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A DIAGNOSTIC ANALYSIS OF ELEMENTARY SCHOOL STUDENTS' MISCONCEPTIONS ABOUT MAGNETISM

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ABSTRACT

Misconceptions in elementary science education remain a significant challenge because they hinder students from developing scientifically accurate conceptual understanding. This study aimed to analyze the misconceptions of fifth-grade elementary school students regarding the use of magnets in everyday life and to identify the instructional factors contributing to the persistence of these misconceptions. A qualitative case study involved five students, one teacher, and one principal, using observations, interviews, and documents. The findings revealed three categories of students' conceptual understanding: misconceptions, partial understanding, and irrelevant conceptions. Students commonly believed that magnets attract all metals, that magnetic force is distributed evenly across the entire magnet, that magnetic strength remains constant regardless of distance, and that magnets function solely through attraction rather than both attraction and repulsion. Partial understanding was evident when students recognized that magnets can attract objects without direct contact and that magnetic fields can penetrate paper, yet they were unable to provide scientifically accurate explanations. Irrelevant conceptions emerged when students relied primarily on everyday experiences without connecting them to accepted scientific principles. The persistence of these misconceptions was associated with instructional practices that emphasized observation over conceptual explanation, limited opportunities for scientific reasoning, and the absence of diagnostic assessment and conceptual change strategies. These findings highlight the importance of incorporating diagnostic assessment, inquiry-based experimentation, conceptual change instruction, visual representations, and explicit scientific explanations to strengthen elementary students' understanding of magnetism and improve the quality of science learning in primary education.
Keywords: misconceptions, magnetism, conceptual understanding, change, elementary science.

INTRODUCTION

The 21st century demands critical thinking skills to adapt to the rapid advancement of science and technology. In the educational context, these skills manifest in scientific literacy competencies, defined as the ability to understand scientific concepts and apply them in everyday life (Kasse & Atmojo, 2021). Science and Social Sciences (IPAS) learning in elementary schools plays a strategic role in developing students' scientific literacy through systematic and contextual introduction to natural phenomena (Putra, Ida Bagus, & I Nyoman, 2024). However, the implementation of IPAS learning in the Merdeka Curriculum era still faces various challenges, particularly in achieving students' conceptual understanding (Kasanah & Setiyawati, 2024a). This challenge arises because the learning process has not fully integrated inquiry-based approaches and supporting experiments, leaving students able to master factual knowledge but unable to establish connections among scientific concepts (Ariantara, Sastri, & Dharma Putra, 2023).

Misconceptions are not simply incorrect answers but stable cognitive structures that influence how students interpret scientific phenomena. Because misconceptions often arise from everyday experiences, they are resistant to conventional instruction and may persist despite repeated classroom instruction. Consequently, identifying misconceptions is essential for designing instructional strategies that promote conceptual change. This condition has implications for the emergence of misconceptions, defined as understandings that do not align with established scientific concepts (Utami, Marwoto, & Sumarni, 2022). Misconceptions are not merely knowledge gaps but alternative cognitive structures that students actively construct from daily experiences and incomplete learning processes (Dewi & Ibrahim, 2019). According to Fariza et al. (2025), misconceptions are incorrect understandings or interpretations of scientific concepts that can hinder successful science learning, as students bring flawed cognitive frameworks into subsequent learning processes. Consequently, the identification and remediation of misconceptions have become critical priorities for improving the quality of science education at the elementary level, as undetected misconceptions will persist and complicate the understanding of more complex concepts at higher educational levels.

The phenomenon of misconceptions in science learning has been documented in various studies at both international and national levels. Research by Sadevi & Sayekti (2023a) revealed the importance of identifying misconceptions to enhance students' conceptual understanding, emphasizing that misconceptions are systematic and persistent rather than merely incidental errors Dewi & Ibrahim (2019) findings reinforced this by demonstrating that conceptual misconceptions in science learning require specific pedagogical interventions to be effectively addressed, as misconceptions are formed through a long process of knowledge construction involving prior learning experiences. In the context of magnetism, Prahasdita, Ngazizah, and Ratnaningsih (2025) found that elementary school students exhibit significant misconceptions about magnet applications and mechanisms of action, particularly regarding the connection between theoretical ideas and real-world situations. Research by Ngazizah, Adilah, Prahasdita, Rahma, & Syarifah (2024) confirmed that magnet-related material remains a persistent source of misconceptions among elementary students, with common errors including the belief that a magnet's magnetic field exists only at the ends and that its mechanism of action is solely based on attraction. Collectively, these findings indicate that misconceptions about magnetism are a widespread problem requiring serious attention from educators and researchers alike.

