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Integrating Sensory-based Activity Modules to Enhance Tactile Sensitivity in Braille Learners: A Comparative Study

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ABSTRACT

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Visual impairment and blindness are significant global health issues that severely impact the lives of affected individuals and those around them. These individuals encounter unique challenges in their daily routines and learning processes, which sighted people do not experience. Despite these obstacles, visually impaired individuals rely heavily on their tactile and auditory senses to perceive and understand their surroundings. Tactile sensory input is especially beneficial in conveying environmental and visual information to those who are visually impaired or blind. Therefore, a sensory-based activity module was developed to improve tactile sensitivity in learning Braille. This module consisted of four game stations: rice play, sand play, playdough, and finger paint. The participants' tactile sensitivity was tested on their index and middle fingers, which are primarily used in reading Braille, both before and after engaging with the games. Specifically, the right middle finger exhibited an enhancement of up to 83%, the right index finger showed a 60% improvement, the left middle finger demonstrated a 71% increase, and the left index finger displayed a remarkable improvement of 298%. During the analysis of the module's effectiveness, it was discovered that an overwhelming 94% of the participants expressed great interest and found it highly impactful and over 70% of the participants successfully followed the game instructions and indirectly developed soft skills at each station. Additionally, there was a notable improvement in finger sensitivity, as measured by the two-point discriminator test. This interactive and enjoyable game-based learning approach is ideal for both blind and sighted players. It offers visually impaired individuals a practical method for learning Braille, enhancing their tactile sensitivity, and making the learning process more engaging and effective. The sensory play module not only supports the educational needs of visually impaired learners but also fosters an inclusive environment for all players.

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1. INTRODUCTION

Human touch involves the physical interaction between fingers and objects, relying on the biophysical properties of tactile skin. When a finger glides over an object, vibrations are generated and transmitted through the skin, allowing the detection of surface texture properties. (Abdouni et al., 2019). Tactile sensitivity, influenced by factors such as age, gender, and illness, is particularly crucial for visually impaired individuals who depend heavily on their tactile and auditory senses to navigate their environment. Studies have shown that visually impaired individuals often develop superior tactile sensitivity compared to sighted individuals, allowing them to compensate for their lack of vision (Kaco et al., 2021; Qu et al., 2020). In contrast, individuals who have recently lost their vision due to illness or accidents may not possess the same level of acute finger sensitivity as those who were born blind but have developed their tactile senses over time. Consequently, these individuals may need to actively enhance their sensitivity to adapt to their changed daily routines. In such cases, guidance or tools may be necessary to assist them in improving their sensitivity.

Therefore, engaging in sensory exploration and sensory play can greatly assist visually impaired individuals in improving their finger sensitivity. Sensory play encompasses activities that stimulate our senses of touch, sight, hearing, scent, and taste (Ying & Zhagan, 2021). Although sensory play is often employed with children to facilitate their comprehension of cause and effect within their surroundings, its advantages extend to individuals of all age groups. Sensory play encompasses a diverse range of activities, such as engaging in arts and crafts, interacting with sensory toys, participating in outdoor play, and more. Its adaptable nature allows for its application in various contexts and for people of different ages to reap its benefits. Tactile sensory play, also known as touch-based play, presents a vast array of games and activities to engage in, such as sensory bins with rainbow rice, mud kitchens, oatmeal sensory bins, kinetic sand, and more. Participating in these activities offers a multitude of benefits. Tactile sensory play fosters brain development, improves memory, assists with complex tasks and problem-solving, and facilitates the development of motor skills (Patel et al., 2022). Furthermore, as sensory perception improves, the challenges related to communication and social skills become less daunting. Interestingly, sensory play also nurtures creativity and encourages independent thinking, all while providing a soothing effect on emotions (Yang & Wang, 2017). Consequently, this active learning approach promotes flexibility and participation among visually impaired individuals, allowing them to acquire information independently through experiential engagement in the learning process. Furthermore, the use of interactive technologies facilitates differentiated instruction, which enhances their motivation to learn Braille (Halamy et al., 2022; Mahmud et al., 2023).

