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Analysis of Conceptual Understanding of Tenth-Grade Science Students on the Topic of Viruses Based on Learning Styles at MA Raudlatus Syabab Jember

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Abstract Conceptual understanding is a critical aspect of learning, particularly in biology, where students must grasp complex and abstract concepts. This study investigates the relationship between students' learning styles and their comprehension of the topic of viruses in a tenth-grade science class at MA Raudlatus Syabab Jember during the 2023/2024 academic year. A qualitative descriptive approach was employed, utilizing questionnaires, observations, and interviews to gather data from 34 students and their biology teacher. The findings indicate that visual learners exhibit strong comprehension when using images, diagrams, and structured notes; auditory learners perform better when engaging in discussions and listening to verbal explanations; and kinesthetic learners achieve deeper understanding through hands-on activities and practical demonstrations. However, each learning style presents unique challenges that can hinder comprehension if instructional methods are not aligned with students' preferences. The study highlights the necessity of incorporating multimodal teaching strategies to cater to diverse learning styles, ensuring more effective knowledge retention and academic success.

Keywords: Conceptual understanding, Science students, Viruses, Learning styles

INTRODUCTION

Education is a structured process designed to guide new generations toward progress through methods that align with their abilities. It aims to develop students' human potential, including physical, intellectual, emotional, and moral capacities, so that these potentials become concrete and functional throughout

their lives (Leonidova, 2019; Kuzminov et al., 2019). Education is an essential need for every individual (Mendrofa et al., 2023). From birth, humans engage in educational activities, transitioning from an initial state of not knowing to gradually acquiring knowledge and skills. As individuals mature, education fosters their independence and intellectual growth (Noor & Dahyati, 2023).

The quality of education in a country significantly influences its development (Saâ, 2018; Tahir, 2017). A nation with poor educational quality will likely experience stagnation or regression. According to UNESCO, education serves as the key to national development, providing individuals with the necessary knowledge and skills to improve their lives and contribute to society. Unfortunately, Indonesia faces numerous educational challenges. A 2018 survey conducted by the Program for International Student Assessment (PISA) in 2019 ranked Indonesia 74th out of 79 countries in terms of secondary education quality, placing it among the lowest-performing nations (Schleicher, 2019), this trend was also observed in previous years (Nasution et al., 2023). This low ranking indicates the persistent struggles within Indonesia's education system, influenced by various factors, including student engagement, teacher effectiveness, economic conditions, infrastructure, and the learning environment.

The challenges in Indonesia's education system manifest at multiple levels, including input, process, and output (Efendi et al., 2024; Faridli et al., 2024). These three aspects are interconnected: the quality of input, such as students' readiness and resources, directly affects the learning process. In turn, the learning process determines the output, which influences students' future education and career paths. If students lack a solid foundation in fundamental subjects, their ability to grasp advanced concepts and apply knowledge in real-world settings may be compromised. Therefore, addressing issues in the learning process is crucial to improving overall educational outcomes.

Conceptual understanding is a student's ability to grasp subject matter beyond mere memorization (Astuti, 2017; Noviyani et al., 2017). It involves interpreting, applying, and expressing knowledge in a meaningful way. A student with strong conceptual understanding can explain ideas in their own words, draw connections between different concepts, and apply knowledge to new situations. Comprehension is one of vital indicator of learning success (Becker et al., 2021), as it determines how well students internalize and utilize information. If students fail to develop a clear understanding of fundamental concepts, their academic performance and ability to build upon previous knowledge may be hindered.

The learning process plays a significant role in shaping students' comprehension. Learning is an ongoing process through which individuals acquire knowledge and refine their cognitive abilities. During learning, students interact with educational materials, engage in discussions, and develop problem-solving skills (Karina et al., 2024; Nasution & Rizka, 2024; Prasetiyo & Rosy, 2021). Self-awareness is crucial in this process, as students must recognize their strengths and weaknesses to optimize their learning strategies (Anggoro et al., 2021). Without this self-

awareness, students may struggle to overcome challenges and fully engage with the learning material.

