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Application of Vignette Activity Sequence (VAS) in Tactile Based Mathematics Learning for Students with Physical Disabilities

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Abstract:
Mathematics learning for students with physical disabilities requires an adaptive approach to enable the development of concepts through direct experience. This study aims to describe how the student with physical disabilities coordinates motor skills in manipulating tactile clock media, how VAS facilitates sensory engagement and conceptual understanding of time units, and how this approach fosters active participation and independence in learning. The study used a qualitative approach with a Single Subject Research (SSR) design, type A–B (baseline intervention), involving a student who lacked both hands. Learning behavior and motor skills were analyzed descriptively through repeated observations in the baseline and intervention phases, focusing on the student's independence, involvement, and accuracy in manipulating tactile clock media. The results showed positive changes during the intervention phase compared to the baseline phase, marked by increased consistency in media use, active involvement in narrative based activities, and the ability to associate clock hand movements with the concept of time units in a more meaningful way. The integration of contextual narratives in VAS helped direct the tactile experience from concrete activities to symbolic representations, in line with Zoltan P. Dienes' theory of mathematics learning. Thus, the tactile-based VAS model showed positive indications and potential effectiveness as an inclusive learning approach for students with physical disabilities, although these findings are still limited and require further testing on more diverse subjects and contexts.

Abstrak:
Pembelajaran matematika bagi siswa dengan hambatan fisik memerlukan pendekatan yang adaptif agar konsep dapat dibangun melalui pengalaman langsung. Penelitian ini bertujuan untuk menggambarkan bagaimana siswa penyandang disabilitas fisik mengkoordinasikan keterampilan motorik dalam memanipulasi media jam taktil, bagaimana VAS memfasilitasi keterlibatan sensorik dan pemahaman konseptual tentang satuan waktu, dan bagaimana pendekatan ini menumbuhkan partisipasi aktif dan kemandirian dalam pembelajaran. Penelitian ini menggunakan pendekatan kualitatif dengan desain Single Subject Research (SSR) tipe A–B (baseline intervention), yang melibatkan siswa yang tidak memiliki kedua tangan. Perilaku belajar dan kemampuan motorik dianalisis secara deskriptif melalui observasi berulang pada fase baseline dan intervensi, dengan fokus pada kemandirian, keterlibatan, serta ketepatan

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siswa dalam memanipulasi media jam taktil. Hasil penelitian menunjukkan adanya perubahan positif selama fase intervensi dibandingkan fase baseline, ditandai dengan meningkatnya konsistensi penggunaan media, keterlibatan aktif dalam aktivitas berbasis narasi, serta kemampuan mengaitkan pergerakan jarum jam dengan konsep satuan waktu secara lebih bermakna. Integrasi narasi kontekstual dalam VAS membantu mengarahkan pengalaman taktil dari aktivitas konkret menuju representasi simbolik, sejalan dengan teori pembelajaran matematika Zoltan P. Dienes. Dengan demikian, model VAS berbasis metode taktil menunjukkan indikasi positif dan potensi efektivitas sebagai pendekatan pembelajaran inklusif bagi siswa dengan hambatan fisik, meskipun temuan ini masih bersifat terbatas dan memerlukan pengujian lanjutan pada subjek dan konteks yang lebih beragam.

Keywords:
Physical Disabilities, Mathematics Learning, Time Units, Tactile Media, Vignette Activity Sequence (VAS)

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INTRODUCTION

Mathematics learning plays an important role in developing students' logical, analytical, and systematic thinking skills. Through mathematical reasoning activities, students are trained to understand concepts, construct arguments, and solve problems in a structured manner (Hadi, Dolk, Kamaliyah, & Hidayanto, 2025). However, for students with special needs, especially those with physical disabilities, mathematics learning often faces complex challenges (Linder, Ayodele, Chokotho, Mulwafu, Tataryn, Polack, Kuper, Pandit, & Lavy, 2021). Limitations in the muscular, skeletal, joint, or nervous systems can restrict students' interaction with the learning environment and the use of conventional learning media, thus requiring adaptive learning strategies (Gervasoni & Peter-Koop, 2020; Sattoe, Hilberink, & Whitney, 2023; Shoaib, Fitzpatrick, & Pitt, 2023).