Hence, conducting a finger sensitivity test is crucial to evaluate the enhancement of tactile sensitivity. Various tools have been previously devised for this purpose, including reflex hammers, tuning forks, and the two-point discrimination (TPD) test. The TPD test is widely employed as a neurosensory assessment in clinical settings. It involves assessing the ability to discriminate the distance between two points of contact, essentially determining the perception of two separate stimuli. This method serves as a means to gauge the recognition capability of tactile touch and determine if an individual can differentiate between two closely spaced stimulation points (Kaco et al., 2021; Lin & Rugama, 2015). This technique has been employed to evaluate the recognition capability of tactile touch with two stimulation points (Dane et al., 2017; Lin & Rugama, 2015; Zimney et al., 2020). Hence, this skill holds significant importance for individuals who are new to learning braille as it enables them to accurately perceive and differentiate braille dots.

Ergo, the primary aim of this study was to explore the effectiveness of utilizing sensory play through a module consisting of game-based activities to enhance finger sensitivity. To accomplish this, a sensory-based activity module was developed, specifically designed to guide individuals, particularly those who are visually impaired and beginners to Braille learning, in improving their finger sensitivity. The participants' finger sensitivity was evaluated using a two-point discriminator at different test points and finger types, measuring improvements throughout the implementation of the module, and assessing the module's effectiveness upon its completion. The findings contribute to the body of knowledge on tactile-based educational interventions and offer valuable insights for educators, therapists, and professionals working with visually impaired individuals, enabling them to design more effective sensory learning activities that cater to the unique needs of their students or clients. Furthermore, by improving finger sensitivity, the study promotes greater accessibility and inclusivity in education, enhancing Braille learning and empowering visually impaired individuals with better literacy and communication abilities. This, in turn, supports their integration into society, fostering independence and improving their overall quality of life.

2. METHODOLOGY

2.1 Research Design

The research employed a quasi-experimental design to explore the effectiveness of a sensory-based activity module in enhancing finger sensitivity among visually impaired individuals, particularly beginners in Braille learning. This design was selected to facilitate the assessment of participants' finger sensitivity before and after the implementation of the sensory play activities, allowing for a comparative analysis of the module's impact. The quasi-experimental approach is particularly suitable for educational interventions where random assignment is impractical.

2.2 Development of Sensory Play Activity Module

A sensory play activity module was created with the goal of assessing and enhancing finger sensitivity, particularly for individuals who are visually impaired due to either congenital blindness or sudden vision loss. This module utilizes tactile activities and integrates various skills, including communication, leadership, teamwork, and creativity to achieve the learning outcomes a) increase finger sensitivity, b) recognize the texture of the materials used and c) increase hand's strength as shown in Figure 1. The goal was to modify the activity to assess the sensitivity of fingers and enhance the finger sensitivity of individuals with visual impairment. The aim was to facilitate their learning of Braille for reading purposes and improve several skills as shown in Figure 1.

Therefore, a series of activities were organized, with each activity station offering a unique game that utilized different materials, such as sand, rice, fingerpaint, and playdough with different mission. Every prepared activity was centred around a tactile experience that is appropriate for enhancing finger sensitivity as shown in Figure 2. Hence, to gauge the impact and reflection of the module, an assessment model was used upon completion including game assessment for each game station, overall evaluation of module and perception of module among the participants to achieve the learning objectives of the modules. The analysis on finger sensitivity was also included in the module where finger test using two-point discriminator (TPD) was carried out before and after each game station.

