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Mathematics Learning Activities using Vignette Activity Sequence and Braille Clock for Visually Impaired Students

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ABSTRACT

Mathematics learning for students with visual impairments is often challenging because many concepts are visual in nature, including units of time that require an understanding of the spatial position of clock hands. This condition requires a more concrete, tactile, and structured learning approach so that concepts can be understood meaningfully. This study aims to describe how Vignette Activity Sequence (VAS) based mathematics learning with braille clock media supports the understanding of time unit concepts in students with visual impairments. This study uses a double case study qualitative approach with two subjects, one with low vision and one with full blind student, selected through purposive sampling. The intervention lasted for one month through a series of VAS sessions that integrated contextual narratives, tactile exploration, and manipulative activities using braille clocks. Data were obtained through observation, semi-structured interviews, and documentation, then analyzed using the Miles and Huberman interactive model. The results showed that VAS helped both subjects understand the relationship between the movement of the short hand and the rotation of the long hand, albeit at different rates of development. The low vision subject was quicker to recognize numbers and understand time units, while the totally blind subject showed gradual improvement in tactile orientation and number touching strategies. Both experienced increased accuracy in reading time and moving the clock hands after attending repeated sessions. These findings confirm that the integration of VAS and braille clocks provides an effective and inclusive multisensory learning experience for students with visual impairments.

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A. INTRODUCTION

Mathematics learning for students with special needs plays an important role in supporting their cognitive development and independence, especially in the context of inclusive education that emphasizes equal access for all students (Abdulah et al., 2025; Gardesten & Palmér, 2025; Shoaib et al., 2023). This issue is becoming increasingly urgent given the high number of individuals with visual impairments, both globally and nationally (Flaxman et al., 2020; Miyauchi, 2020; Rif'ati et al., 2020). WHO notes that 2.2 billion people worldwide have visual impairments, with 1.1 billion of them experiencing blindness or severe impairment, while Indonesia ranks third with the highest number of blind people after India and China (WHO, 2023).

This high prevalence not only illustrates the large population that needs attention, but also emphasizes the urgency of ensuring that the learning process, especially mathematics, is accessible to all students with visual impairments (Klingenberg et al., 2019; Legesse et al., 2024). Recognizing the magnitude of this challenge, inclusive education must provide learning strategies and media that can bridge sensory limitations and support students in understanding mathematical concepts (Immelman, 2025; Shoaib, 2024). This is even more important because the abstract nature of mathematics and its heavy reliance on visual representations put students with visual impairments at risk of falling behind their peers in understanding the subject (Aktas & Argun, 2025; Lemessa, 2022; Smyth et al., 2022).

Based on initial observations conducted by researchers on several students at a special school in Surabaya, it was found that one of the main problems faced was the low level of understanding of students with visual impairments regarding the concept of time units. This finding shows that even though students have participated in mathematics lessons, they still have difficulty understanding abstract and temporal concepts (Aktas & Argun, 2025; Zhang & Hudson, 2018). Most students with visual impairments are unable to read clocks, both analog and digital, making it difficult for them to manage their study time and daily activities independently (Husniati & Firdaus, 2025). This issue is an important basis for reviewing how the concept of time units is taught in mathematics education, especially for students with visual impairments (Maqbool & Ashraf, 2023).

The concept of time units is an important part of the basic mathematics curriculum because it relates to everyday activities, such as understanding duration and managing schedules (Bommel & Walla, 2025; Thomas et al., 2023). However, learning the concept of time requires not only the ability to read a clock, but also an understanding of the relationships between time units in a meaningful context (NCTM, 2014). For students with visual impairments, this process becomes more challenging due to limited access to visual representations commonly used in the classroom (Hersh & Johnson, 2008). They often struggle to visualize the abstract relationship between numbers and changes in the position of clock hands, requiring tactile or auditory media support (Tipi et al., 2023). Therefore, learning strategies that provide concrete experiences are necessary for more effective understanding of time concepts (Bari et al., 2015).