Various approaches have been developed to address these challenges, including tactile methods and manipulative based learning (Luo & Zhang, 2020). However, these approaches generally focus on sensory and motor aspects separately, without an explicit pedagogical framework linking students' physical experiences to conceptual understanding and everyday contexts (Cuturi, Cappagli, Yiannoutsou, Price, & Gori, 2022). In particular, studies

integrating tactile methods with narrative based learning frameworks such as Vignette Activity Sequence (VAS) in mathematics learning are still very limited, especially on the concept of time units for students with physical disabilities. This limitation indicates a theoretical and practical gap in understanding how sensory experiences, motor activities, and meaning construction can be facilitated in an integrated manner within a systematic learning design.

Physical disabilities, whether congenital or acquired, have a direct impact on students' fine and gross motor skills, which affects their engagement in mathematics learning activities (Bray, Spencer, & Edwards, 2020; Wang & Wang, 2024). This condition emphasizes that mathematics learning for students with physical disabilities requires more than just providing manipulative media; it also requires a learning structure that can guide these physical experiences toward meaningful conceptual understanding. Without a clear pedagogical framework, manipulative activities risk becoming merely motor exercises that are disconnected from the conceptual goals of mathematics learning (Cuturi, Cappagli, Yiannoutsou, Price, & Gori, 2022). Therefore, a learning approach is needed that systematically connects student physical engagement with the process of reflection, meaning making, and generalization of mathematical concepts.

The tactile method is one relevant approach because it emphasizes learning experiences through touch and manipulation of concrete objects (Price, Yiannoutsou, Jonshon, & Outhwaite, 2020; Winarto, Pertiwi, Novitasari, & Damayanti, 2024). This approach allows abstract mathematical concepts to be presented in a more accessible form, thereby helping students build conceptual understanding through direct sensory experiences (Moustafa, Opoku, & Belbase, 2022). Tactile media support enables students to actively interact with learning objects, reinforcing mental representations and increasing learning engagement (Ozdemir & Kilic, 2023; Ponte, Viseu, Neto, & Aires, 2023). However, without a structured activity framework, tactile learning has the potential to stop at physical manipulation alone and does not fully guide students toward the process of reflection and concept generalization.

The tactile approach is particularly relevant in teaching time concepts, which require an understanding of the relationship between clock hand movements, time units, and event duration (Bommel & Walla, 2025; Jimenez & Stanger, 2017). This concept is not only abstract but also closely related to temporal experiences in daily life (Andriyani, 2020). Through tactile activities and media manipulation, students with physical disabilities can associate

physical experiences with the meaning of time being learned, making conceptual understanding more concrete (Holstermann, Grube, & Bogeholz, 2010; Thomas, Clarke, Mcdonough, & Clarkson, 2023; Zhan & Cheng, 2025). However, these experiences require a narrative context so that students not only understand how to read a clock but also comprehend the function and meaning of time in real world activities.

It is in this context that the Vignette Activity Sequence (VAS) has conceptual added value compared to tactile or manipulative approaches alone. VAS is a narrative-based learning model that presents a series of contextual activities through everyday situations, thus serving as a bridge between sensory experiences and conceptual meaning. Through vignettes, tactile activities do not stand alone but are placed in a meaningful storyline, allowing students to associate physical manipulation with the concepts of time, sequence of events, and duration of activities. For students with physical disabilities, this narrative structure helps direct attention, maintain engagement, and facilitate gradual conceptual reflection (Shelton, Kerschen, & Wilkerson, 2021).

Previous research indicates that tactile methods are effective in enhancing mathematical concept understanding and motor skills in students with special needs (Hawani, Masmoudi, Trabelsi, Souissi, Chikha, Mrayah, Souissi, Marsigliante, Rozmiarek, & Muscella, 2023; Moustafa, Opoku, & Belbase, 2022), while manipulative activity based time concept learning can strengthen student temporal perception (Rasulyanti, Jelita, Kusuma, Fatihah, & Darmadi, 2025; Thomas, Clarke, Mcdonough, & Clarkson, 2023). On the other hand, VAS has been proven to increase student emotional engagement and participation in contextual learning (Crisan, 2025; Shelton, Kerschen, & Wilkerson, 2021). However, the integration of these two approaches has rarely been studied, especially in the context of teaching time units to students with physical disabilities.