Although various studies have identified misconceptions about magnets, most have used quantitative assessment instruments to measure the extent of these misconceptions without exploring in depth the cognitive processes and instructional factors that contribute to their formation (Kismiati & Hutasoit, 2024a). Quantitative approaches are indeed effective for measuring the prevalence of misconceptions, but they have limitations in explaining why and how these misconceptions form and persist within students' cognitive structures. Furthermore, previous studies have not systematically distinguished between different types of misconceptions, namely conceptual and interpretive misconceptions, nor have they distinguished them from partial understanding and irrelevant conceptions. This distinction is crucial because each type of misconception requires different remediation strategies; therefore, a one-size-fits-all approach to addressing misconceptions will not be effective.

Another identified gap is the limited analysis of instructional factors that contribute to the persistence of misconceptions, particularly in the context of implementing the Merdeka Curriculum in Indonesia. However, Kusnadi, Febiani Musyadad, and Fauzi Heka Perdana (2020) have shown that teaching methods, media, and learning approaches are determining factors in the progress of understanding magnetic concepts. Harefa & Humendru's (2024) findings also indicate that magnets are not merely theoretical concepts but have real benefits in everyday life. However, students' inability to connect concepts to applications indicates a significant gap in science instruction, most likely due to a lack of learning design intentionally structured to build deep conceptual understanding. Therefore, an in-depth exploration of students' cognitive processes and instructional factors influencing misconception formation is urgently needed to produce evidence-based pedagogical recommendations.

Based on these identified deficiencies, this investigation offers novelty in three main areas. First, this study uses a qualitative approach with a case study design to deepen understanding of students' cognitive processes as they learn magnetic concepts. It distinguishes conceptual misconceptions, interpretive misconceptions, partial understanding, and irrelevant conceptions, mapping each category to specific conceptual aspersions. Therefore, this study aims to analyze the misconceptions of fifth-grade elementary school students regarding the use of magnets in everyday life, identify the conceptual aspects in which these misconceptions arise, distinguish them from partial understanding and irrelevant conceptions, and examine the instructional factors that contribute to their persistence. The findings are expected to provide evidence for developing diagnostic assessment tools, evidence-based instructional strategies, and conceptual change approaches that improve conceptual understanding of magnetism in elementary science education.

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LITERATURE REVIEW

Constructivist Learning Theory as the Grand Theory

This study is grounded in Constructivist Learning Theory, which serves as the overarching theoretical foundation for explaining how elementary school students develop scientific understanding. Constructivism posits that knowledge is not transmitted directly from teachers to learners but is actively constructed through the interaction between learners' prior knowledge and new learning experiences (Wardani, Putri Zuani, & Kholis, 2023a). According to Piaget 1970, cognitive development occurs through the complementary processes of assimilation and accommodation, whereby learners continuously reorganize their cognitive structures in response to new experiences. When prior conceptions differ from scientifically accepted explanations, students may develop alternative conceptions that, if not challenged through appropriate learning experiences, gradually become misconceptions (Cakir, 2008b).

Within the constructivist perspective, conceptual understanding is regarded as the outcome of successful knowledge construction. Students demonstrate conceptual understanding when they can explain scientific phenomena accurately, relate concepts across contexts, apply scientific principles to solve problems, and distinguish scientific explanations from intuitive beliefs (Kasanah & Setiyawati, 2024a; Ningsih, Wahyuni, Fauziah, & Desfitri, 2022). Consequently, meaningful science learning requires instructional practices that actively engage students in constructing, evaluating, and refining their scientific understanding rather than memorizing factual information (Ariantara et al., 2023).

Constructivist Learning Theory and Conceptual Change

This study is primarily grounded in Constructivist Learning Theory, which serves as the overarching theoretical framework for explaining how elementary school students develop scientific understanding. Constructivism asserts that knowledge is actively constructed through learners' interactions with their environment rather than passively transmitted from teachers to students (Wardani et al., 2023). Through the processes of assimilation and accommodation, learners continuously reorganize their cognitive structures to integrate new experiences with prior knowledge, resulting in progressively more sophisticated conceptual understanding (Rahmaniar, Maemonah, & Mahmudah, 2021). Within science education, this perspective has become a fundamental theoretical foundation because students' initial conceptions determine how they interpret scientific phenomena and whether they can achieve scientifically accurate understanding (Cakir, 2008). Recent studies further demonstrate that constructivist learning effectively promotes inquiry, conceptual understanding, and scientific reasoning in elementary science education by encouraging learners to construct evidence-based explanations actively rather than memorizing isolated scientific facts (Astuti, Bhakti, & Prasetya, 2021; Kismiati & Hutasoit, 2024a). Building upon the constructivist perspective, this study adopts. Conceptual Change Theory was proposed by Posner et al. (1982) to explain the cognitive processes through which misconceptions are maintained and reconstructed. Therefore, misconceptions cannot be corrected merely by providing scientifically accurate information, as students tend to preserve explanations consistent with their prior experiences (Voutsina & Ravanis, 2011).