The development of adaptive learning strategies and media is urgent in the context of mathematics education for students with special needs (Boza-chua et al., 2021). The media used should not only function as a tool, but also as a means to foster independence and a deep understanding of mathematical concepts (Miyauchi & Thamburaj, 2025). Previous studies have highlighted the importance of using braille and other tactile media in mathematics education for students with visual impairments. Braille media combined with audio has been proven to increase learning independence (Haryanti et al., 2023), while other studies emphasize the need to integrate tactile media with interactive technology to enrich the learning experience (Shoaib et al., 2023; Zebehazy & Holbrook, 2025). Additionally, the development of a self learning system based on braille cards and smartphone applications also demonstrates the potential of technology in supporting independent learning for students with visual impairments (Ardiansah & Okazaki, 2024). These findings indicate that tactile media plays an important role in facilitating the understanding of concepts that are difficult to access visually.

In the context of learning time concepts, braille clocks are a relevant form of tactile media because they allow students to gain direct experience through touching braille numbers and clock hands (Igirisa et al., 2019; Kintonova et al., 2025; Vandana, 2023). By touching the structure and shape of the clock, students can build a more concrete understanding of the concept of time, which is usually abstract when explained verbally. This tactile interaction not only strengthens cognition and memory, but also increases students' independence in reading time and organizing daily activities (Chao & Ishizuka, 2024; Stylianidou & Nardi, 2023; Tipi et al., 2023).

However, despite the extensive use of braille and various tactile media in mathematics education, the use of braille clocks to teach time concepts has been rarely explored in depth. In addition, learning approaches that combine a series of activities or narratives, such as *Vignette Activity Sequence* (VAS), have also rarely been found to be applied to students with visual impairments. This approach actually has the potential to provide gradual reinforcement of understanding through more realistic and easier to understand everyday contexts.

Vignette Activity Sequence (VAS) is a scenario based or vignette based learning approach structured in a series of activities to help understand concepts more deeply and contextually (Shelton et al., 2021). In its early literature, VAS was mostly used in the context of mathematics teacher education, particularly to help them recognize critical issues and connect theory with practice (Budiarto et al., 2021; Crisan, 2025; Tzou, 2023), so research applying it directly to students, especially students with visual impairments, is still very limited. In fact, VAS has great potential for the development of authentic situation based learning (Budiarto et al., 2021), as demonstrated in research showing how vignettes can capture children's natural interactions, play activities, and the emergence of mathematical ideas in everyday life, thereby providing a rich picture of how conceptual understanding develops through real experiences (Wallin et al., 2021).

Research linking VAS with adaptive media for students with visual impairments is still limited, opening up opportunities to develop approaches that combine tactile media such as Braille clocks with the Vignette Activity Sequence (VAS) approach to provide concrete access to material while increasing interactivity, participation, and learning motivation. Although braille and tactile media have been used in mathematics learning, mastery of time concepts through special media is still minimal. Time management skills are very important for student independence, so the use of VAS based braille clocks offers a more concrete and systematic learning approach for students with visual impairments.

Based on this background, research on Vignette Activity Sequence (VAS) based mathematics learning using braille clocks for students with visual impairments is important. This study aims to provide an empirical description of the implementation of VAS based mathematics learning, particularly in introducing the concept of time units, thereby enriching learning practices that are appropriate for the needs of students with visual impairments.

B. METHODS

This study uses a qualitative methodology with a case study approach, or more specifically, *a double case study*, as it involves two subjects with different visual conditions (Yin, 2017). This method was chosen because the study focuses on the problems of student with special needs, particularly students with visual impairments, in special schools. This approach was chosen because it provides an opportunity for in depth exploration of experiences, challenges, and learning strategies relevant to students with special needs. This research was conducted at a special school in Surabaya for one month during the odd semester of the 2025/2026 academic year.

1. Participants

The research subjects were selected using *purposive sampling* techniques that focused on specific criteria (Etikan et al., 2016). The selection of subjects followed the following criteria: (1) the research subjects were students at SLB-X Surabaya who had congenital visual impairment according to the WHO definition of visual impairment; (2) the subjects had learned material in the form of recognition of numbers 1–12, number sequences, and simple arithmetic operations; and (3) the subjects were expected to be accustomed to reading braille number symbols so that it would be easier for them to understand the concept of time through braille clocks. Based on these criteria, two research subjects were obtained, namely Subject-1 (S1), a student with *low vision*, who can still see vaguely at close range, and Subject-2 (S2), a student with total blindness. Mastery of basic material and the ability to read braille are the foundation for students to be able to follow the learning of time concepts through braille clocks without experiencing additional obstacles.

