they should be understood flexibly. (b) Auditory Learning Style; Students with an auditory learning style find it easier to understand material through hearing. They prefer listening to teacher explanations, discussions, or reading aloud (Rogowsky et al., 2020; Wandah et al., 2024). Characteristics include: Enjoying discussions and verbal presentations, Easily distracted by noise, Remembering information heard more easily than seen, and being good at speaking and explaining material again (Chen et al., 2024). (c) Kinesthetic Learning Style; Students with a kinesthetic learning style find it easier to understand material through movement and direct experience (Putri & Suwarna, 2020). They learn by practicing or touching real objects. Characteristics include: unable to sit still for long periods, preferring activity-based learning, learning faster through practice than theory, using a lot of body language when speaking or thinking (Mindrescu et al., 2022). Therefore, VAK is used here as a descriptive framework to map learning preferences, while instructional planning should prioritize multimodal resources and other evidence-based practices.

2.5. The Relationship Between Learning Styles and Conceptual Understanding in IPAS

Learning styles significantly impact students' conceptual understanding of IPAS. Each student has their own unique mode of intake and processing of information. Visual learners are more likely to learn concepts when teachers display visual aids such as pictures or actual demonstrations (Guo et al., 2020). Hearing type learners achieve better understanding when the teacher is a clear verbal explanation, with the support of discussions and sessions of questions and answers (Tam, 2021). Kinesthetic learners learn faster when they are participating in experiments or hands-on activities. When teachers take into consideration their students' learning styles, they can design IPAS learning opportunities that are engaging, dynamic, meaningful, and allowing students to acquire the best possible conceptual understanding (Ariswari et al., 2024).

3. Method

3.1. Research Design

This study falls under quantitative research with a correlational (non-experimental) design. Its purpose is to determine the relationship between fourth-grade students' conceptual understanding of IPAS (Y) and their learning styles (X). The study does not involve variable manipulation, interventions, or control groups; data are collected once within an ongoing instructional context (cross-sectional) and analyzed to examine the strength and direction of the relationship between the variables. Figure 1 presents the model of relationships among the variables.

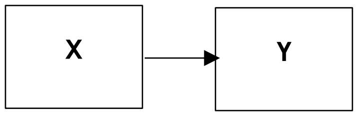

Figure 1. Research Design

Description:

X = Learning Style

Y = Conceptual Understanding of IPAS

This study was conducted at Alam Islami Elementary School, located at Jl. Setia II A RT.02/12, Jatiwaringin, Pondok Gede, Bekasi. The study was conducted during the usual class period at the school.

3.2. Respondent

In this research, the 42 fourth-graders of Alam Islami Elementary School made up the population. According to Willie (2024), a population refers to the entire group of individuals that become the object of research and possess certain characteristics. The sample in this study was determined using the saturated sampling technique, which is a sampling technique in which all members of the population are used as research samples (Hennink & Kaiser, 2022). Consequently, 32 fourth-graders made up the study's complete sample.

3.3. Data Collection

The data in this study were obtained through two main instruments: a questionnaire and a learning achievement test. The first instrument was a learning style questionnaire used to collect data on variable X (Learning Style). This questionnaire was developed using a Likert scale consisting of 30 statements. Always (A, with a score of 4), Often (O, with a score of 3), Sometimes (S, with a score of 2), and Never (N, with a score of 1) were the possible answers for each item. The learning-style questionnaire was developed based on the three VAK dimensions: Visual (V), Auditory (A), and Kinesthetic (K). Each statement item was mapped to one of these dimensions and labeled as positive or negative according to the instrument blueprint. The scoring procedure was as follows:

a. For positive items: Always (A) = 4, Often (O) = 3, Sometimes (S) = 2, Never (N) = 1.
b. For negative items (reverse scoring): Always (A) = 1, Often (O) = 2, Sometimes (S) = 3, Never (N) = 4. (This reversal follows the principle that responses opposite to the indicator should not increase the dimension score.)