The relevance of these theoretical perspectives is strengthened by Piaget's Theory of Cognitive Development, which explains the developmental characteristics of the participants involved in this study. Fifth-grade elementary school students are generally in the concrete operational stage, during which they demonstrate logical reasoning but continue to rely on concrete experiences to understand abstract scientific concepts (Adi Sanjaya, Ni Ketut Suarni, & I Gede Margunayasa, 2024). At this developmental stage, students are capable of classifying objects, recognizing observable causal relationships, and solving concrete problems; however, they frequently encounter difficulties when interpreting invisible scientific phenomena, including magnetic fields, magnetic interactions, and the relationship between distance and magnetic force. Consequently, effective science instruction requires experimentation, visualization, contextual learning, and explicit scientific explanations to facilitate conceptual reconstruction and minimize misconceptions (Kusnadi et al., 2020).

The research is situated within the context of Ilmu Pengetahuan Alam dan Sosial (IPAS) implemented through the Merdeka Curriculum, which emphasizes inquiry-based learning, scientific investigation, and contextual problem solving as essential components of elementary science education (Marwa, Usman, & Qodriani, 2023). Rather than emphasizing factual memorization, IPAS encourages students to develop conceptual understanding by investigating natural phenomena and connecting scientific knowledge with everyday experiences (Harefa & Humendru, 2024; Kasse & Atmojo, 2021). These characteristics are conceptually aligned with Constructivist Learning Theory because both emphasize that meaningful learning occurs when students actively construct knowledge through authentic learning experiences and social interaction. Therefore, the implementation of IPAS provides an appropriate educational context for examining how elementary school students construct a scientific understanding of magnetism and why misconceptions persist despite inquiry-oriented instruction.

Based on this theoretical framework, the present study investigates three primary constructs, namely misconceptions, partial understanding, and irrelevant conceptions.

Misconceptions are scientifically inaccurate beliefs that are persistently held because they are supported by learners' existing cognitive structures rather than by accepted scientific principles. Partial understanding refers to incomplete conceptual understanding in which students correctly recognize selected scientific concepts but fail to explain the underlying scientific mechanisms comprehensively (Janah & Hidayati, 2025; Ningsih et al., 2022). These constructs are examined across six conceptual dimensions of magnetism: magnetic properties; magnetic and non-magnetic materials; magnetic attraction without direct contact; magnetic fields; the relationship between distance and magnetic force; and magnetic attraction and repulsion. Distinguishing these dimensions enables a more comprehensive analysis of students' conceptual understanding, as each reflects a distinct stage of cognitive construction and conceptual development within the constructivist learning process. Consequently, this integrated theoretical framework establishes a coherent conceptual basis for interpreting students' understanding of magnetism while explaining how cognitive development and classroom instruction contribute to the formation and persistence of misconceptions.

METHODOLOGY

This study employed a qualitative approach, using a descriptive case study design, to gain an in-depth understanding of elementary school students' misconceptions about the application of magnetism in everyday life. A qualitative case study was considered appropriate because it enables researchers to explore participants' conceptual understanding within their natural educational context and to examine how misconceptions are formed, maintained, and interpreted through direct interaction with participants. The study focused on describing the characteristics of students' conceptions rather than measuring the effectiveness of an instructional intervention.

The research was conducted at a public elementary school in East Jakarta, Indonesia, involving fifth-grade students who had previously studied magnetism in science. Participants were selected through purposive sampling in collaboration with the classroom teacher. The selection considered students' academic performance, classroom participation, and preliminary diagnostic results to ensure the inclusion of students representing different levels of conceptual understanding. The primary participants consisted of five students representing distinct levels of conceptual understanding. At the same time, the fifth-grade classroom teacher and the school principal served as supporting informants, providing contextual information on science instruction and classroom learning practices.

Data were collected through classroom observations, semi-structured in-depth interviews, and document analysis. Classroom observations were conducted to examine the implementation of science instruction, teacher instructional practices, student participation, and learning situations that may have contributed to conceptual understanding or misconceptions. Field notes were systematically recorded throughout the observation process to capture learning interactions and contextual factors.

Semi-structured interviews constituted the primary data collection technique. Individual interviews were conducted with each student using open-ended questions designed to explore students' conceptual understanding of magnetic properties, magnetic interactions, magnetic and non-magnetic materials, magnetic force, magnetic poles, the influence of distance on magnetic attraction, and the application of magnets in everyday life. Follow-up probing questions were employed to clarify participants' reasoning and identify whether their responses reflected scientifically accurate conceptions, partial understanding, irrelevant conceptions, or misconceptions. Additional interviews with the classroom teacher and the school principal were conducted to gather information on instructional strategies, students' learning characteristics, classroom experiences, and efforts to address misconceptions during science instruction.

Document analysis was used as a complementary source of evidence by examining students' assessment records, instructional modules, lesson materials, and other relevant school documents related to learning about magnetism. These documents provided supporting information for interpreting students' conceptual understanding and for triangulating findings from observations and interviews.