Subject-1 (S1) is an 11th grade high school student with low vision. Cognitively, her abilities are equivalent to those of students in lower grades. S1 has learned the basics of braille, is cooperative, responsive, and interested in understanding the material. Meanwhile, subject 2 (S2) is a third grade elementary school student with total visual impairment (full blindness). S2 is still in the concrete thinking stage, has a limited understanding of the basics of Braille, but has understood the numbers 1–12 and simple arithmetic operations. S2 shows curiosity, enthusiasm, and good motivation to learn, thus having a strong foundation for developing braille skills and further understanding of mathematics. Both subjects were selected to represent different levels of visual perception, allowing the researcher to obtain a more complete picture of the variation in responses under different visual conditions.

2. Data Collection

Data were collected through two main instruments: (1) observation guidelines used to record the learning process, student responses, and how students explored and used braille clocks during the series of activities; and (2) interview guidelines designed to explore students' understanding, learning experiences, and difficulties they encountered in learning time concepts through tactile media. In addition, two supporting instruments were used to strengthen the data collection process, namely (3) Vignette Activity Sequence (VAS) as a structured learning activity guide, and (4) braille clocks as a learning medium to help students recognize and determine time. Data collection was conducted in several consecutive learning sessions, and all procedures were applied consistently to each subject to maintain data validity.

3. Instrument

The research instruments used in this study included primary and supporting instruments. The primary instruments included observation guidelines and interview guidelines. Meanwhile, the supporting instruments were the Vignette Activity Sequence (VAS) and braille clock learning media. The Vignette Activity Sequence (VAS), developed by Shelton et al. (2021), is a learning approach that uses short narratives or *vignettes* to raise real situations or simulations in the context of mathematics teaching. However, VAS is not only relevant to educators but can also be applied directly to students. Through the application of VAS, students are given the opportunity to explore authentic learning scenarios, stimulate reasoning processes, encourage discussion, and deepen their understanding of concepts through structured situation analysis.

Meanwhile, a braille clock is a learning medium in the form of a circular board with a diameter of about 60 cm and a thickness of 9 mm, with raised numbers 1–12 accompanied by raised braille codes. The braille clock is equipped with two needles of different shapes, namely a short wavy needle and a long straight needle, so that the subject can tell the difference by touch. The material is selected from smooth wood so that it is strong and safe to touch. The clock hands are designed to be rotated manually, so that students can actively participate in moving the hands according to the teacher's instructions.

In addition, semi-structured interviews were also conducted with accompanying teachers. The interviews were conducted to obtain more in-depth information about the implementation of mathematics learning for students with visual impairments at SLB-X. The interviews were conducted in relation to the implementation of mathematics learning, which included the components of learning implementation and learning principles. The data from these interviews were used to complement and enrich the findings from the observations, as well as to identify patterns of experience that could not be revealed solely through learning activity data.

4. Research Procedure

The research approach began with collaboration between the school and assistant teachers to determine the research schedule and prepare instruments in the form of Vignette Activity Sequence (VAS) stages, braille clock learning media, observation guidelines, and interview guidelines. The VAS stages were arranged sequentially from introduction to application of the concept of time units, while the braille clock media were designed according to the needs of students with visual impairments and then evaluated by experts to ensure the suitability of the content and its relevance to the context of special schools. The validated instruments were then tested on other students with visual impairments to assess their clarity, reliability, and usability. After this stage was completed, an originality assessment was conducted on the research subjects.

During the activity, researchers observed student activity, responses to *vignettes*, and how they used braille watches. After the lesson, interviews were conducted with accompanying teachers to obtain additional information regarding obstacles, effectiveness, and student development. Documentation in the form of photos of activities and video recordings was collected as additional data to reinforce the results of observations and interviews. The data from the observations and interviews were then analyzed systematically to obtain an in depth picture of the VAS based mathematics learning process using braille watches for students with visual impairments.