After scoring, learning-style scores were calculated per dimension by summing the item scores within each category:

a. Visual score (V) = total score of all Visual items
b. Auditory score (A) = total score of all Auditory items
c. Kinesthetic score (K) = total score of all Kinesthetic items

Students' learning styles were classified using a dominance approach:

a. Compare each student's V, A, and K scores
b. A student is classified as having a dominant learning style (Visual/Auditory/Kinesthetic) if the highest score is greater than the other two scores and the difference is at least 3 points.
c. If the highest score is tied (e.g., V = A) or the difference between the highest and second-highest score is less than 3 points, the student is classified as multimodal (e.g., VA, VK, AK, or VAK).

This difference rule serves as a simple cut-off to prevent assigning a dominant classification based only on very small score differences. With this survey, the researchers aimed to identify students' predispositions in learning styles while finding out and organizing the information as these tendencies may enable easier processing of the learning contents by the students. The dimension scores (V, A, K) and the dominance-based classification results were used to develop students' learning-style profiles in the descriptive section. The second instrument was a test of learning achievement, which was administered to the students in order to assess variable Y (Concept Understanding). This test contained 40 multiple choice questions (MCQ) from the IPAS subject Force. There were four alternatives for every question: A B, C, and D. One point was awarded for a correct response, and zero for an incorrect response. The total score got by the students indicated how much he/she conceptually understood the content taught. The two instruments were given successively to the same students. Questionnaire results provided a general profile of the students' learning styles, whilst the test results provided an indication of the students' level of conceptual understanding. Using these two tools, the researcher also compares how many diverse media/materials and other means of teaching/facilitating learning greater than what is traditionally deemed as lecture-based teaching/learning being offered affects students' understanding or conceptualizing vis a vis students' preferred learning modes.

3.4. Data Analysis

This study was analyzed using a quantitative correlational approach. The data were first tested for prerequisite assumptions—normality using the Liliefors test and homogeneity using the F-test—to ensure that parametric analysis was appropriate. After these assumptions were met, the relationship between learning styles (X) and students' conceptual understanding of IPAS (Y) was examined using the Pearson Product–Moment correlation. This correlation was used to identify the direction and strength of the relationship between learning styles (visual, auditory, and kinesthetic) and IPAS conceptual understanding, not to test variables outside the scope of this study. The correlation coefficient (rxy) was calculated using the Pearson Product–Moment formula as follows (Kusdiwelirawan, 2014):

$$r_{xy} = \frac{\sum xy}{\sqrt{(\sum x^2)\,(\sum y^2)}}$$

Explanation:

r_{xy} : Correlation coefficient between the item and the total score
Σxy : Sum of the product between each item and total score
Σx : Score of a specific item for each respondent
Σy : Total score for each student

The correlation is represented by (r), provided that its value is within the range of (-1 ≤ r ≤ +1). While r = 0 indicates no connection, r = 1 indicates a very strong correlation, and r = -1 indicates a fully negative correlation. The interpretation in Table 1 will be used to determine the significance of the r value in the interim. These are the r values:

Table 1. Interpretation of the Correlation Coefficient (r)

Coefficient Interval	Level of Relationship
0.80 – 1.00	Very Strong
0.60 – 0.799	Strong
0.40 – 0.599	Fairly Strong
0.20 – 0.399	Low
0.00 – 0.199	Very Low

In this study, the t-test was not used to compare two groups or two means; instead, it was used to test the significance of the correlation coefficient (the significance test of *r*) with degrees of freedom df = n − 2. The formula used was as follows (Kusdiwelirawan, 2014):

$$t = \frac{r\sqrt{(n-2)}}{\sqrt{(1-r^{2)}}}$$

Description:

t: The correlation coefficient's significance score
n: The quantity of data points
r: The product-moment correlation coefficient

The coefficient of determination was calculated using the following formula to determine the extent to which learning styles contribute to students' conceptual understanding of IPAS. Thus, the magnitude of X's contribution to Y was measured using the coefficient of determination:

$$CD = r_{xy}^2 \times 100\%$$

Where:

CD : Coefficient of determination

rxy : Product-moment correlation coefficient

3.5. Validity and Reliability

3.5.1. Instrument Trial

An indicator of an instrument's level of validity or accuracy. The method of product moment correlation was used to assess the validity of the questionnaire for variable X. The correlation formula for product moment is (Arikunto, 2010):

$$r_{xy} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\{n\sum x - (\sum x)^2\}\{n\sum y^2 - (\sum y)^2\}}}$$