The research instruments consisted of observation guidelines, semi-structured interview protocols, and documentation sheets, developed from indicators of conceptual understanding of magnetism derived from the elementary science curriculum and relevant literature. Prior to data collection, all research instruments were reviewed and validated by experts in elementary science education to ensure content validity, conceptual appropriateness, and alignment with the research objectives.

The credibility of the findings was enhanced through source triangulation by comparing information obtained from students, the classroom teacher, the school principal, classroom observations, and documentary evidence. Member checking was also conducted by confirming interpretations of the interviews with participants to improve the accuracy of the collected data. Furthermore, prolonged engagement during field observations enabled the researcher to gain a comprehensive understanding of the learning context and strengthened the trustworthiness of the findings.

Data were analyzed using the interactive model proposed by Miles & Huberman (2014), which consists of four interconnected stages: data collection, data condensation, data display, and conclusion drawing and verification. During the data condensation stage, interview transcripts, observation notes, and documentary evidence were coded and organized according to predetermined analytical categories while allowing new themes to emerge inductively. Subsequently, the organized data were presented through descriptive matrices and thematic narratives to facilitate interpretation. Finally, conclusions were continuously verified by comparing findings across multiple data sources to ensure consistency and credibility.

Students' responses were classified into four conceptual categories: (1) scientific understanding, indicating responses consistent with accepted scientific concepts; (2) partial understanding, referring to incomplete but generally correct explanations; (3) misconceptions, representing scientifically incorrect conceptions that were consistently maintained with high confidence; and (4) irrelevant conceptions, indicating responses unrelated to the scientific concepts being investigated. This categorization enabled a comprehensive analysis of students' conceptual profiles regarding the application of magnetism in everyday life while identifying specific conceptual aspects that require instructional improvement (Supriani, Priyantoro, et al., 2026; Supriani, Rosanti, et al., 2026).

Ethical considerations were maintained throughout the research process. Permission to conduct the study was obtained from the school administration prior to data collection. All participants and their parents or guardians received information regarding the research objectives and voluntarily agreed to participate. Participants' identities were kept confidential using pseudonyms, and all collected data were used solely for academic research purposes.

RESULT AND DISCUSSION

Based on the findings of this study, obtained through observation, interviews, and documentation, fifth-grade elementary school students hold misconceptions about magnets. Most students demonstrated an understanding of magnetism that did not align with scientific concepts because they were accustomed to understandings derived from everyday experiences without proper explanations of scientific phenomena. A case study identified by the researcher revealed various indicators of misconceptions, as follows:

Students' Belief That Magnets Can Attract All Metal Objects

For this indicator, an interpretive misconception was identified among all five participants. All students believed that a magnet could attract all metal objects. This understanding arises from their experience of magnets attracting metal objects such as nails, needles, and pins. For instance, Student A stated: "I think magnets can attract all metals because I saw magnets attract nails, needles, and pins in the classroom" (Student A, interview, Apr 30, 2026). Similarly, Student A explained: "Magnets can attract all metals because they are all metal" (Student A, interview, Apr 30, 2026).

This response indicates that students generalized from limited learning experiences and categorized objects by visible appearance rather than by scientific properties. Students associated the shiny or metallic surface of an object with magnetic attraction, even though magnetism is determined not by metallic appearance but by a material's magnetic properties. From a scientific standpoint, only ferromagnetic materials such as iron, nickel, and cobalt are strongly attracted to magnets.

The document analysis of the teaching module supported this finding. The teaching module revealed that learning activities were limited to students observing objects that can be attracted by magnets and responding to questions about objects around them that magnets can attract. The module did not explicitly guide teachers to compare various types of metals. Consequently, learning activities only reinforced students' initial experiences without expanding their understanding.

Students' Understanding of Magnets That Can Attract Objects Without Touching Them

For this indicator, most students already understand that magnets can attract objects without direct contact. However, this understanding is not yet conceptual, as students are unable to explain its reason or the role of the magnetic field. Students only understand that objects can move toward a magnet when they are at a certain distance, but they do not yet understand how magnets work.

This finding indicates a difference between knowing a phenomenon and understanding the correct concept. Students know that magnets can work without direct contact because they have observed it in experiments. However, this understanding is still basic. Therefore, students are not entirely wrong, but they cannot yet provide a complete scientific explanation.