5. Data Analysis

Data analysis in this study used the Miles & Huberman interactive model, which includes three stages: data reduction, data presentation, and conclusion drawing and verification. Data were obtained from observations of student activities, interviews with assistant teachers, and learning documentation, which were then simplified and focused on student responses, engagement, and obstacles encountered. The reduction results were compiled narratively to describe the VAS-based mathematics learning process, student interactions with braille clock media, and learning profiles from interviews. Conclusions were drawn by examining the consistency of findings from various sources, thereby assessing the effectiveness of learning. Throughout the study, ethical considerations were maintained through official permission, explanation of research objectives, and anonymization of subjects using codes S1 and S2 (Miles et al., 2014).

C. RESULT AND DISCUSSION

1. Result

a. Description of the Vignette Activity Sequence (VAS) and Braille Clock

In this study, the vignette used was a contextual story related to the concept of time units. The vignette used was the story of the "Tree Clock" kept by the Koala brothers. Koko was in charge of moving the long hand, while Ola moved the short hand. Contextual stories were chosen so that students with visual impairments could more easily understand abstract concepts through narratives that were close to their everyday lives. The researchers compiled a guide containing the *vignette* plot, prompting questions, teacher prompts, and student activity steps. This guide helped the researchers conduct the learning systematically and maintain consistency in the application of VAS. In addition, this guide also served as a reference in evaluating the effectiveness of learning, so that each stage of learning could be controlled and in accordance with the expected objectives. The following are the stages of the Vignette Activity Sequence (VAS) used as shown in Table 1.

Table 1. VAS stages used

Step	Verbal Instructions	Tactile Instructions
Story Prompt	*"In the middle of the forest there is a very large Tree Clock. This clock is guarded by the Koala brothers. Koko is in charge of moving the long hand, while Ola moves the short hand. They start work at 6 a.m. To work until 11 a.m., Koko makes five turns. Meanwhile, Ola makes only five steps."*	1) The researcher gives the Braille clock to the students. 2) Students are guided to feel the shape of the clock face, finding the Braille numbers 12 and 6. 3) Students are directed to distinguish between the long hand (Koko) and the short hand (Ola). 4) Students feel the numbers 6 and 11.
Concept Exploration	*"Every time the short hand moves to the next number, it means one hour has passed. When the short hand moves one step, the long hand has already made a*	1) The researcher positions the short hand on the number 6. 2) The students move the long hand one full rotation while mentioning Koko's rotation.

	full rotation from the number 12 back to the number 12 again."	3) After the long hand returns to the number 12, the student moves the short hand to the number 7 (Ola). 4) Repeat until the short hand moves from 6 to 11.
Main Activity	*"Now we are going to play the Hand Movement Mission. If you are working as Koko and Ola, every time you move the short hand one number, make sure the long hand has turned one full rotation."* Example mission: *"Start at 2 o'clock. Touch the number 2 on the clock. Move the hands to 5 o'clock while counting: one hour... two hours... three hours..."*	1) The student moves the long hand one full turn and then the short hand one step. 2) Repeat until the target time is reached. 3) The researcher ensures that students feel the full rotation of the long hand before moving the short hand.
Reflection	Prompting question: - *"If the short hand moves from 5 to 6, how many turns does the long hand make?"* - *"If from 9 to 12, how many rotations does the long hand make?"* - *"What happens if Ola and Koko forget to work?"* → Discussion about the importance of punctuality.	(No special tactile instructions; students simply touch the clock while answering the questions.)
Conclusion	The researcher reiterates the concept of time: for every number the short hand moves, the long hand completes one full rotation. Moral message: *"If you are late, all activities are delayed. Therefore, we must be punctual so that others do not have to wait."*	(No special tactile instructions; only reinforcement of the concept using a braille clock if needed.)