Description:

r_{xy} : The Pearson correlation coefficient

Σxy : The total of the multiplied values of x and y

Σx : The overall sum of all x values

Σy : The overall sum of all y values

Ξx^2 : The total of the squared x values

Σy^2 : The total of the squared y values

N : The total number of individuals (or students) involved in the study

The crucial value in the r product moment table at the 5% significance level (α = 0.05) is then compared with the computed correlation coefficient (r_{xy}). The following are the requirements for testing the validity of an instrument: The item is legitimate if r_calculated > r_{table}. The item is invalid if $r_{calculated} < r_{table}$. Therefore, an item is deemed legitimate when its correlation coefficient (r_{xy}) exceeds r_{table}. The purpose of reliability testing is to ascertain the instrument's (test's) dependability and consistency. An instrument is considered dependable if it consistently yields the same results when used on the same subject several times. A reliability test is conducted subsequent to the validity test. If a measurement device is steady, constant, and trustworthy, it is deemed dependable. The degree to which a correctly constructed instrument can be depended upon as a data gathering tool is known as reliability. Cronbach's Alpha is the formula used to calculate dependability (Arikunto, 2010).

$$r_{11} = \left[\frac{k}{k-1}\right]\left[1 - \frac{\sum o_{i^2}}{\sum t^2}\right]$$

Description:

r_{11} : Reliability coefficient

k : Number of items

$\sum o_{i^2}$: Sum of item variances for each question

$\sum t^2$: Total variance

3.5.2. Data Analysis Prerequisite Test

The normality and homogeneity tests are among the necessary data analysis tests used in this investigation. Using the Lilliefors test, the normality test was performed to see if the IPAS learning results of the students are regularly distributed.

1) Statistical Hypotheses:
   H_0: There is a normal distribution of the data.
   H_1: There is no normal distribution of the data.
2) The test used was the Lilliefors test, following these steps:

The procedure outlined below was implemented for the H0 test:

a) The observations X_1, X_2, X_3, …, X_n are converted into standardized scores Z_1, Z_2, Z_3, …, Z_n using the formula (Kusdiwelirawan, 2014):
$$Z_i = \frac{X_i - \overline{X}}{s}$$
($\overline{X}$ denotes the sample mean, and s denotes the standard deviation).
Description:
Z_i : Standardized score
$\overline{X}$: Mean
s : Standard deviation

b) Determine the probability for each standardized score (Z_i), using the conventional normal distribution table: $F(Z_i) = P(Z \leq Z_i)$.

c) Calculate the proportion of Z_1, Z_2, …, Z_n that are less than or equal to Z_i. This proportion is denoted as (Kusdiwelirawan, 2014):
$$S(Z_i) = \frac{\text{Number of } Z_2, \ldots, Z_n \leq Z_i}{n}$$

d) Compute the differences between $F(Z_i)$ and $S(Z_i)$, then find their absolute values.

e) Take the largest of these absolute differences—this value is called L_calculated (L_0)

f) Compare L_calculated with L_table. The decision rule is:
If the data are not normally distributed, reject H_0 if $L_{calculated} > L_{table}$.
If $L_{calculated} < L_{table}$, then they are regularly distributed, thus accept H_0.

4. Findings

The study was carried out at Alam Islami Elementary School, which is situated in the Pondok Gede District of Bekasi City at Jl. Setia II A Jatiwaringin. 42 fourth-grade children made up the study's sample in order to ascertain how learning styles affect scientific learning outcomes (IPAS).

4.1. Instrument Trial Analysis

4.1.1. Instrument Validity Analysis

Prior to starting the study, the validity of the instrument was assessed to find out how many items were deemed to be legitimate. A learning style questionnaire with thirty statements served as the study's tool. The following scores (Table 2) were assigned to the responses: agree = 4, frequently = 3, sometimes = 2, and never = 1. The learning outcome exam also included 40 multiple-choice (MC) questions with four possible answers (a, b, c, and d). A score of one was awarded for a right response, and a score of zero for a wrong response. The Product Moment Correlation equation was used to assess the results' dependability. In this instance, the validity test criterion is whether the computed correlation number (rcalculated) is greater than the table's correlation number (r_{table}). Based on the number of pupils, the r-abel value was obtained using the Product Moment Correlation Table. The instrument trial in this investigation, which included 34 students, yielded an r-able value of 0.361 ($r_{calculated} \geq r_{table}$).