Students' Understanding of Which Part of a Magnet Has the Strongest Attractive Force

Regarding the indicator of which part of a magnet has the strongest attractive force, most students exhibited conceptual misconceptions. Some students believed that all parts of a magnet have the same strength. This understanding does not align with the actual scientific concept, as the strongest magnetic force is located at the poles. When students do not understand this, they will have difficulty explaining why objects are more strongly attracted to the ends of a magnet

Students' Understanding of Magnetic Fields Penetrating Paper

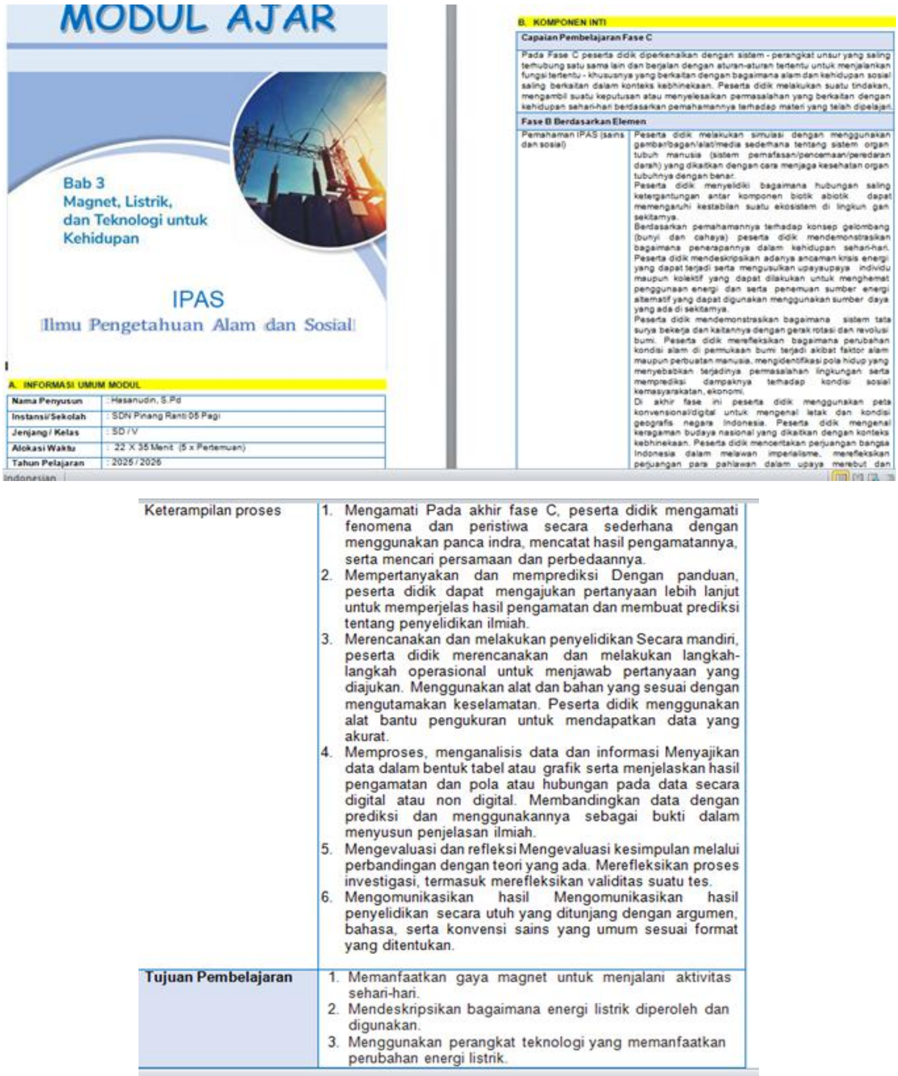
For this indicator, students' understanding showed a better grasp than in the previous indicator. Students have observed that a magnet can penetrate paper; however, this understanding remains empirical because some students cannot yet explain why the magnetic field penetrates the paper. This finding indicates that concrete experiments can help students recognize magnetic phenomena but do not yet fully explain scientific concepts accurately.

Students' Understanding of the Effect of Distance on the Strength of Magnetic Force

In this indicator, it was found that most students still do not understand the relationship between distance and the strength of magnetic force. Students assume that as long as a magnet can still attract an object, the magnetic force acts with the same strength. This indicates a conceptual misconception because students have not yet been able to distinguish between the presence of a magnetic force and its magnitude. Physically, the magnetic force weakens as the distance between the object and the magnet increases. To understand this concept, students need to engage in experiment-based learning with measurable observations.

Students' Understanding of Attractive and Repulsive Forces in Magnets

In this indicator, students do not yet fully understand that interactions between magnets can be attractive or repulsive, depending on the orientation of the opposing poles. In daily life, students more often observe magnets attracting objects, so the repulsive force of magnets is less familiar to them. If a magnet can still attract an object, then the magnetic force acts with the same strength. This indicates a conceptual misconception because students are not yet able to distinguish between the presence of a magnetic force and its magnitude. Scientifically, the magnetic force weakens as the distance between the object and the magnet increases. To understand this concept, students need to engage in experiment-based learning with measurable observations.