Meanwhile, the braille clock used is designed to be simple to help students with visual impairments understand the concept of time units tactilely. Made of smooth wood, the clock face is equipped with braille dots representing the numbers 1 to 12, so that students can feel the time with their fingers. The braille clock used has a diameter of 60 cm with braille dots and numbers embossed on its surface. These braille dots and numbers can be felt directly by students, providing a real tactile experience to recognize the position of the clock numbers. The clock hands are designed to be easily turned and moved manually by students with visual impairments so that they can actively set and feel the time shown. This design is made to be simple, sturdy, and comfortable for direct use without barriers such as a glass cover, to support independent learning for students with visual impairments through direct touch on the media.

b. Students' Understanding and Responses During Vignette Activity Sequence (VAS) Learning

Vignette Activity Sequence (VAS)-based learning shows that both subjects gradually built their understanding of the concept of time through a combination of narration, tactile activities, and exploration of the braille clock medium. The observation results show that S1 (low vision) immediately identified the long hand by saying, *"Oh, this is the hand, the long one means minutes, right?"*. She responded to the learning more quickly, was able to recognize the position of the numbers, distinguish between the short and long hands, and independently connect the story in the vignette with the activities on the clock. Meanwhile, S2, who was completely blind, slowly felt the braille clock while asking, *"What is this? I don't recognize its shape*." *"Why are there numbers and braille here?*" At the beginning of the learning process, S2 also needed guidance, especially in determining the position of the numbers and recognizing the shape of the hands. However, as the activity progressed, observations showed that S2 began to discover his own touching patterns, for example, by starting from the number 12 as a reference point before moving along the numbers in sequence. She then stated, *"If I start from the top, I understand the direction of rotation better*," which indicates the emergence of a more consistent tactile strategy, as shown in Figure 1 and Figure 2.

Figure 1. S1's VAS Learning Activity

Figure 2. S2's VAS Learning Activity

During the exploration of the concept and mission of the clock hands, both students showed active involvement. S1 was quicker to understand the relationship between the movement of the hands and units of time. She was also able to explain, *"If the short hand moves one number, that's one hour, right?*". Meanwhile, S2 took a little longer than S1, but with guidance in finding the numbers and clock hands, she was finally able to complete the instructions independently. In one session, S2 said, *"So if the short hand moves to the next number, that's one hour, right? I'll try again to be sure,"* showing an increase in understanding and confidence.

During the reflection stage, both students were able to explain the relationship between the short hand, long hand, and time changes. S1 gave a smoother explanation, while S2 answered carefully while checking the position of the hands again, *"When the long hand makes a full turn, the time changes. the short hand moves one number*." This finding is in line with the observation notes that S2 relied more on tactile abilities before giving answers. Overall, empirical evidence in the form of student dialogue and observation results shows that the responses and understanding of both subjects developed positively. This confirms that the VAS approach is effective in helping students with visual impairments understand the concept of time units through narrative experiences, tactile exploration, and direct practice using braille clocks.

c. The Tactile Abilities of Students with Visual Impairments in Using Braille Clocks During Vignette Activity Sequence (VAS) Based Learning

The tactile abilities of both students with visual impairments developed gradually throughout the Vignette Activity Sequence (VAS) based learning using braille clock learning media. Initial observations showed that S1 (low vision) immediately traced the surface of the clock and commented, *"This is the number 12... and this long one is the minute hand, right?"* She demonstrated fairly strong tactile abilities from the start. S1 was able to quickly feel, recognize, and distinguish numbers and short and long hands. This tactile ability was combined with the little residual visual aid that she had, so that his exploration process was more efficient and accurate. On several occasions, he verified his findings by saying, *"Let me check again* to *see if it's correct,"* then brought his face closer to the braille clock to see the numbers and the position of the hands more clearly. After that, he slowly turned the hands to ensure the most accurate position before concluding the time she had read. The combination of touch and a little visual assistance enabled S1 to position and move the clock hands independently throughout the VAS activities.

Meanwhile, S2, who has total visual impairment, began learning with more basic tactile skills. When she first held the media, he asked hesitantly, *"What is this object? I've never seen anything like this before."* When she began exploring the surface of the clock, he was confused and said, *"What kind of object is this with numbers on it? It has braille too, right?"* In the early stages of the activity, she needed guidance to find the position of the numbers and understand the orientation of the braille clock. However, through repeated practice and direct interaction with the media, S2 showed significant progress. In the third session, observations noted that S2 began using both hands one hand to feel the numbers, the other to move the hands and said*, "If I start from the top here, I can follow the direction more easily."* This strategy of using both hands helped improve consistency and accuracy.