Table 2. Classification of Learning Style Questionnaire Items

Classification	Number of Questions	Item Numbers
Valid	25	1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 30
Dropped	5	5, 10, 15, 20, 29

Out of thirty questions, it may be inferred that twenty-five are legitimate and five are invalid in terms of item discrimination. In this research, the instrument consisted of 25 legitimate questions.

4.1.2. Instrument Reliability Test Results

As a measuring instrument, reliability shows how accurate the test items are. If the computed correlation coefficient ($r_{calculated}$) is more than or equal to the table value (rtable) ($r_{calculated}$ >

r_{table}), the instrument is deemed credible. The KR-20 formula was used to determine the rcalculated value, which came out to be 0.78. At a significance level of a = 0.05, the $r_t$abel value for n = 30 was 0.361. Consequently, because rcalculated = 0.78 > rcalculated = 0.361, it may be said that the learning style assessment is appropriate for use in the study. Consequently, the device might be deemed trustworthy.

4.2. Description of Research Data

4.2.1. Description of Learning Style Data

Based on the calculation findings, data were acquired from the students' learning style questionnaire, with the greatest score being 90 and the lowest score being 62, from a total sample of 34 students. 75.9 was the average score, 74.8 was the median, 68.1 was the mode, and 8.67 was the standard deviation (Table 3).

Table 3. Frequency Distribution of Learning Style Questionnaire

No	Class Interval	Real Limits	Midpoint	Frequency		
				Absolute	Cumulative	Relative (%)
1	62-66	61,5-66,5	64	7	7	23%
2	67-71	66,5-71,5	69	6	13	20%
3	72-76	71,5-76,5	74	5	18	16,70%
4	77-79	76,5-81,5	79	5	23	16%
5	82-86	81,5-86,5	84	7	30	23%
6	87-89	86,5-91,5	89	4	34	13%
∑				34		100%

Based on the frequency distribution table (Table 3), a histogram and frequency polygon were constructed to visually represent the data, as shown in the figure below (Figure 2).

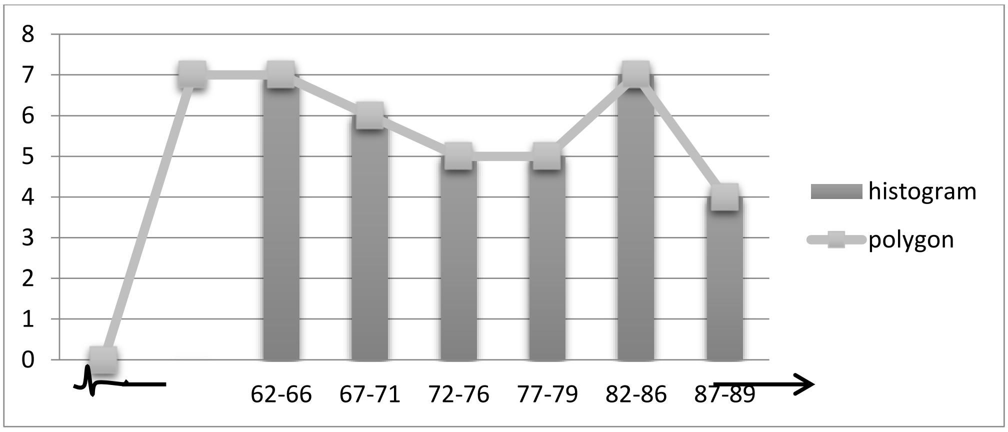

Figure 2. Frequency Distribution of Learning Style Questionnaire

The data are shown to be regularly distributed in the graph above.

4.2.2. Description of IPAS Learning Outcome Data

The fourth-grade IPAS learning outcomes provided the study data; the greatest score was 90, and the lowest was 63. Based on 34 students, the mean score was 64.82, the median was 69.28, and the standard deviation was 7.70. A frequency distribution table of IPAS learning outcomes was created using the data that was collected (Table 4).