Recognizing one's own learning style is one of key step in enhancing educational experiences (Nasution et al., 2023). Learning styles refer to the preferred ways individuals absorb, process, and retain information. According to DePorter (2019), learning styles can be broadly categorized into three types: visual, auditory, and kinesthetic. Each style has distinct characteristics that influence how students engage with educational content. Visual learners prefer images, diagrams, and written materials (Alabi, 2024); auditory learners benefit from listening to explanations and discussions (Oladele & Mccall, 2024; Wahab & Nuraeni, 2020); and kinesthetic learners learn best through hands-on experiences and physical activities (Oladele, 2024, Blessing et al., 2024). Understanding these preferences is essential in designing effective teaching methods that accommodate diverse learning needs.

The Visual, Auditory, and Kinesthetic (VAK) learning approach combines these three styles to create a holistic learning experience. This approach emphasizes direct learning experiences, allowing students to strengthen their understanding through various sensory inputs. Visual learners engage through observation and visualization, auditory learners through listening and verbal communication, and kinesthetic learners through movement and practical activities (Bezo & Hala, 2021). By integrating multiple learning modalities, educators can enhance student engagement and comprehension.

This study emphasizes the importance of exploring students' conceptual understanding based on their learning styles. Each student has a unique preference for acquiring knowledge, some learn best by seeing, others by listening, and some through hands-on experiences. By acknowledging and accommodating these differences, education can become more inclusive and effective. When students engage with content in ways that align with their learning styles, they are more likely to retain information and perform better academically. This is especially crucial in subjects like biology, which involve abstract and complex concepts that require deep comprehension.

Based on an interview conducted on November 10, 2023, with a biology teacher at MA Raudlatus Syabab Jember, it was found that while some students achieved the minimum competency score in their biology assessments, others still faced difficulties in understanding conceptual material. Conceptual understanding is essential in biology, as mastering fundamental concepts facilitates learning in subsequent topics. If students struggle with basic concepts, they may find it challenging to grasp more advanced biological principles. Therefore, strengthening conceptual understanding is vital for academic success. Given the importance of conceptual comprehension in biology education, this study aims to investigate how students' learning styles influence their understanding of viruses.

METHOD

This study employed a qualitative research approach to explore students' conceptual understanding of viruses based on their learning styles in the tenth-grade science class at MA Raudlatus Syabab Jember during the 2023/2024 academic year. Qualitative research, as defined by Taylor et al. (2015), involves descriptive data collection in the form of written words, images, and observable behaviors rather than numerical data. This approach allows for a deeper understanding of students' learning processes in their natural environment without manipulation, making it particularly suitable for studying individual learning styles. The study aimed to describe students' learning activities based on visual, auditory, and kinesthetic (VAK) learning styles in the biology instruction.

A descriptive research design was utilized to systematically investigate students' comprehension of biological concepts without altering or manipulating the learning environment. Descriptive research aims to provide a detailed account of a particular phenomenon (Doyle et al., 2020), in this case, students' conceptual understanding of viruses in relation to their learning preferences. This study was conducted at MA Raudlatus Syabab Jember, an Islamic senior high school located in Dusun Krajan, Desa Sumber Wringin, Sukowono District, Jember Regency, East Java, Indonesia.

The subjects of this research were tenth-grade science students and their biology teacher. The sample consisted of 34 female students who participated in biology lessons. From this group, six students were selected for in-depth interviews, with two representing each of the three primary learning styles: two visual learners, two auditory learners, and two kinesthetic learners. This selection allowed for an in-depth analysis of the variations in conceptual understanding among different learning styles.

Data collection techniques included questionnaires, observations, and interviews to ensure a comprehensive understanding of students' learning styles and conceptual grasp of the subject matter. The questionnaire was used to identify students' learning styles based on characteristics outlined by Taylor et al. (2015). The questionnaire included statements related to students' learning preferences, with responses categorized into visual, auditory, and kinesthetic learning styles. Questions focused on students' preferred ways of acquiring and processing information, such as their inclination towards reading, listening, discussing, or engaging in hands-on activities.

Observations were conducted during biology lessons to examine students' behaviors, interactions, and engagement levels based on their identified learning styles. The researcher observed students' tendencies to read textbooks, listen attentively to explanations, ask questions, take notes, participate in discussions, and engage in practical learning activities. The observation process provided valuable insights into how different learning styles influenced students' comprehension and interaction with biological concepts, particularly regarding virus replication and characteristics.