S2's tactile sensitivity developed more rapidly, especially during the exploration of the concept and mission of the needle's movement. At this stage, he began to recognize the shape of the needle and understand the relationship between the movement of the needle and units of time. In one reflective attempt, he tried to explain his findings by saying*, "If the short hand moves one number forward, that's one hour... I'll repeat it again to be sure*." This shows an increase in understanding as well as more structured tactile skills. Overall, VAS based learning provides a learning experience that strengthens the tactile abilities of both students. Observational notes show that narrative and exploratory activities encourage both students to develop spatial orientation on the braille clock, improve the accuracy of their touch, and build tactile strategies appropriate to their respective visual conditions. Empirical findings in the form of dialogue, spontaneous responses, and behavior patterns during activities show that the VAS approach is able to facilitate tactile development as well as conceptual understanding in students with low vision and total blindness.

d. Is there a gap between the understanding of time unit concepts and the tactile abilities of students with visual impairments during Vignette Activity Sequence (VAS) based learning?

To understand how students with visual impairments develop an understanding of time units during Vignette Activity Sequence (VAS) based learning, it is necessary to map their conceptual understanding and tactile abilities. This mapping helps to identify aspects that are developing well and those that still need strengthening, especially when students interact with braille clocks as the main medium. A summary of these findings is presented in Table 2 to illustrate the relationship between conceptual understanding and tactile skills that emerged during the learning process.

Table 2. Profile of Conceptual Understanding and Tactile Skills in VAS-Based Learning

Key Aspects	S1 (low vision)	S2 (full blind)
Conceptual understanding of time units	Quickly understands the relationship between clock hands and time units	Understanding the concept after several repetitions.
Tactile ability on a braille clock	Able to feel the numbers and clock hands directly; often performs visual verification from close range.	Able to recognize numbers and hands with tactile ability; requires a relatively long time for initial orientation.
Integration of concept and tactile skills	Quick integration; concepts are more dominant than tactile precision.	Gradual integration; requires more repetition for synchronization of time unit concepts.

The results in Table 2 show differences in the pace of development between the understanding of time unit concepts and the tactile abilities of the two students with visual impairments. S1 (low vision) demonstrated faster conceptual understanding, particularly in connecting the movement of the clock hands with changes in time. However, they still perform close range visual verification to ensure the accuracy of their tactile perception, so the integration between conceptual understanding and tactile precision is not yet fully balanced. Meanwhile, S2 (totally blind) showed stable tactile development despite requiring more time in the initial orientation stage, such as recognizing numbers and hand positions. The conceptual understanding of time units began to form after several repetitions, and the integration between concepts and tactile skills developed gradually through repeated practice during VAS activities.

Overall, these findings indicate that the gap that emerges is not only influenced by the visual condition of each student, but also by the synchronization process between conceptual understanding and manipulative skills with braille clocks. The Vignette Activity Sequence (VAS) approach plays an important role in reducing these gaps through narrative, exploratory, and reflective activities that allow both students to develop conceptual understanding and tactile accuracy in parallel according to their respective abilities.

2. Discussion

a. Meaningful Learning for Students with Visual Impairments

The results of the study show that the use of the Vignette Activity Sequence (VAS) with braille clock learning media produces a meaningful learning experience for students with visual impairments, especially in understanding the concept of time measurement. One key finding is that both subjects were able to build conceptual understanding through a combination of tactile exploration and narrative context. This finding supports Hayes & Proulx's (2023) idea that accessibility to mathematics for students with visual impairments must be facilitated through strategies that reduce structural barriers and allow them to construct meaning in ways that are appropriate to their sensory modalities.

In previous studies, assistive technologies such as the Kasi system, the MyA+ Math application, or VR-based media have helped students with visual impairments access mathematics materials (Gaggi et al., 2023; Jariwala et al., 2020; Wegwerth et al., 2023). However, these studies focus on improving accessibility rather than how conceptual learning occurs through multisensory interaction. The contribution of this research is to show how meaningful processes are formed, for example, when students tactilely check the position of the clock hands or when narration helps them connect tactile activities with real-time situations. Thus, this research not only confirms the effectiveness of assistive technology but also expands our understanding of the learning mechanisms that occur in subjects with low vision or total blindness.