MODUL AJAR

Bab 3
Magnet, Listrik, dan Teknologi untuk Kehidupan

IPAS
Ilmu Pengetahuan Alam dan Sosial

A. INFORMASI UMUM MODUL

Nama Penyusun	: Hasanudin, S.Pd
Instansi/Sekolah	: SDN Pinang Ranti 05 Pagi
Jenjang / Kelas	: SD / V
Alokasi Waktu	: 22 X 35 Menit (5 x Pertemuan)
Tahun Pelajaran	: 2025 / 2026

B. KOMPONEN INTI

Capaian Pembelajaran Fase C	
Pada Fase C peserta didik diperkenalkan dengan sistem - perangkat unsur yang saling terhubung satu sama lain dan berjalan dengan aturan-aturan tertentu untuk menjalankan fungsi tertentu - khususnya yang berkaitan dengan bagaimana alam dan kehidupan sosial saling berkaitan dalam konteks kebhinekaan. Peserta didik melakukan suatu tindakan, mengambil suatu keputusan atau menyelesaikan permasalahan yang berkaitan dengan kehidupan sehari-hari berdasarkan pemahamannya terhadap materi yang telah dipelajari.	
Fase B Berdasarkan Elemen	
Pemahaman IPAS (sains dan sosial)	Peserta didik melakukan simulasi dengan menggunakan gambar/bagan/alat/media sederhana tentang sistem organ tubuh manusia (sistem pernafasan/pencernaan/peredaran darah) yang dikaitkan dengan cara menjaga kesehatan organ tubuhnya dengan benar. Peserta didik menyelidiki bagaimana hubungan saling ketergantungan antar komponen biotik abiotik dapat memengaruhi kestabilan suatu ekosistem di lingkungan sekitarnya. Berdasarkan pemahamannya terhadap konsep gelombang (bunyi dan cahaya) peserta didik mendemonstrasikan bagaimana penerapannya dalam kehidupan sehari-hari. Peserta didik mendeskripsikan adanya ancaman krisis energi yang dapat terjadi serta mengusulkan upayaupaya individu maupun kolektif yang dapat dilakukan untuk menghemat penggunaan energi dan serta penemuan sumber energi alternatif yang dapat digunakan menggunakan sumber daya yang ada di sekitarnya. Peserta didik mendemonstrasikan bagaimana sistem tata surya bekerja dan kaitannya dengan gerak rotasi dan revolusi bumi. Peserta didik merefleksikan bagaimana perubahan kondisi alam di permukaan bumi terjadi akibat faktor alam maupun perbuatan manusia, mengidentifikasi pola hidup yang menyebabkan terjadinya permasalahan lingkungan serta memprediksi dampaknya terhadap kondisi sosial kemasyarakatan, ekonomi. Di akhir fase ini peserta didik menggunakan peta konvensional/digital untuk mengenal letak dan kondisi geografis negara Indonesia. Peserta didik mengenal keragaman budaya nasional yang dikaitkan dengan konteks kebhinekaan. Peserta didik menceritakan perjuangan bangsa Indonesia dalam melawan imperialisme, merefleksikan perjuangan para pahlawan dalam upaya merebut dan

Keterampilan proses	1. Mengamati Pada akhir fase C, peserta didik mengamati fenomena dan peristiwa secara sederhana dengan menggunakan panca indra, mencatat hasil pengamatannya, serta mencari persamaan dan perbedaannya. 2. Mempertanyakan dan memprediksi Dengan panduan, peserta didik dapat mengajukan pertanyaan lebih lanjut untuk memperjelas hasil pengamatan dan membuat prediksi tentang penyelidikan ilmiah. 3. Merencanakan dan melakukan penyelidikan Secara mandiri, peserta didik merencanakan dan melakukan langkah-langkah operasional untuk menjawab pertanyaan yang diajukan. Menggunakan alat dan bahan yang sesuai dengan mengutamakan keselamatan. Peserta didik menggunakan alat bantu pengukuran untuk mendapatkan data yang akurat. 4. Memproses, menganalisis data dan informasi Menyajikan data dalam bentuk tabel atau grafik serta menjelaskan hasil pengamatan dan pola atau hubungan pada data secara digital atau non digital. Membandingkan data dengan prediksi dan menggunakannya sebagai bukti dalam menyusun penjelasan ilmiah. 5. Mengevaluasi dan refleksi Mengevaluasi kesimpulan melalui perbandingan dengan teori yang ada. Merefleksikan proses investigasi, termasuk merefleksikan validitas suatu tes. 6. Mengomunikasikan hasil Mengomunikasikan hasil penyelidikan secara utuh yang ditunjang dengan argumen, bahasa, serta konvensi sains yang umum sesuai format yang ditentukan.
Tujuan Pembelajaran	1. Memanfaatkan gaya magnet untuk menjalani aktivitas sehari-hari. 2. Mendeskripsikan bagaimana energi listrik diperoleh dan digunakan. 3. Menggunakan perangkat teknologi yang memanfaatkan perubahan energi listrik.