In addition to questionnaires and observations, in-depth interviews were conducted to gain further insights into students' conceptual understanding and the challenges they faced in learning biology. The interviews focused on students' experiences with different instructional methods, their preferred ways of learning, and the difficulties they encountered when engaging with content that did not align with their learning style. The biology teacher was also interviewed to gain additional perspectives on how different learning styles impacted students' academic performance and classroom participation.

Data analysis followed the qualitative model developed by Miles et al. (2013), which includes data collection, data condensation, data display, and conclusion drawing. Data condensation involved selecting and simplifying relevant information by categorizing students' responses and behaviors based on their learning styles. Data display involved organizing the information into descriptive narratives to identify patterns and relationships among students' learning preferences and conceptual understanding. Finally, conclusions were drawn by verifying the findings and interpreting their implications for instructional strategies in biology education.

To ensure the validity and reliability of the data, the study employed triangulation techniques, including source triangulation and methodological triangulation (Sugiyono, 2013). Source triangulation involved comparing responses from students and teachers to validate the findings. Methodological triangulation was achieved by cross-checking data obtained from questionnaires, observations, and interviews. This approach ensured that the conclusions drawn from the study were accurate and reflective of students' actual learning experiences.

FINDINGS AND DISCUSSION

This study categorized students into three main learning styles: visual, auditory, and kinesthetic, identifying distinct comprehension patterns within each group. Based on the analysis of learning style questionnaire data completed by 34 students of Class X IPA at MA Raudlatus Syabab Jember, the results show that the majority of students demonstrate a preference for the Kinesthetic learning style. Out of the total respondents, 16 students (47.1%) were categorized as kinesthetic learners. The second most dominant learning style is the Visual learning style, with 15 students (44.1%) showing a preference. Finally, the Auditory learning style was the least common among the students, with only 3 students (8.8%) falling into this category. The following pie chart illustrates the proportion of each learning style among the students (Figure 1).

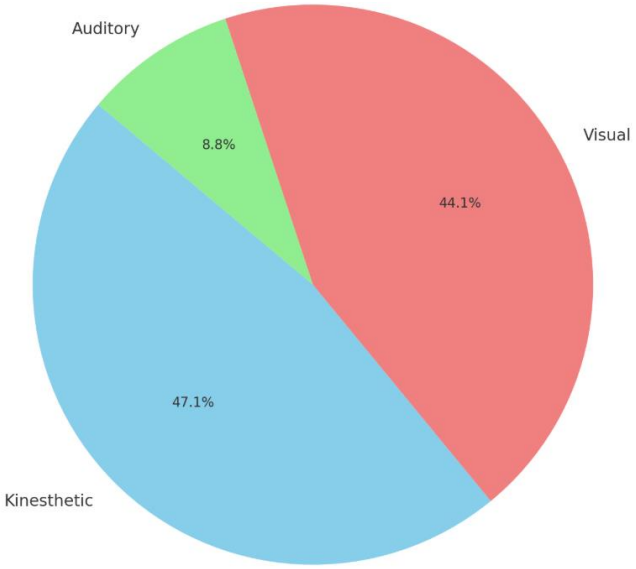

Figure 1. Distribution of Learning Styles in Class X IPA MA Raudlatus Syabab Jember.

Students with a visual learning style demonstrated a strong preference for graphical representations, images, and structured notes to enhance their understanding of biological concepts. These students exhibited highly organized and neat written responses, aligning with the theory that visual learners thrive on structured information. They benefited significantly from visual aids such as diagrams, concept maps, and video-based explanations, which facilitated the interpretation of complex biological processes such as virus replication. Their ability to summarize key concepts, compare biological entities, and draw logical inferences was notable. For example, they effectively differentiated between viruses and bacteria, illustrating the distinctions using graphical representations. Moreover, their skill in explaining cause-and-effect relationships, such as the role of handwashing in preventing viral infections, was evident through their ability to recall visual information and integrate it into logical explanations.

One possible reason why visual learners excel in processing structured information is the brain's natural affinity for pattern recognition. However, the main limitation observed in visual learners was their struggle with purely auditory instructional methods, as they found it challenging to retain information delivered solely through verbal lectures. This suggests that while visual learning enhances conceptual clarity, it requires supplemental auditory reinforcement to optimize retention and recall.