These findings also reinforce the literature on the importance of adaptive inclusive learning design for visually impaired students (Miyauchi & Thamburaj, 2025; Park et al., 2020). While many studies have developed innovative media (e.g., 3D manipulatives, tactile images, or 3D printed geometry), these studies show that tactile media alone is not sufficient; the combination of narrative context and VAS activity structure is a factor that enables the gradual and directed formation of time understanding.

b. Multisensory Learning and Knowledge Construction in Students with Visual Impairments

The results of the study show that the integration of tactile and auditory channels in VAS plays an important role in helping students build an understanding of time units. When students touch numbers, move needles, and listen to the vignette "Koko and Ola," they not only engage in sensory activities but also build connections between concrete experiences and mathematical representations. This is in line with the multisensory learning model that places tactile and auditory stimuli as the main compensation pathways for students with visual impairments (Zhu et al., 2025).

Furthermore, this study provides empirical evidence on how this multisensory combination works in the context of time unit concepts. This field is rarely discussed in the blind mathematics literature, which more often focuses on geometry, graphs, or algebra (Aktas & Argun, 2025; Zebehazy et al., 2022). Thus, the scientific contribution of this research is to expand the scope of multisensory studies into the realm of time measurement, including how students construct spatial temporal mappings between needle positions and time quantities through firsthand experience.

Furthermore, these findings support research showing that multisensory approaches enhance engagement and conceptual understanding for visually impaired students (Chao & Ishizuka, 2024; Chit et al., 2024), but this study adds an important dimension: the role of the VAS structure as an organizer of multisensory experiences, rather than merely the separate use of multisensory media.

c. Contribution of the Adapted Vignette Activity Sequence (VAS)

Previous studies have shown that the Vignette Activity Sequence (VAS) is effective for training prospective teachers in reflection and decision making (Budiarto et al., 2021;

Crisan, 2025; Shelton et al., 2021). The scientific contribution of this study is to extend the use of VAS to the context of students with visual impairments, a group that has not been the primary focus of this approach. This adaptation demonstrates that VAS can function not only as a pedagogical tool but also as a cognitive structure that helps students with visual impairments build mathematical concepts through the integration of narrative and tactile experiences.

Another contribution of this study is to provide new insights into how synchronization between tactile abilities and conceptual understanding occurs in students with different visual characteristics. The literature often assumes that the main challenge for visually impaired students lies in visual representation (Herzberg & McBride, 2023; Ookeditse & Garegae, 2024; Papadopoulos et al., 2025), but this study shows that challenges can arise in the synchronization between conceptual knowledge and the ability to manually manipulate a clock. These findings expand on previous studies by showing that this gap can be narrowed through structured activity designs such as VAS.

Ultimately, this research provides a practical contribution in the form of an inclusive VAS-based learning model with braille clock learning media that can be replicated for other mathematics topics. This research also confirms that students with visual impairments' understanding of time concepts can be strengthened through systematically designed multisensory experiences, not just by providing accessible media.

D. CONCLUSION AND SUGGESTIONS

Based on the results of research on Vignette Activity Sequence (VAS) based mathematics learning using braille clock learning media in students with visual impairments, empirical findings show that the tactile representation on the braille clock helps students with visual impairments improve their accuracy in recognizing the position of the hands and understanding the relationship between the movement of the hands and time units, while the VAS activity sequence facilitates the formation of a more coherent and meaningful understanding of the concept. These findings directly address the research objective, which is to describe how VAS activities and braille clock learning media support the process of understanding the concept of time units in students with visual impairments through structured tactile learning experiences.

The link between the development of tactile abilities and the construction of the concept of time units makes an important academic contribution by showing that vignette based learning designs can bridge the gap between tactile representation and abstract conceptual understanding. However, the results should be interpreted with caution given the limitations of the study, such as the limited number of subjects and the relatively short duration of the intervention, so that further research with a broader scope is still needed to strengthen the generalization of the findings.

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