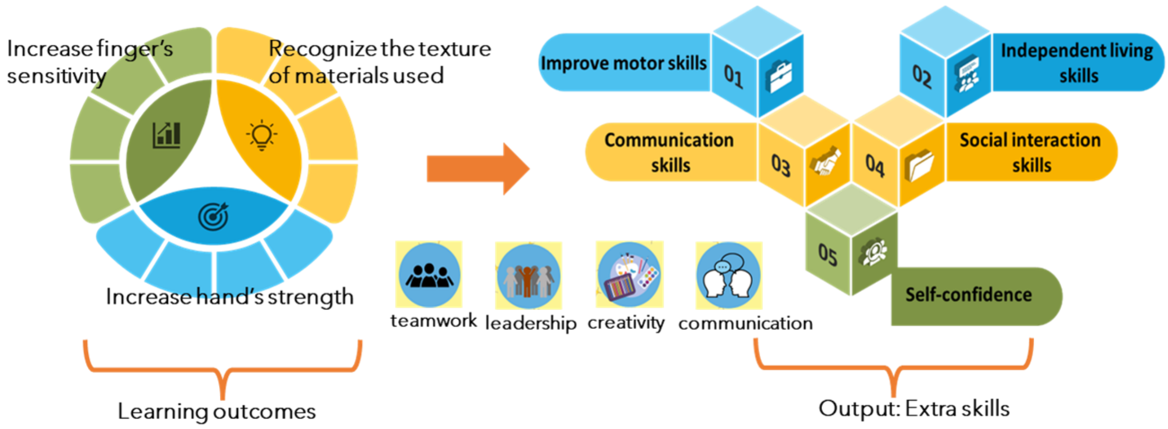


Figure 1: Learning outcomes and extra skills developed from activity module

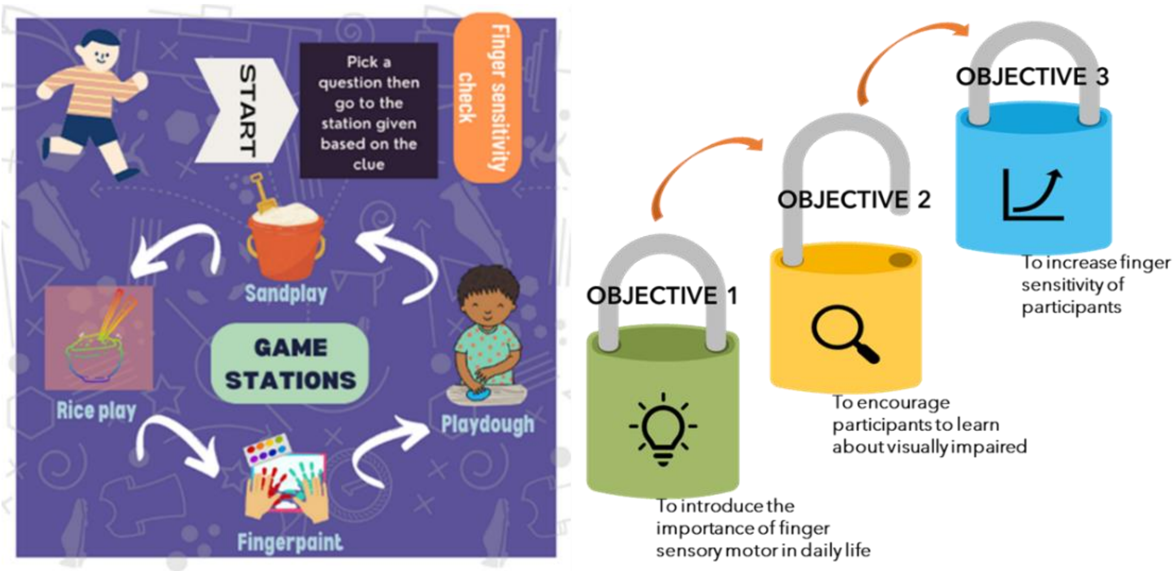


Figure 2: Game stations developed to achieve learning objectives.

2.3 Implementation of Sensory Play Activity Module

2.3.1 Sampling and module execution

A purposive sampling method was utilized to select participants for this study. Seventeen participants (10 females and 7 males) between the ages of 14 and 15 were chosen to represent a demographic likely to benefit from improved finger sensitivity due to their involvement in Braille learning class. To simulate the experience of being visually impaired, the participants performed the module with their eyes closed during finger sensitivity test. During the implementation, each game station process and concepts behind the activity were delivered by the instructor and at the conclusion of the program activity, a survey was administered to evaluate its efficacy.

2.3.2 Tactile sensitivity test

The tactile sensitivity was evaluated through the implementation of a tactile sensitivity test using the baseline two-point discriminator (TPD) as a tool. The test was conducted by placing the two tips of the device on the test site, with the stimulus intensity adjusted to a level that the subject could perceive as consistent touching or movement without experiencing any discomfort or pain. The TPD test began with an initial distance of 10 mm, which was gradually reduced to 5, 4, 3, and 2 mm. If the subject was unable to perceive the initial distance accurately, a longer distance was employed as the initial distance. A threshold was established using a descending stimulus magnitude, and an intermittent point was introduced during the descending series to prevent the subject from anticipating a continuous decrease in the distance between the two points. If the subject responded correctly to the changes, the distance between the points decreased in 1 mm intervals. This process continued until the subject answered incorrectly, at which point the experimenter returned to the next longer distance, indicating the endpoint of the TPD test (Won et al., 2017; Dane et al., 2017). The subjects had three choices for their responses: "one" if they felt a single point, "two" if they perceived two distinct points, or "I can't discriminate one or two" if they couldn't differentiate between one or two points. Any response outside these options was considered incorrect.