Figure 1Distribution of Student Misconceptions Across Six Conceptual Indicators

DISCUSSION

The findings of this study reveal that fifth-grade elementary school students still experience misconceptions regarding the utility of magnets in everyday life. These misconceptions are not limited to factual inaccuracies; they also reflect greater conceptual difficulties in understanding magnetic objects, magnetic force, magnetic poles, magnetic fields, the relationship between distance and magnetic strength, and magnetic interactions. The dominance of conceptual misconceptions indicates that students' responses are shaped by prior knowledge, everyday observations, and classroom experiences that have not yet been reconstructed into scientifically valid concepts.

Viewed through Constructivist Learning Theory, students' misconceptions about magnets can be understood as the result of active knowledge construction. Students do not enter the classroom as empty recipients of information; rather, they bring prior experiences that influence how they interpret scientific phenomena. When these prior experiences are limited, incomplete, or not clarified through systematic instruction, students may construct alternative explanations that appear logical from their perspective but differ from accepted scientific concepts. This position is consistent with Dewi & Ibrahim (2019), who explain that misconceptions are not merely the absence of knowledge but alternative cognitive structures formed through students' interpretation of learning experiences. Similarly, Sadevi & Sayekti (2023) emphasize that identifying misconceptions is essential, as such conceptions tend to persist without appropriate pedagogical intervention.

One major finding concerns students' misunderstanding of magnetic and non-magnetic materials. Several students assumed that magnets could attract all metallic objects. This response indicates a tendency to classify objects by visible appearance rather than by scientific properties. Students associated the shiny or metallic surface of an object with magnetic attraction, even though magnetism is not determined by metallic appearance but by the material's magnetic properties. Scientifically, only certain materials, particularly ferromagnetic materials such as iron, nickel, and cobalt, are strongly attracted to magnets. Therefore, when students categorize aluminum, coins, or all metal objects as magnetic, their reasoning reflects overgeneralization from everyday experience. From a constructivist perspective, this misconception arises because students derive meaning from repeated yet limited observations. When they often see magnets attracting nails, paper clips, or iron objects, they generalize that all metals must have the same magnetic property. This form of reasoning shows that students' prior knowledge has not been challenged by sufficient empirical evidence. If classroom learning does not provide opportunities to directly compare various materials, students may retain the belief that "metal" and "magnetic" are identical categories. This finding is in line with Ngazizah, Adilah, et al. (2024), who found that magnet-related material remains a common source of misconceptions among elementary school students. It also supports Prahasdita et al. (2025), who reported that students often have difficulty connecting theoretical explanations of magnets to real-world situations.

This finding can be interpreted through Piaget's Theory of Cognitive Development. Fifth-grade elementary school students are generally in the concrete operational stage, where logical reasoning begins to develop but remains closely tied to concrete objects and direct experiences. At this stage, students can understand that a magnet attracts certain objects, but they may struggle to explain invisible and abstract concepts such as magnetic fields. Consequently, when magnetic force acts without contact, students tend to describe what they see rather than explain why it occurs. Kismiati & Hutasoit (2024) also emphasize that abstract science concepts require visualization to bridge concrete experience and formal scientific explanation. Without appropriate visualization, students may develop fragmented or superficial understanding.

This finding is consistent with Prilandi et al. (2025), who reported that elementary students often misunderstand the mechanism of magnetic action and reduce it merely to attraction. It also aligns with Harefa & Humendru (2024), who argue that magnets should not be treated solely as theoretical content, as their practical benefits are closely tied to students' ability to understand the concept in everyday contexts. Nevertheless, the present study differs from previous studies by showing that students' difficulty is not solely due to unfamiliarity with the term "magnetic force." Instead, the difficulty lies in connecting the visible phenomenon of attraction with the invisible concept of a magnetic field.

Students' Understanding of Magnetic Poles

Another important finding of this study concerns students' misconceptions regarding magnetic poles. Although several participants correctly identified that magnets possess two poles, many were unable to explain the scientific principle governing magnetic interactions. Some students believed that magnets always attract regardless of pole orientation, whereas others assumed that repulsion occurs randomly, without considering the relationship between like and unlike poles. These responses demonstrate that students possess fragmented knowledge, in which isolated facts are remembered but the underlying conceptual relationships remain poorly integrated.

Constructivist Learning Theory provides a meaningful explanation for this finding. Knowledge is actively constructed through learners' interaction with their environment; therefore, students frequently interpret new scientific information based on prior experiences rather than established scientific principles. During interviews, students commonly referred to observations of magnets attaching to metallic objects encountered in everyday life. However, they had limited opportunities to observe interactions between two magnets with different pole orientations. As a result, students generalized magnetic attraction as the only possible interaction because this interpretation appeared consistent with their daily experiences. Such reasoning illustrates that misconceptions arise when incomplete empirical experience reinforces prior knowledge without sufficient conceptual clarification.