Table 4. Frequency Distribution of IPAS Learning Outcomes

No	Class Interval	Real Limits	Midpoint	Frequency		
				Absolute	Cumulative	Relative
1	63-67	62,5-67,5	65	6	6	20%

No	Class Interval	Real Limits	Midpoint	Frequency		
				Absolute	Cumulative	Relative
2	68-72	67,5-72,5	70	7	13	20,50%
3	73-77	72,5-77,5	75	6	19	20%
4	78-82	77,5-82,5	80	8	27	23%
5	83-87	82,5-87,5	85	5	32	17%
6	88-92	87,5-92,5	90	2	34	5,80%
∑				34		100%

Based on the frequency distribution table of IPAS learning outcomes, a histogram of the frequency distribution was constructed, as shown in the figure below (Figure 3).

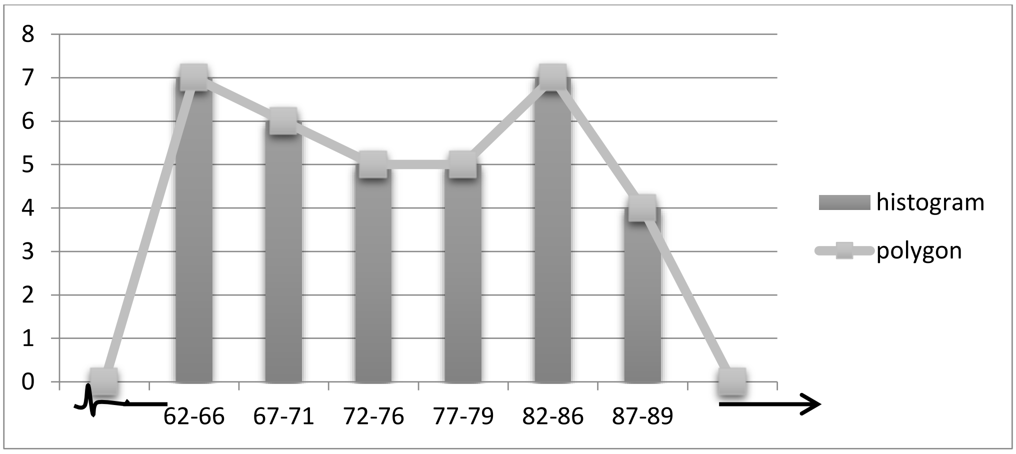

Figure 3. Frequency Distribution of IPAS Learning Outcomes

Based on the graph above, it can be seen that the data are normally distributed.

4.3. Prerequisite Test for Analysis

Prerequisite tests were performed prior to hypothesis testing. Among these preparatory tests were the homogeneity and normalcy tests.

4.3.1. Normality Test

The normality test used was the Liliefors test at a significance level of 0.05. The results of the normality test calculation are shown in the following Table 5.

Table 5. Results of the Liliefors Test Calculation

No	Variable	Lcalculated	Ltable	Conclusion
1	Learning Style (X)	0,1340	0,1519	Normal
2	IPAS Learning Outcomes	0, 1403	1,1519	Normal

According to the study, the experimental class's data are normally distributed at the 0.05 significance level. For n = 34, the Ltable value is 0.1519, but the Lcalculated value for learning style is 0.1340. Thus, the data on learning styles may be said to be regularly distributed. At the 0.05 level of significance, the analysis also reveals that the experimental class's data for scientific learning outcomes are regularly distributed. Ltable is 0.1519 for n = 34, and the resultant Lcalculated value is 0.1403. It follows that the statistics on scientific learning results are also regularly distributed.

4.3.2. Homogeneity Test

The homogeneity test was conducted using the Fisher test or F-test. The results of the homogeneity test calculations can be seen in the following Table 6.

Table 6. Homogeneity Test Criteria

Group Class	Number of Samples	α	$F_{calculated}$	F_{table}	Description
Learning Style Learning Outcome	N_1 = 34 N_2 = 34	0,05	1,30	1,795	Homogeneous

Based on the table above, the test results show that $F_{calculated}$ = 1.30, while F_{table} = 1.795 at a significance level of a = 0.05, with degrees of freedom for the numerator = 34−1 = 33 and for the denominator = 34−1 = 33. Since Fcalculated (1.30) < F_{table} (1.795), the null hypothesis (H_0) is accepted. This indicates that the data on learning styles and learning outcomes are homogeneous.