Throughout the implementation of sensory play module, an instructor conducted a finger test on all participants before and after each activity. an instructor conducted a finger test on all participants before and after each activity. The test was carried out in a separate room, kept at room temperature to minimize the influence of temperature on finger sensitivity, as investigated by Won et al. (2017). The subjects were comfortably seated in parallel with the instructor, and care was taken to ensure that there were no obstacles present that could interfere with the test. Throughout the test, the subjects were instructed to keep their eyes closed.

2.4 Assessment and Analysis of Impact of Module Implementation

2.4.1 Satisfaction Survey

After administering a set of questionnaires for sensory play module execution, both qualitative and quantitative analyses were conducted. These analyses were based on criteria that included participant information, activity effectiveness, program effectiveness, and suggestions for improvement. Participants responded to the questions using a Likert scale, and the highest percentage of responses for each question was used to draw inferences and identify relationships between the items. The outcomes of the analysis can help the instructor to enhance the functionality of sensory play module and improve finger sensitivity. In addition, the instructor's evaluation was also included in the analysis to examine participant engagement and performance across each game station, using both qualitative and quantitative methods.

2.4.2 Interview

To anticipate potential inquiries that could provide insightful responses, interviews were conducted with a group of selected participants who shared similar demographics and characteristics at the conclusion of the sensory play module implementation. These interview sessions were recorded and subsequently transcribed.

3. RESULTS AND DISCUSSION

3.1 Insight into Sensory Play Activity Module

The module consists of four (4) game stations prepared for all participants. Each participant must test for their finger sensitivity level before stated each game to investigate the effect of the prepared game on their level of finger sensitivity. This module activity selects sand, paint, playdough and rice as the main item for improving finger sensory. Finger painting is one of the activities that can train fine motor skills in students because finger painting activities focus on students' hand movements to paint colours on paper freely (Kurniawati et al.2018; Sawitri et al. 2019). Meanwhile, playdough is a sensory play that is especially important for social connection and interpretation surrounding among people who are beginner to improve their finger and hand sensory (Jameel et al., 2019; Majumdar, 2020).

At the sand play station, the materials needed are tray and three different types of sand. Each participant is instructed to search for a hidden treasure that contains three distinct types of sand. The participants are free to use their sand to creatively design and decorate any shape they desire. Meanwhile, at the fingerpaint game station, the instructor will assess teamwork skills through a riddle. the materials needed are drawing sheets and paint colours. Participants will work together in groups to answer the riddle given by the instructor, and the answer must be presented in the form of finger paint using different paint colours. At the playdough station, three types of materials will be provided, namely clay, playdough foam, and playdough. The instructor will select a shape that must be created using the given materials. In the rice play station, three types of rice will be used: basmati rice, white rice, and ponni rice, each with a different texture. The rice will be mixed with vinegar in a ziplock bag, and participants will use their creativity to draw on the rice within a frame. Instructions for each game stations were summarized in Figure 3(a), 3(b), 3(c) and 3(d), respectively.

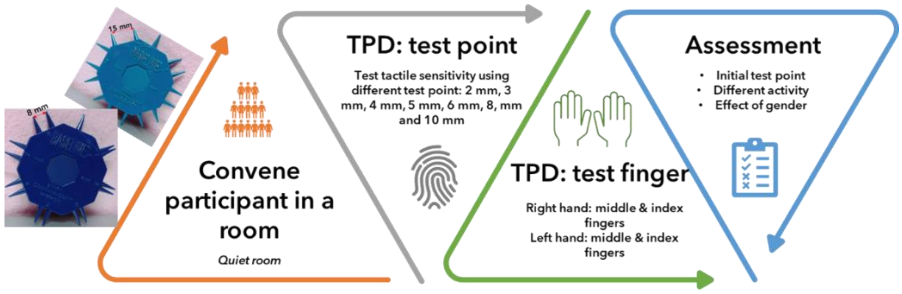
(a) (b)

(c) (d)