Piaget's Cognitive Development Theory further supports this interpretation. Students at the concrete operational stage generally understand scientific concepts more effectively when they manipulate objects directly. Although magnetic attraction is easily observed, magnetic repulsion requires more systematic experimentation because students must intentionally arrange identical poles to experience the phenomenon. Without repeated opportunities to manipulate magnets under different conditions, students may fail to establish logical relationships between pole orientation and magnetic interaction. Consequently, conceptual understanding remains dependent on isolated experiences rather than coherent scientific reasoning.

From the perspective of Conceptual Change Theory, this misconception indicates that students have not yet encountered sufficient cognitive conflict to reconstruct their prior understanding. Learning activities should therefore encourage students to formulate predictions regarding magnetic attraction at different distances, test those predictions experimentally, and evaluate discrepancies between their expectations and empirical evidence. Such experiences allow students to replace intuitive explanations with scientifically acceptable concepts through active conceptual reconstruction.

Students' Understanding of the Utility of Magnets in Everyday Life

The findings further demonstrate that students experienced difficulty connecting scientific concepts of magnetism with their practical applications in everyday life. Although participants were familiar with several common examples, such as refrigerator magnets, they generally had a limited understanding of the broader uses of magnets in technological devices, transportation systems, communication equipment, medical instruments, and household appliances. This finding suggests that students' conceptual knowledge remains compartmentalized and has not yet been integrated with authentic real-world contexts. According to Constructivist Learning Theory, meaningful learning occurs when students actively connect new knowledge with previous experiences. However, when classroom instruction emphasizes conceptual definitions without relating them to authentic contexts, students frequently perceive scientific knowledge as isolated information rather than as explanations of phenomena encountered in daily life. Consequently, students experience difficulty transferring classroom learning to practical situations beyond the school environment.

This interpretation is consistent with Harefa & Humendru (2024), who argued that magnetism should be introduced through contextual learning because magnets constitute an essential component of numerous technologies encountered in everyday life. Similarly, Kusnadi et al. (2020) emphasized that instructional approaches integrating practical activities and contextual learning significantly improve students' conceptual understanding of magnetic concepts. Nevertheless, the present study extends previous findings by demonstrating that students' inability to explain applications of magnets stems not only from limited factual knowledge but also from insufficient opportunities to connect scientific concepts to authentic experiences.

Furthermore, qualitative evidence from interviews indicates that students generally recognize objects containing magnets but cannot explain the scientific principles underlying their operation. This distinction is important because scientific literacy requires learners not only to identify technological products but also to understand the scientific concepts that underlie their functioning. Therefore, contextual science instruction should encourage students to investigate how magnets operate in familiar technologies rather than merely identifying examples of magnetic objects.

Theoretical Contribution

This study contributes to the literature by demonstrating that misconceptions concerning magnetism among elementary school students cannot be explained solely as deficiencies in factual knowledge. Instead, they emerge through interactions among students' prior experiences, developmental characteristics, and instructional practices. Constructivist Learning Theory provides the principal framework for explaining how students actively construct alternative conceptions from everyday experiences; Piaget's Cognitive Development Theory clarifies how learners' cognitive characteristics influence conceptual understanding; and Conceptual Change Theory explains why these misconceptions persist when instruction fails to promote conceptual reconstruction.

Unlike previous studies that primarily identified misconceptions using quantitative diagnostic instruments (Ngazizah, Adilah, et al., 2024; Prahasdita et al., 2025; Prilandi et al., 2025), the present qualitative case study provides deeper insight into the cognitive processes underlying students' reasoning and the instructional factors that contribute to misconception formation. Consequently, this study extends current understanding by explaining not only what misconceptions exist but also how they develop, why they persist, and how they may be addressed through theoretically informed instructional practices. These findings strengthen the theoretical foundation of elementary science education while providing practical guidance for the development of diagnostic assessment and evidence-based instructional strategies aimed at improving conceptual understanding of magnetism.

CONCLUSION

This study concludes that fifth-grade elementary school students still hold misconceptions about the use of magnets in everyday life, with conceptual misconceptions being more prevalent than interpretive ones. The misconceptions were identified across several indicators, including the types of objects magnets attract, magnetic attraction without direct contact, the strongest part of a magnet, magnetic fields, the relationship between distance and magnetic force, and the attractive and repulsive interactions between magnetic poles. These misconceptions arise not only from students' limited prior knowledge and everyday experiences but also from instructional practices that have not fully supported conceptual change. The analysis of classroom learning revealed that teaching activities primarily emphasized observation of magnetic phenomena without providing sufficient scientific explanations, diagnostic assessment, conceptual visualization, or structured conceptual reinforcement. Consequently, students tended to memorize observable phenomena rather than understand the underlying scientific principles. Therefore, improving students' conceptual understanding requires inquiry-oriented and experiment-based learning supported by concrete demonstrations, visual learning media, diagnostic assessments, and explicit scientific explanations that encourage conceptual change. Such instructional improvements are expected to minimize misconceptions and promote meaningful science learning in elementary schools

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