4.1. Hypothesis Testing

The hypothesis testing was conducted using the *t-test*. Based on the data of learning styles and IPAS learning outcomes, the mean and variance values are presented in the following Table 7.

Table 7. Data on Learning Styles and IPAS Learning Outcomes

Class	Number of Students	Mean	Variance
Learning Style	34	64,82	7,60
IPAS Learning Outcomes	34	75,90	8,67

After the analysis assumptions (normality and homogeneity tests) were met, the hypothesis regarding the relationship between variables X and Y was tested by calculating the Pearson correlation coefficient (r) and examining its significance using a t-test for the correlation coefficient with degrees of freedom df = n − 2 (df = 32). A summary of the significance test results is presented in Table 8.

Table 8. Results of Statistical Test Calculations

Uji-*t*		Conclusion
$t_{calculated}$	t_{table}	
4,646	1,998	Reject Ho

Based on Table 8, the calculated t-value (4.646) is greater than the critical t-value (1.998), so H_0 (r = 0) is rejected and H_1 is accepted. This indicates that there is a significant positive relationship between learning styles (X) and students' conceptual understanding of IPAS (Y) among fourth-grade students at SD Alam Islami. Next, the correlation coefficient (r) was calculated to determine the strength of the relationship between the two variables:

$$r_{xy} = \frac{Exy}{\sqrt{(Ex^2)(Ey^2)}} = \frac{194161}{\sqrt{113900769888}} = \frac{194161}{\sqrt{337491{,}8}} = 0{,}575$$

To find out how much variation in Y is determined by variable X, the coefficient of determination (CD) test was used with the following formula:

CD = rxy X 100%

= $0{,}575^2$ X 100%

= 0,3306 X 100%

= 33,06%

From these results, learning styles account for 33.06% of the variance in students' conceptual understanding of IPAS, while other factors explain approximately 66.94%. This finding indicates that learning styles are a meaningful contributor, but not the only factor associated with overall learning outcomes. In addition to statistical significance, the magnitude of the relationship (effect size) was evaluated using the correlation coefficient and the coefficient of determination. The obtained correlation coefficient was r = 0.575, indicating a positive relationship between learning styles and IPAS conceptual understanding. The coefficient of determination was r^2 = 0.3306 (CD = 33.06%), meaning that learning styles explain 33.06% of the variation in students' IPAS conceptual understanding, while the remaining 66.94% is related to other factors.

5. Discussion

The study at Islamic Nature Elementary School revealed that learning styles significantly affect the IPAS concept comprehension of 4th grade students. From the results of the hypothesis test by the t-test, the t-value of tcalculated was 4.646 and it is higher than the t-value of ttable=1.998 at the significante level of 0.05. Thus, H_0 is rejected and H_1 is accepted. This indicates that there was a statistical significant difference between the students' learning styles and their knowledge of IPAS concepts. The positive correlation coefficient (r_xy) is 0.56, showing a moderately strong relationship between these two variables and the value of coefficient of determination (r^2) is 33.06%, indicating that learning style explain 33.06% on the IPAS concept understanding, while other factors such as teacher's teaching style, learning atmosphere and students' motivation of learning explain 66.94% of the variation. Educationally, CD = 33.06% indicates practical significance: learning styles are a meaningful contributor and can be used as a basis for instructional design (for example, by combining visual representations, well-structured verbal explanations, and hands-on activities). However, learning styles should not be treated as the sole primary factor, because the remaining 66.94% of the variance is related to other determining factors (such as prior knowledge, teachers' instructional strategies, the learning environment, and student motivation). The statistical results must be interpreted carefully. First, this study used a correlational design, so it cannot establish a causal relationship; a significant result indicates an association within this sample, not evidence that learning styles alone cause higher IPAS conceptual understanding. Second, learning styles were measured using a self-report questionnaire, which may introduce response bias and may overlap with other student characteristics. Third, the sample was limited to one school (n = 34), and relevant confounding variables (such as students' initial ability, variation in teachers' teaching strategies, classroom climate, and motivation) were not controlled. Therefore, these findings are best understood as evidence of a relationship within the studied context. Future research is recommended to use experimental or quasi-experimental designs (e.g., pretest–posttest) and include relevant covariates to test the effectiveness of multimodal instruction more rigorously.