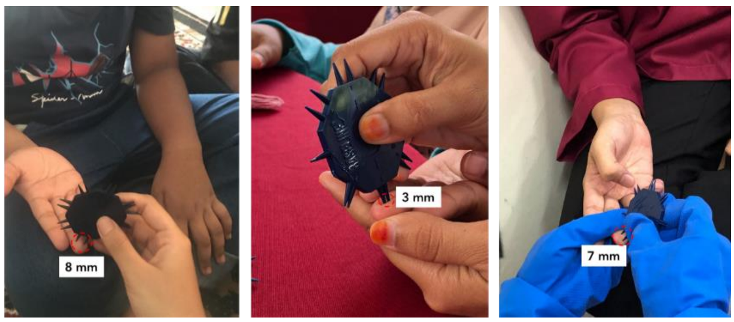
Figure 3: Game instruction for (a) sand play (b) fingerpaint, (c) playdough and (d) rice play in sensory play module

3.2 Tactile Test Implementation

As depicted in Figure 4(a), the TPD consists of two compass points with a maximum distance of 20 mm and a minimum distance of 2 mm. A larger distance between the two adjacent points indicates reduced finger sensitivity. TPD test was implemented towards participants before and after each activity performed. Figure 4(a), the flow process depicts how the test was conducted with the participants' eyes closed. Following each activity, the participants were assembled in a room, and the test was conducted separately for their four different fingers: the index and middle fingers of both the left and right hand, respectively. On the other hand, Figure 4(b) illustrates the test being performed at various test points.



(a)



(b)

Figure 4: Tactile implementation (a) using TPD and its flow and (b) various test point tested using tactile test.

3.3 Finger Sensitivity Test Results

Figure. 5(a), 5(b), 5(c) and 5(d) displays the initial percentage (before sensory play) and the corresponding percentage (after sensory play) of finger sensitivity in the right middle finger (RMF), right index finger (RIF), left middle finger (LMF) and left index finger (LIF) among the participants prior to implementing the sensory play module, respectively. In the context of the finger sensitivity test, a higher test point indicates decreased sensitivity, while a lower test point suggests heightened sensitivity. The data shows a clear rise in the percentage of finger sensitivity at test points 2 and 3 across all test fingers. This finding suggests that as the test points get closer, finger sensitivity increases, indicating an improved ability to perceive the distance between two points. In contrast, the percentage allocation of test points 4 and 5 decreased, with the values being reassigned to the enhanced test points 2 and 3.

Remarkably, participants observed an overall rise in sensitivity in their right middle finger subsequent to engaging with the sensory play activity module. Test point 4 experienced a complete reduction of 100%, while test point 5 exhibited a decrease of 79.9%. In contrast, test points 2 and 3 demonstrated significant increases of 67% and 83.43%, respectively. Similarly, participants' right index finger sensitivity improved after the sensory play activity module. Test points 4 and 5 decreased by 49.8% and 100%, respectively. Conversely, test point 3 displayed an increase of 60.2.4%. Moving to the left middle finger of the participants, the data indicates a substantial enhancement in finger sensitivity. Test point 2 and test point 3 increased by 25.1% and 71.4%, respectively, while test points 4 and 5 decreased by 100%. Lastly, the sensitivity of the participants' left index finger increased following the sensory play activity module. Test point 2 demonstrated a significant increase of 298.3%, in contrast to test point 4, which experienced a decrease of 298.3%.