The use of tactile media for children with motor disabilities who don't have functional hands may present certain challenges, as many learning activities are designed around the use of the upper limbs. As a result, opportunities for children to explore and develop alternative motor skills through their lower limbs may be limited. Vignette Activity Sequence (VAS) offers an approach that presents activities in a gradual, structured, and meaningful way, allowing children to engage in movement sequences using their feet. Through a clear narrative context and an organized sequence of activities, VAS can support children's active participation in learning while

encouraging the development of functional motor skills that are aligned with their individual abilities and learning needs.

Therefore, this study occupies a different position from previous studies by placing VAS not merely as a complement but as a conceptual framework that systematically organizes tactile experiences. Theoretically, this study contributes to the development of inclusive mathematics learning by integrating sensory-motor perspectives and narrative based learning. Practically, this study provides an empirical basis for teachers in designing time unit learning that is not only physically accessible but also conceptually meaningful for students with physical disabilities.

Based on a review of theory and previous research results, this study aims to describe and analyze how a student with physical disabilities coordinates motor skills, engages sensorially, and constructs conceptual understanding of time units through tactile-based clock media within a Vignette Activity Sequence (VAS) model. This study uses a Single Subject Research (SSR) approach to observe changes in student learning behavior and motor skills individually after being given learning interventions. Specifically, this study focuses on (1) how the student with physical disabilities coordinates motor skills in manipulating tactile clock media; (2) how VAS facilitates sensory engagement and conceptual understanding of time units; and (3) how tactile-based VAS learning fosters the student's active participation and independence.

METHODS

This study is a qualitative study with a Single Subject Research (SSR) design type A–B (baseline–intervention) using a descriptive approach. This approach was chosen because it aims to deeply understand the learning experiences, movement patterns, and adaptation strategies of a student with physical disabilities in participating in mathematics learning based on the tactile method through the application of the Vignette Activity Sequence (VAS). The SSR type A–B design was chosen because the study focused on one subject who was observed repeatedly to see changes in behavior and motor skills after being given the intervention.

The research was conducted at one of the special schools (SLB) in East Java, Indonesia, a school that serves students with special needs, including physical disabilities. This school was chosen because it has facilities and a learning environment that support the implementation of tactile media-based activities. The main objective of this study was to determine how a student with

physical disabilities who does not have both hands uses other parts of the body to operate tactile media during the mathematics learning process.

1. Subject Characteristics

The research subject was a Grade XII senior high school student at a special school (SMALB) with physical disabilities who did not have both hands, selected using purposive sampling based on relatively high motor adaptation abilities. Before the intervention, the student was able to recognize numbers from 1 to 12 and identify several components of a clock, but experienced difficulties in understanding the relationship between clock-hand movements and time units. The student demonstrated adequate motor adaptation by using the feet to perform daily learning activities. This criterion was used because tactile-based learning with the Vignette Activity Sequence (VAS) approach requires active student involvement in interacting with the media, so adequate adaptation abilities are necessary so that the process of media use and learning responses can be clearly observed. The researcher realizes that selecting subjects with a high level of motor adaptation limits the transferability and external validity of the findings, so the results of this study are not intended to be generalized, but rather to provide an in-depth understanding of the learning process and motor adaptation in the context of specific subjects and to serve as a basis for further research with more diverse student characteristics. As this is an initial exploratory or pilot study on SSR, subjects with relatively good motor skills were selected so that the researchers could observe how the tactile media and VAS functioned when the pupils were able to interact actively with the media.

2. Vignette Activity Sequence (VAS) Design

The research intervention used a tactile-based Vignette Activity Sequence (VAS). The VAS design was structured in the form of a learning scenario, with the following activity steps.

Table 1. Vignette Activity Sequence Design

No.	VAS Stage	Objective	Instructions for Subjects (Using tactile media)
1.	Story Prompt	Attract attention and prepare the subject for learning	Researchers introduce an initial context or brief situation to spark the subject's interest in the material unit of time using tactile media.