These results are in line with the VARK model (visual, auditory, read/write, kinesthetic), which is based on the concept of learning styles that everyone has different preferences on how they receive and process information. Visual learners tend to grasp concepts more solidly when learning is supplemented with pictures, charts or videos. This was confirmed by the highest mean scores of the visual and kinesthetic learners in this study. These findings are consistent with the results of several previous studies, which have revealed that learners exhibiting a visual learning style are more likely to perform better in visión related learning environments (Goldberg et al., 2021; Zamar et al., 2020). In addition, other studies have revealed that there is a statistically significant positive correlation between style of learning and achievement in science learning (Gajić et al., 2021; Suciani et al., 2022).

Nevertheless, visual style learners obtained the highest achievement despite the prevalence of auditory learning style among the students in the 4th grade in Islamic Nature Elementary School (Alam Islami Elementary School) through the findings of observations. This means that the higher learning style dominance does not always have a direct relationship to better learning achievement but is affected by the suitability of students' learning styles and teacher's instructional strategies. As many researchers have mentioned learning becomes more effective if teaching strategies are tuned to a learning style from which learner is dominant (Rasheed & Wahid, 2021; Wahyudin & Wahyuni, 2022). The consequences of instructors' teaching styles not aligning with students' learning styles may be a decrease in learning outcomes, even if students are enthusiastically engaged in class activities. Thus, the results of this study are in line with the assumption that learning styles influence the comprehensibility of IPAS for fourth grade students at Alam Islami Elementary School. These findings both reaffirm the core theory of individual-differences learning and align with previous studies which highlight how learning styles should be accounted for in order to effectively tailor teaching methods. In general, learning styles are considered one of the best determinants to improve the quality of the learning process and the result especially in IPAS subjects that involve the capability to think scientifically visually and practically.

To emphasize the research gap addressed, the statistical findings of this study need to be positioned as empirical evidence from face-to-face learning in elementary school, with IPAS conceptual understanding as the primary outcome variable. In contrast to many comparison studies conducted in technology-based learning contexts or those emphasizing general achievement, this research extends the evidence on the relationship between learning styles and conceptual understanding within IPAS learning in regular Indonesian elementary classrooms. However, the interpretation of these results must be handled carefully. Recent literature distinguishes preference from effectiveness: although students may show preferences for certain modalities, large-scale international experimental evidence indicates that teaching that is directly "matched" to learning-style labels (e.g., visual learners always receiving visual materials, auditory learners always receiving audio materials) does not consistently improve learning outcomes. For example, Rogowsky et al. (2020) found no meshing effect between visual–auditory preferences and fifth-grade students' reading or listening comprehension performance; Jones et al. (2020) likewise concluded that empirical support for such claims is very limited. Therefore, the findings of this study are more appropriately interpreted as evidence of an association between learning preferences and conceptual understanding outcomes in the IPAS context examined, rather than causal proof that teaching strictly according to learning styles will automatically increase achievement.

The study at Alam Islami Elementary School has several differences from the studies of El-Sabagh (2021), Huang et al. (2020), and Almasri (2024). In terms of content, it focuses on learning styles and concept understanding in IPAS learning at the elementary school level and is not limited to subsections of educational technology, such as adaptive e-learning (El-Sabagh, 2021), immersive virtual reality (Huang et al., 2020), or artificial intelligence in education (Almasri, 2024). This method advances a stronger empirical direction for traditional elementary education, particularly in the Indonesian setting since prior similar investigations in the country are regarded as a meager number. The study also applies inferenstial statistical method (t-test, and coefficient of determination) to reveal the degree of effect of learning styles on conceptual understanding, which undoubtedly would be a practical consideration for teachers in developing instructional designs that appropriate with student's characateristics. This article is unique as it successfully connects learning style theory to quantitative and practical applications in elementary education, which are rare in the field. However, the limitations of this study—particularly the use of a questionnaire to measure preferences and the non-experimental design—should be taken into account. Future research is recommended to use experimental or quasi-experimental designs to evaluate the effectiveness of multimodal learning strategies and to control for relevant confounding factors. Methodologically, these results indicate that the study remains correlational and that learning styles were measured through a self-report questionnaire; therefore, it cannot establish a causal relationship and does not control for confounders such as prior ability, variation in teachers' instructional strategies, and learning motivation. Further studies are advised to employ quasi-experimental or experimental designs using a pretest–posttest model and to include relevant covariates in order to test more convincingly the effectiveness of multimodal instruction in improving students' conceptual understanding of IPAS.