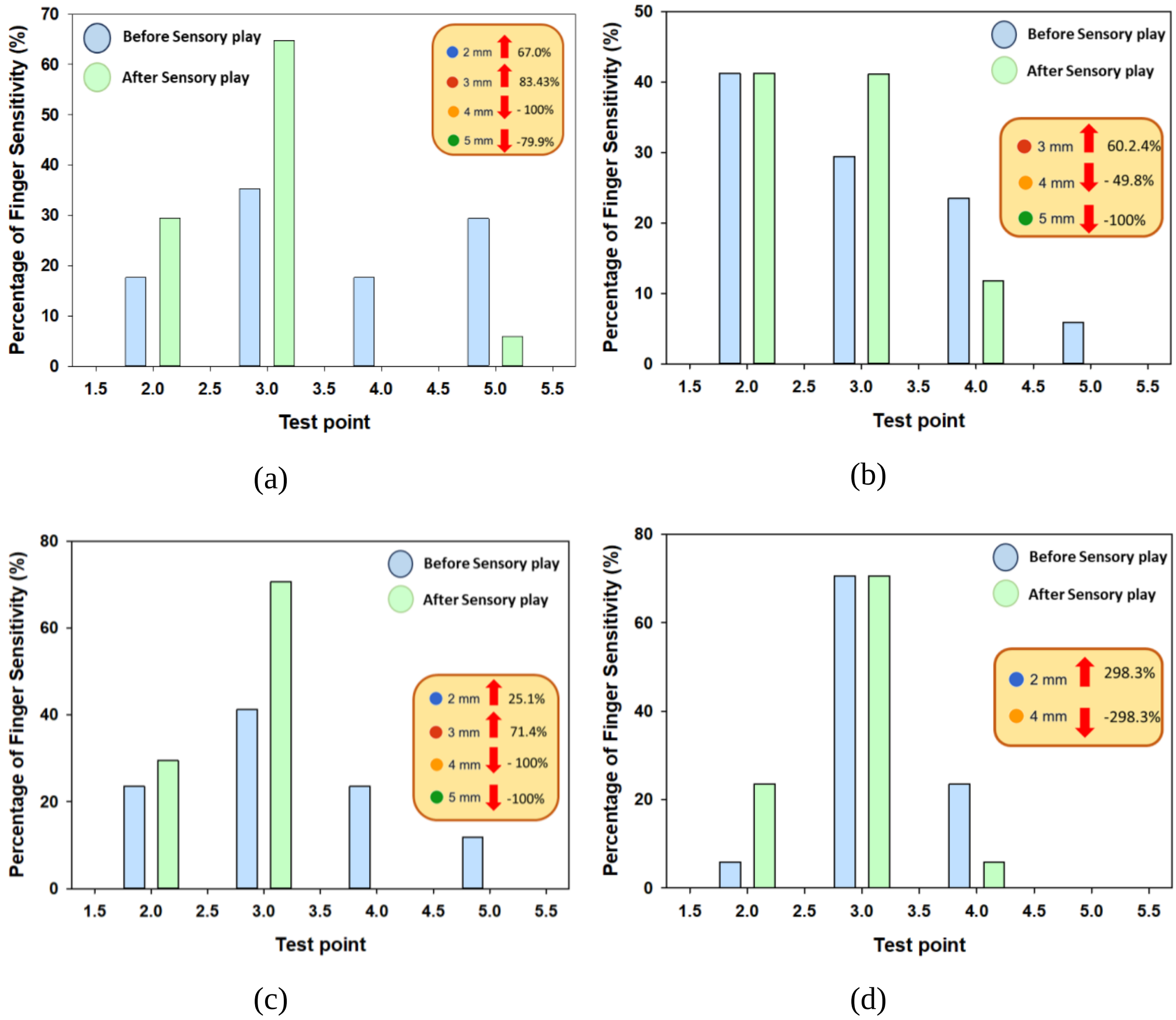


Figure 5: Percentage of finger sensitivity before applying sensory play activities for (a) Right middle finger, (b) Right index finger, (c) Left middle finger and (d) Left index finger at different test point.

3.4 Implementation of Sensory Play

Figure 6 (a) to Figure 6(f) illustrates the execution of sensory activities across four game stations, along with the finger sensitivity test conducted before and after the activities. All participants were able to comprehend and successfully complete each activity through active participation. Additionally, a significant majority of 82% found the instructions provided to be highly accessible and easy to comprehend. These findings highlight the effectiveness of the sensory program in engaging participants and facilitating improved finger sensitivity (Manzano-Leon et al., 2021).

(a)

(b)

(c)

(d)

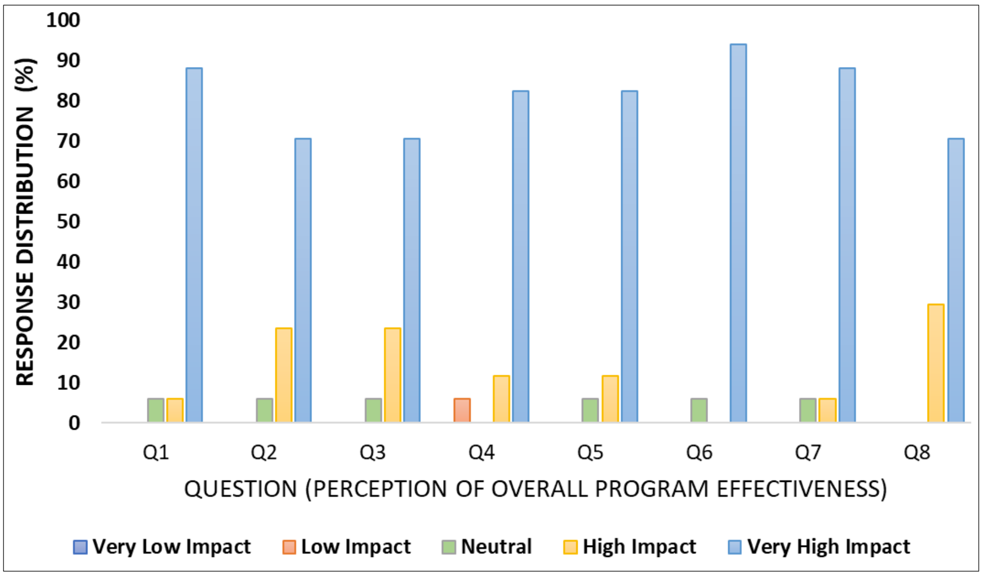
(e)