No.	VAS Stage	Objective	Instructions for Subjects (Using tactile media)
2.	Concept Exploration	Understanding the basic material and concepts to be studied	Subject exploring media tactile for recognizing clocks, numbers, and the duration of time with the guidance of a researcher.
3.	Main Activities	Applying concepts through manipulative media	Subjects practice reading, telling time, or counting duration time using tactile media according to instructions.
4.	Reflection	Evaluating the learning process and adaptation strategies	The subject discusses the steps taken, difficulties encountered, and adaptation strategies in using tactile media.
5.	Closing	Strengthening understanding and consistency of skills	Subject repeats core activities or is given additional exercises to ensure consistent skills in manipulating media and understanding concepts, units, and time are consistent.

The research data collection process was carried out through a Type A–B Single Subject Research (SSR) design consisting of a baseline phase and an intervention phase. The baseline phase (A) was conducted for 4 consecutive days with a duration of 45 minutes per session per day. In this phase, the subject performed tactile media based mathematics learning activities without the application of the Vignette Activity Sequence (VAS). Observations in the baseline phase aimed to obtain initial data on motor skills, body adaptation patterns, and the subjects' strategies in completing tactile based mathematics tasks. Baseline stability was determined based on the consistency of the subjects' performance between sessions, which was characterized by no significant trends of change and relatively small data variations before the intervention was given.

Next, the intervention phase (B) was carried out for 4 days with a duration of 90 minutes per session per day. This study adopted a qualitative SSR approach emphasizing descriptive observation rather than quantitative performance measurement. Therefore, changes across baseline and intervention sessions were documented through repeated qualitative observations focusing on conceptual understanding, independence, engagement, and motor adaptation. In this phase, subjects participated in Vignette Activity Sequence

(VAS) based mathematics learning using the " " method, which included the stages of story sparking, concept exploration, main activities, reflection, and closing. During the intervention, subjects manipulated tactile learning media using alternative body parts according to the designed scenario. The entire learning process was documented through direct observation and photo and video recordings to capture the subjects' responses, adaptation strategies, and overall engagement.

During the research process, additional data were collected through semi-structured interviews with subjects and assistant teachers, as well as non-systematic observations. Documentation in the form of photos and videos was also used to strengthen the analysis. To ensure data validity, this study used time triangulation to assess the consistency of the subjects' abilities in phases A and B, as well as source triangulation to obtain accurate information from various perspectives.

The data were analyzed qualitatively and descriptively by presenting the results of observations through reflective narratives, tables, and visual documentation of the subjects' body movements. Session-by-session observations were summarized in a qualitative observation table to illustrate changes across the baseline (A1–A4) and intervention (B1–B4) phases. The analysis focused on changes in the subjects' learning behavior between the baseline phase (A) and the intervention phase (B). Motor skills were identified through the subjects' smoothness and control of movement when manipulating tactile media, while adaptation strategies were observed from the way the subjects independently and consistently chose and used alternative body parts. Learning behavior was analyzed based on the subject's level of focus, initiative, and response during learning activities, while learning effectiveness was interpreted from the subject's ease in completing activities and the reduction of obstacles during the learning process. Changes in each construct were interpreted comparatively between phases to understand the contribution of the application of the tactile-based Vignette Activity Sequence (VAS) to the learning process of students with physical disabilities.

RESULTS AND DISCUSSION

1. Baseline Condition

Based on the results of observations during the learning activities, the application of the tactile based vignette activity sequence showed positive developments in the abilities of students with physical disabilities in

understanding the concept of time units. At the beginning of the activity, students appeared cautious when they started interacting with the tactile clock media. They needed time to adjust, especially in recognizing the raised numbers and distinguishing between the long and short hands. Limited movement caused students to use their feet to reach and turn the clock hands, so coordination between movement and tactile perception became a challenge. During baseline sessions (A1–A4), the student demonstrated limited understanding of the relationship between clock-hand positions and time units. The student frequently guessed clock positions and required assistance when manipulating the tactile clock.