Auditory learners in the study displayed a strong reliance on listening and verbal interactions to grasp biological concepts. These students excelled in recalling information presented through lectures and discussions, preferring spoken explanations over written or visual materials. During interviews, auditory learners expressed a preference for learning through teacher explanations and peer discussions, as these methods reinforced their ability to process and retain information. They demonstrated strengths in summarizing key points, comparing biological structures, and drawing inferences based on verbal instruction. Their

comprehension of viral replication was facilitated by listening to detailed explanations rather than viewing diagrams.

A well-documented advantage of auditory learners is their ability to recall spoken information with high accuracy, particularly when it is structured into narratives or discussions (Oladele & Mccall, 2024). Research indicates that auditory learners often benefit from active participation in debates, oral presentations, and Socratic questioning techniques (Oladele & Mccall, 2024; Ananda & Hayati, 2020). However, their primary challenge lay in their limited engagement with visual and kinesthetic learning materials. They often struggled with written assessments and required verbal reinforcement to solidify their understanding of abstract concepts. This highlights the importance of integrating auditory-friendly teaching methods, such as recorded lectures or discussion-based activities, into science education to support these learners more effectively.

Kinesthetic learners exhibited a hands-on approach to learning, preferring experiential activities such as laboratory experiments, physical demonstrations, and active engagement with learning materials. These students performed best when involved in practical tasks that allowed them to manipulate objects, perform experiments, or participate in interactive activities. They reported higher retention rates when learning involved movement or direct engagement with the material, such as constructing models of viral structures or participating in group activities. Their strengths were evident in summarizing biological processes through practical demonstrations and providing concrete examples from real-world experiences.

This preference aligns with constructivist learning theories, which suggest that knowledge is best acquired through direct experience and active engagement (Zajda & Zajda, 2021; Abualhaija, 2019). Kinesthetic learners, therefore, excel in environments where inquiry-based learning and problem-solving tasks are emphasized. However, kinesthetic learners faced difficulties in traditional classroom settings where learning was primarily lecture-based (Blessing et al., 2024). They often found it challenging to focus during passive learning sessions and required more interactive and movement-based teaching strategies to maintain engagement. This challenge suggests that a shift toward more experiential learning, such as case studies, simulations, and project-based learning, could significantly benefit these students.

The findings highlight the necessity for differentiated instructional strategies to accommodate diverse learning preferences. Visual learners benefit from structured visual materials such as charts, concept maps, and videos, while auditory learners thrive in discussion-based environments that emphasize verbal explanations and storytelling. Kinesthetic learners require an active learning approach that incorporates hands-on activities, role-playing, and real-world applications. Given these variations, an inclusive teaching methodology that integrates multiple learning modalities would enhance student engagement and comprehension of complex biological topics.

Additionally, the study underscores the importance of aligning teaching methods with cognitive processes described in Anderson & Krathwohl's (2001) revised Bloom's taxonomy. Visual learners exhibited proficiency in interpreting information, classifying biological phenomena, and explaining cause-and-effect relationships. Auditory learners excelled in verbal summarization, comparison, and inferential reasoning, while kinesthetic learners demonstrated strong practical application skills and conceptual integration through hands-on activities. However, kinesthetic learners showed limitations in articulating theoretical explanations, emphasizing the need for targeted instructional interventions.

From an educational perspective, these findings emphasize the necessity of adopting a multimodal teaching approach that caters to different learning styles. While traditional education often favors auditory and visual learners, kinesthetic learners frequently struggle due to the lack of hands-on experiences. Blended learning models that incorporate visual, auditory, and kinesthetic elements could bridge these gaps, ensuring that all students can develop a strong conceptual understanding regardless of their preferred learning style.

CONCLUSION

This study demonstrates that students' conceptual understanding of viruses is significantly influenced by their learning styles. Visual learners excel when provided with structured visual materials, auditory learners benefit from discussion-based learning, and kinesthetic learners require active, hands-on experiences. Despite their strengths, each group faces challenges when exposed to teaching methods that do not align with their preferred learning styles. These findings underscore the importance of implementing multimodal instructional approaches that integrate visual, auditory, and kinesthetic elements to accommodate diverse student needs. By aligning teaching strategies with students' learning preferences, educators can foster deeper comprehension, improve engagement, and enhance overall academic performance. Future research should explore the long-term effects of tailored instructional strategies on student learning outcomes in biology and other science disciplines.

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