(f)

Figure 6: Implementation of sensory play activities

3.5 Impact of Sensory Play on Tactile Sensitivity

In Figure 7, the influence of sensory play module on the program's overall effectiveness is demonstrated. Additionally, Figure 7 also displays the questions posed to the participants, revealing that their responses consistently indicated a significant impact across all aspects. More specifically, in question Q6, the majority of participants, with a percentage of 94.12%, selected the "Very High Impact" rating on the scale. During the feedback, participants expressed their belief that this program has the potential to enhance community awareness regarding individuals with visual impairments. Furthermore, the participants demonstrated a high level of satisfaction with the activities, with 88.24% of them selecting the "Very High Impact" rating on the scale. In Q5, a significant proportion of participants, specifically 82.35%, indicated a "Very High Impact" rating on the scale, expressing their belief that this program can effectively enhance finger sensitivity for visually impaired individuals. These findings align with the results of the tactile tests, which demonstrated a measurable improvement in finger sensitivity after implementing sensory play module. Therefore, the successful implementation of sensory play module has not only had a significant impact on the participants but has also demonstrated notable improvements in finger sensitivity due to their ability to stimulate sensory receptors, integrate sensory inputs, promote active participation and exploration, provide sensory feedback, and leverage the brain's neuroplasticity. These factors collectively contribute to improving tactile sensitivity and the participant's ability to interpret and respond to tactile stimuli (Majumdar, 2020).



Q1: I'm satisfied with the activities prepared in Module.
Q2: I hope that this program can be done again in the future.
Q3: I learn something new through this program.
Q4: I'm interested to join this program.
Q5: I think that this program can be used to help visually impaired people to improve their finger sensitivity.
Q6: This program can improve awareness among community on visually impaired people.
Q7: This program has the potential to serve as an alternative approach to teaching.
Q8: Engaging in these activities offers several benefits within the community.

Figure 7: Likert scale distribution percentage on overall program effectiveness

3.6 Interview

Interviews were conducted to evaluate the effectiveness of the program which aimed aimed to gather insights and feedback from participants regarding the program's impact and outcomes. The interviews revealed positive feedback regarding the program's impact on the participants' knowledge, skills, and overall well-being. Participants reported that their finger sensitivity has increased when playing sensory game specifically for visually impaired people. They also highlighted that all games were interesting to them where they able to improve their confidence and communications skills. The findings indicate that the program effectively promotes empowerment and the application of acquired knowledge in real-life scenarios.

4. CONCLUSION

In conclusion, the establishment of sensory play module has introduced an exceptional learning approach through sensory play, effectively addressing the challenges faced by individuals with visual impairments. The development of sensory play module, comprising four sensory play activities, has proven successful. By incorporating the finger sensitivity test, the implementation of sensory play module has yielded positive outcomes. Notably, it has significantly enhanced tactile sensitivity among the participants, offering a novel and impactful learning experience. This approach serves as an alternative method to support individuals who have recently experienced vision loss by improving their finger sensitivity, which plays a pivotal role in their ability to read braille and actively engage in their daily activities. Overall, sensory play module marks a significant milestone in empowering visually impaired individuals and fostering their educational and functional independence.

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AUTHORS' CONTRIBUTION

NNI and KIBKA developed and implemented the module. FMI, NMN, and SMM contributed to the conceptualization and methodology. MSS refined the data analysis and secured funding. HK contributed to the conceptualization, data analysis, and secured funding.

CONFLICT OF INTEREST

None declared

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