To provide a clearer representation of the Single Subject Research (SSR) A–B design, observations were documented across four sessions at the start (A1–A4) and four sessions during the intervention (B1–B4). During the first phase, the student often found it hard to link the position of the clock hands with the time of day. They also needed a lot of help when dealing with things they could touch. And they did not seem very interested in the learning activities. After the VAS-based intervention was put into practice, there were small improvements each time. The student got better at connecting story events to clock-hand movements, using less help to touch the clock, and taking part in learning activities.

Table 2 Session by Session Observation Results Across Baseline and Intervention Phases

Session	Phase	Understanding of Time Concept	Use of Tactile Media	Engagement
A1	Baseline	Unable to associate clock hands with time units	Fully assisted	Passive
A2	Baseline	Frequently guessed clock positions	Fully assisted	Passive
A3	Baseline	Recognized some clock components	Assisted	Limited engagement
A4	Baseline	Inconsistent understanding of time units	Assisted	Limited engagement
B1	Intervention	Began relating story events to clock movements	Assisted	Engaged

Session	Phase	Understanding of Time Concept	Use of Tactile Media	Engagement
B2	Intervention	Demonstrated partial understanding of time duration	Minimal assistance	Active
B3	Intervention	Correctly identified several time positions	Minimal assistance	Highly engaged
B4	Intervention	Consistently demonstrated simple time concepts	Independent	Highly engaged

During the first phase (A1–A4), the student's performance was quite stable. They had a limited understanding of time, needed help to use touch to interact with the world, and were not very engaged. After the VAS-based intervention (B1–B4), there were small but steady improvements in understanding, using touch to learn, and taking part in learning activities.

These changes indicate that story-based activities and direct experiences through tactile media can create an inclusive and meaningful learning environment for students with physical disabilities. Detailed observations of student development before and after the implementation of the Vignette Activity Sequence (VAS) can be seen in table 3 below.

Table 3. Qualitative Observation Results of Student Abilities

Aspects observed	Initial Condition	After Activity
Understanding of the Concept of Time	Does not yet understand the relationship between the long and short hands; often guesses the position of the clock.	Understands the meaning of the movement of the hands and can show simple time accurately.
Use of tactile aids	Hesitates and requires assistance when turning the clock hands.	Able to use media independently and purposefully according to the teacher's instructions.
Attitude and Engagement	Passive and easily loses focus.	Enthusiastic, confident, and engaged. Active in story-based activities.

To clarify the interpretation in table 3, understanding of the concept of time is defined as the subject's ability to associate the position of the clock hands

with the intended unit of time and to demonstrate this on a tactile medium in accordance with the context of the story without direct assistance. Independence and learning engagement were identified through consistency in adaptation strategies in manipulating media, the ability to complete tasks without physical correction from the teacher, and the subject's active and focused responses while following the Vignette Activity Sequence (VAS) based activity flow.

2. Changes During VAS Intervention

The lesson began with the presentation of a vignette entitled "The Koala Siblings," which formed the basis for all learning activities. The teacher opened the activity by telling the story of two koala siblings named Koko and Ola who were tasked with guarding a giant clock at the top of a tree in the middle of the forest. In the story, Koko was responsible for moving the long hand, while Ola adjusted the short hand. The two worked together from six in the morning until eleven in the afternoon.



Figure 1. Story Prompt Stage

In response to the provided story prompt, students engaged with the tactile clock, identifying the raised numerals and differentiating between the long and short hands through tactile perception. In light of the absence of both hands, the student was required to utilize the feet and other available body movements in order to manipulate the tactile clock. Initially, the student required guidance to coordinate foot movements with the direction of the clock hands and to identify the target positions accurately. However, during subsequent activities, the student gradually demonstrated greater control in rotating the clock hands and locating specific numbers on the tactile clock.

The student was then tasked with representing a series of timeframes presented in the vignette. Through repeated tactile manipulation, the student began to recognize that one complete rotation of the long hand represented one

hour and that the short hand moved to the next number accordingly. These activities enabled the student to establish a connection between physical manipulation of the tactile clock and the mathematical meaning of time units and duration. After the vignette was read, the teacher invited the student to discuss the content of the story. The teacher asked, "What time did Koko and Ola start working?" or "Why did the clock stop ticking?" These questions encouraged students to think logically and interpret the relationship between time and the movement of the clock hands. At this stage, the teacher also introduced the learning media used, namely a tactile clock with raised numbers and textured hands. The teacher explains that they will play the roles of Koko and Ola directly using this media to understand how the long and short hands move. This approach allows students to not only understand conceptually but also experience physically and emotionally through story based role playing.