These research results are very promising for educational applications, especially for teachers and primary schools. The fact that learning styles have a significant impact on the comprehension of the concepts of IPAS students also tells teachers the urgency of identifying and adjusting their teaching strategies to students' learning styles. Appropriate interventions—such as introducing visual media, kinesthetic exercises, and multisensory methods—can enhance learning and mitigate disparities in student achievement. For educational policy makers, the findings further underscore the need for teacher education in the identification of learning styles and the formulation of differentiated instructional methods. In a more general sense, this work may also provide the basis for designing curricula suited to the individual learning needs, for enhancing conceptual understanding, especially in courses such as IPAS that require linking theory and practice. To ensure that instructional recommendations do not rely on overly strong claims about matching teaching to learning styles, the suggested strategy is to enrich IPAS learning with a multimodal approach, such as using visual representations, well-structured verbal explanations, and hands-on activities or simple experiments. This approach remains consistent with the study's findings, while being theoretically safer because it does not lock students into a single learning-style label.

6. Conclusion

Based on the analysis of 34 fourth-grade students at SD Alam Islami, this study shows that learning styles (visual, auditory, and kinesthetic) have a positive and significant relationship with IPAS conceptual understanding. The significance test for the correlation coefficient indicates that the calculated t-value is t = 4.646, which is greater than the critical t-value of 1.998 (α = 0.05); therefore, H_0 (r = 0) is rejected, suggesting a meaningful association between the two variables. The correlation coefficient of r = 0.575 falls into the moderately strong category, and the coefficient of determination r^2 = 0.3306 (33.06%) indicates that part of the observed variation in IPAS conceptual understanding is associated with variation in learning-style scores, while the remaining 66.94% is related to other factors.

Limitation

This study's limitations should be noted. The first limitation was that the sample size was 34 4th grade students from a single school, Alam Islami Elementary School, which means the results cannot be generalized to other schools as of now. Secondly, the determination of learning styles by means of questionnaires may suffer from the subjectivity of the students. Third, the study focused only on the influence of learning styles on conceptual understanding and did not take into account other variables such as teaching strategies, motivation and the learning context. Besides, the assessment of conceptual understanding relied exclusively on multiple-choice instruments, which may not be adequate for evaluating students' deep understanding. However, it is important to emphasize that this study used a non-experimental design, so the findings cannot be interpreted as a cause–effect relationship. In other words, the results do not prove that learning styles cause improvements in conceptual understanding; rather, they indicate that the two are associated within the context and sample examined. Practically, these findings support the importance of multimodal and differentiated instruction (for example, combining visualizations, well-structured verbal explanations, and hands-on activities or simple experiments) to better respond to the diversity of students' learning preferences, without locking students into a single learning-style label.

Recommendation

From the results, some recommendations can be drawn. It is recommended that teachers be aware of their students' learning styles and adapt their teaching style to suit them in order to increase the effectiveness of the learning process and the motivation of the students. Teacher training should be provided in school for the use of instructional approaches related to students' traits. Future studies may consider a larger diverse sample and additional variable like motivation of learning, learning environment, and teaching methods to provide more robust findings. Further, the employment of other types of measurement tools, for example observations or interviews could contribute to a deeper insight into the connection between learning styles and conceptual understanding of students. To strengthen the evidence, future research is recommended to use quasi-experimental or experimental designs (e.g., a pretest–posttest design), involve a larger and more diverse sample, and include important covariates (such as prior ability and motivation) so that the observed relationship can be tested more rigorously and the risk of confounding effects can be minimized.

Declaration of Generative AI and AI-assisted Technologies

This manuscript was prepared with the assistance of Generative AI tools (Grammarly and QuillBot) for language refinement and formatting organization. All intellectual contributions, critical analyses, and final revisions were conducted by the authors. The authors take full responsibility for the accuracy, originality, and integrity of the content presented in this work.

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