Figure 2. Exploring the Tactile Clock Components

Figure 2 shows how the test subject explored the tactile clock. This included identifying raised numbers and working out the difference between the long and short hands by touching them.



Figure 3. Guided Exploration of Clock Hand Movement

During the guided exploration, the student learned how the clock hands move and how they are connected to time units. This was done by touching and using the teacher's help.

The next stage is the main VAS activity. The teacher demonstrates how to use the tactile clock while explaining the role of each hand based on the vignette story. The teacher demonstrates Koko's movements by turning the long hand around the clock five times to show the passage of time from six in the morning to eleven in the afternoon, while the short hand (Ola) only moves five small steps to reach the number eleven. This demonstration is carried out using narrative language, for example, "Now Koko runs a full circle." That means one hour has passed, and Ola moves one number forward." Students are asked to observe by touch, feel the difference in texture between the long and short hands, and recognize the position of the numbers indicated. For students with limited mobility, the teacher provides hand-over-hand assistance so that they can feel the direction of the hands' movement with their feet or hands slowly.



Figure 4. Demonstration of Time Representation

3. Motor Adaptation in Manipulating Tactile Clock Media

The tactile exploration stage also involved students actively playing the characters in the vignette. The teacher gave instructions such as "Now you are Koko; turn the long hand five times around the clock, while your friend is Ola, and move the short hand five small steps." The student enthusiastically turned the clock hands with their feet, while another student helped ensure that the hands were in the correct position. After that, the teacher presents a follow-up situation from the story, for example, when Ola goes out to play and loses track of time. The teacher asks, "If Ola leaves at eleven o'clock and returns at twelve o'clock, where are the long and short hands now?" Students are then asked to

show the position on the tactile clock by touching, feeling, and turning the hands until they match. Through this activity, students learn that the long hand moving one full turn indicates that one hour has passed, while the short hand only moves one number.



Figure 5. Student Practice in Manipulating Clock Hands

In the applied practice stage, students perform a series of context-based tasks based on a story. The teacher gives new instructions, such as "Now Ola is watching a circus show at six in the afternoon and promises to return at seven. Show the change in the position of the clock hands between six and seven." Students again use the tactile clock to show the position of both hands while explaining the steps they took. This activity is repeated with variations in time and situations taken from the vignette story. With this approach, students not only practice reading the clock but also understand the meaning of duration and the relationship between the positions of the clock hands. The teacher provides positive reinforcement every time a student successfully shows the correct time position, either in the form of verbal praise or encouragement to try the next challenge.



Figure 6. Reflection Stage

The final stage is reflection and conclusion. The researcher invites students to review the content of the story and the learning experience they have just had. The researcher asks, "Why did the clock in the forest stop?" and "How can Ola remember the time again?" Students provide answers based on their understanding of the story and the activities they have done. Some students conclude that to keep time running, they must turn the clock hands regularly and accurately. The researcher then gave individual assessments by asking the student to indicate five different times without assistance, such as six, nine, twelve, three, and seven.



Figure 7. Closing and Individual Assessment Stage

Based on observations during the learning process, qualitative data were obtained showing changes in the learning behavior of students with physical disabilities after the implementation of the Vignette Activity Sequence (VAS) in tactile-based mathematics learning. The improvement in student abilities was evident not only in the cognitive aspect of accuracy in showing the time, but also in the affective and psychomotor aspects.

At the beginning of the activity, students still showed hesitation in recognizing numbers and turning the clock hands using tactile media. They needed intensive guidance from researchers to understand the relationship between the position of the clock hands and units of time. However, as the story of "The Koala Brothers" unfolded, which was the core of the vignette, students began to show active engagement and a high level of curiosity. The story helped them relate the abstract concept of time to concrete, meaningful situations.

The student appeared enthusiastic when participating in each segment of the activity. When the teacher asked the students to play the roles of Ola or Koko, they began to understand that the long and short hands had different functions. Students who were initially awkward began to dare to turn the clock

hands using their feet or hands in a more focused manner. Additionally, their facial expressions and verbal responses showed positive changes, namely looking happy, smiling, and being eager to try again, even though they had previously made mistakes.

4. VAS, Tactile Learning, and Dienes' Theory

Based on the results of observations, the application of the Vignette Activity Sequence (VAS) based on the tactile method showed positive changes in the understanding of time concepts, media usage skills, and the learning attitudes of students with physical disabilities. The increase in conceptual understanding was not only reflected in the students' ability to show the time accurately, but also in their ability to relate the movement of the clock hands to the flow of activities in the story. This change occurred because each tactile action, such as touching raised numbers and turning clock hands using alternative body parts, was directly positioned in a meaningful narrative context, so that the physical experience did not stand alone but was directed towards conceptual meaning (Alotaibi, Al-Khalifa, & Al-Saeed, 2020).

The story "The Koala Brothers" serves as a conceptual trigger linking tactile actions with causal changes in time units, for example, when one hour of play is represented by one rotation of the clock hands. It is this explicit relationship between tactile actions and temporal consequences that drives increased conceptual understanding, beyond mere engagement with narrative. These findings align with story-based learning approaches that place everyday contexts as a means of forming mathematical meaning (Mishra, Klapwijk, Vries, De, & Spandaw, 2025; Mystakidis, Filippousis, Tolis, & Tseregkouni, 2021). Additionally, the use of tactile clock media with manipulable physical characteristics allows students to consistently develop motor adaptation strategies, so that learning not only strengthens cognitive aspects but also motor coordination and self confidence (Cuturi, Cappagli, Yiannoutsou, Price, & Gori, 2022; Ponte, Viseu, Neto, & Aires, 2023).

Theoretically, these results support Dienes' view that mathematics learning occurs through stages of concrete experience leading to symbolization. Free exploration of the clock medium reflects the free play stage, while setting the hands based on the storyline reflects the games and representation stage, until finally students are able to tell time symbolically. The integration of VAS with tactile methods clarifies the transition between these stages because each

sensory experience is placed within a directed narrative structure, rather than manipulative activities that are separate from conceptual goals (Abrar, 2013).

However, these findings should be interpreted cautiously, as they are based on a single subject and a limited number of sessions, which constrains external validity and generalizability. The SSR design enables in-depth analysis of individual learning processes but does not support universal conclusions. Therefore, the findings suggest that VAS functions as a pedagogical bridge between tactile experience and mathematical meaning-making. Rather than limiting learning to physical manipulation of tactile media, the narrative structure of VAS helped the student connect sensory experiences with conceptual understanding of time units and symbolic representations. A limitation of this study is the difference in session duration between the baseline and intervention phases. The baseline sessions were conducted for 45 minutes, whereas the intervention sessions lasted 90 minutes. Consequently, the observed improvements may have been influenced not only by the implementation of the Vignette Activity Sequence (VAS) but also by the longer learning exposure during the intervention phase. Therefore, the findings should be interpreted cautiously. Future studies are recommended to use equivalent session durations across phases to better isolate the effects of the intervention. Other future studies involving multiple students and longer intervention periods are recommended to examine the effectiveness and sustainability of this approach more comprehensively.

CONCLUSION

The findings indicate that the integration of Vignette Activity Sequence (VAS) and tactile methods shows promising potential in supporting conceptual understanding, motor skills, and emotional engagement of students with physical disabilities in learning time-unit concepts. Contextual narratives and multisensory interactions help students connect clock hand movements with the meaning of time in a concrete and meaningful way. Consistent with Dienes' theory, learning progresses from concrete experience to symbolic representation. However, as this study employed a Single Subject Research (SSR) design with one student, the findings are exploratory and not broadly generalizable. Therefore, the findings provide exploratory evidence and indicate positive potential for the integration of Vignette Activity Sequence (VAS) and tactile methods in mathematics learning for students with physical

disabilities, requiring further investigation with larger samples, comparative designs, and longer interventions.

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