Empowering Learning through Touch by Designing a Tactile Fabric Alphabet for Visually Impaired Learners

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Abstract

The blind and visually impaired are among the groups with the greatest needs for care and assistance, especially in the fields of education and rehabilitation. **This study emphasizes the need to** bridge the gap between visual and tactile education because conventional educational materials often lack the tactile clarity and durability that the blind need to learn effectively. **The goal of this research** is to improve multimodal learning for visually impaired people by using the Jacquard technique to create an innovative tactile textile alphabet that features raised letters, Braille dots, and corresponding images. The research aims to improve educational outcomes and literacy for the blind community by creating a durable and easily accessible alphabet learning aid.

The objective of the present work is to create a tactile educational textile with easily identifiable components that allow students utilizing touch to investigate both abstract and tangible symbols. To gather feedback and ensure the fabric's effectiveness, the method involves creating digital designs, choosing suitable decorative yarns, weaving the fabric on a Jacquard loom, and testing it on blind individuals. The assessment concentrates on user feedback, tactile usability, and durability. The results show how a highly effective teaching tool can be developed to improve tactile learning and engagement for blind learners. This endeavor aims to create a novel and beneficial teaching tool that fosters inclusivity and participation, ultimately enhancing educational outcomes for the blind community by utilizing tactile features and Jacquard technique.

Keywords

Visually Impaired, Tactile Fabric Alphabet, Braille Dots, Jacquard Technique, Tactile Learning.

الملخص

إن المكفوفين وضعاف البصر من الفئات الأكثر احتياجًا للرعاية والمساعدة، وخاصة في مجالي التعليم والتأهيل. **تؤكد هذه الدراسة** على الحاجة إلى سد الفجوة بين التعليم البصري واللمسي لأن المواد التعليمية التقليدية غالبًا ما تفتقر إلى الوضوح اللمسي والمتانة التي يحتاجها المكفوفون للتعلم بشكل فعال. **الهدف من هذا البحث** هو تحسين التعلم المتعدد الوسائط للأشخاص المكفوفين باستخدام تقنية الجاكارد وذلك من خلال إنشاء أبجدية نسيجية لمسية مبتكرة تتميز بأحرف بارزة ونقاط

برايل وصور مقابلة. ويهدف البحث إلى تحسين النتائج التعليمية ومحو الأمية لمجتمع المكفوفين من خلال إنشاء وسيلة تعليمية أبجدية متينة يسهل الوصول إليها.

الهدف من العمل الحالي هو إنشاء نسيج تعليمي لمسي بمكونات يمكن التعرف عليها بسهولة تسمح للطلاب باستخدام اللمس لاستكشاف الرموز المجردة والملموسة. لجمع الملاحظات وضمان فعالية القماش، تضمن البحث إنشاء تصميمات رقمية واختيار خيوط زخرفية مناسبة ونسج القماش على نول جاكارد واختباره على الأفراد المكفوفين. وقد ركز التقييم على ملاحظات المستخدمين، وسهولة الاستخدام اللمسية، والمتانة. وأظهرت النتائج كيف يمكن تطوير أداة تعليمية فعالة للغاية لتحسين التعلم اللمسي والمشاركة للمتعلمين المكفوفين. يهدف هذا المسعى إلى إنشاء أداة تعليمية جديدة ومفيدة تعزز الشمولية والمشاركة، مما يعزز في النهاية النتائج التعليمية لمجتمع المكفوفين من خلال الاستفادة من الميزات اللمسية وتقنية الجاكارد.

الكلمات المفتاحية

ذوي الإعاقة البصرية، الأبجدية النسيجية التلمسية، نقاط البرايل، تقنية الجاكارد، التعلم اللمسي.

Introduction

Education is a cornerstone of personal and societal development, serving as a critical factor in shaping individuals' knowledge, skills, and abilities. It fosters cognitive development, critical thinking, and the acquisition of essential life skills. Education not only enhances individual potential but also contributes to economic growth, social stability, and cultural enrichment. An inclusive education system ensures that every individual, regardless of their abilities or disabilities, can access quality education, thereby promoting equality and social integration. For the blind and visually impaired, education is particularly significant as it provides the tools and skills necessary for independent living and active participation in society. Traditional educational materials, however, often lack the tactile clarity and durability required for effective learning by visually impaired individuals. This gap in educational resources can lead to significant barriers in literacy, employment, and social integration for the blind community. Therefore, it is crucial to develop specialized educational tools that cater to their unique learning needs and enhance their educational experiences.

Importance of the Research

This research is vital because it addresses the need for innovative educational materials that bridge the gap between visual and tactile learning. By developing a tactile textile alphabet using the Jacquard technique, this study aims to create a durable and accessible learning aid that can significantly improve educational outcomes for visually impaired learners. The creation of such a tool will not only enhance literacy but also foster greater independence and societal participation for the blind community.

Research Problem

Traditional educational materials often fail to meet the tactile needs of visually impaired students, leading to gaps in their learning and hindering their ability to achieve educational and social milestones. Current tactile educational tools are often limited in their durability, accessibility, and engagement. There is a pressing need for more effective, durable, and engaging tactile educational resources.

Research Objectives

1. To design an innovative tactile textile alphabet incorporating raised letters, Braille dots, and corresponding images using the Jacquard technique.
2. To enhance the multimodal learning experience for visually impaired individuals through the development of a durable and accessible tactile educational tool.
3. To evaluate the effectiveness of the tactile fabric alphabet in improving literacy and educational outcomes for visually impaired learners.
4. To gather feedback from visually impaired users to refine and optimize the design for maximum educational benefit.

Research hypotheses

1. The use of a tactile textile alphabet with raised letters, Braille dots, and corresponding pictures would significantly improve the literacy outcomes of visually impaired learners compared to traditional non-tactile learning materials.
2. Visually impaired learners would find the research-designed tactile textile alphabet more durable and effective for long-term learning compared to traditional tactile learning materials.

3. The combination of abstract (raised letters) and tactile (Braille dots and corresponding pictures), symbols in the tactile textile alphabet would enhance the ability of visually impaired learners to associate letters with their alphabetic form, their Braille equivalents, and their corresponding words.
4. Tactile learning materials designed with decorative threads would be rated as higher in tactile usability and engagement by visually impaired users compared to other non-textile tactile tools.
5. The introduction of the tactile textile alphabet would increase learner motivation and engagement in learning activities among visually impaired students compared to current non-tactile learning resources.

Research Methodology

The research will follow an empirical analytical approach.

Steps in the procedure

The study will employ a methodical methodology comprising many crucial stages:
1. Literature Review: Perform an extensive analysis of the body of research on tactile learning, Braille, Jacquard weaving, and assistive technology for the blind.

2. Design and Development: Make digital designs for the tactile alphabet, choose suitable materials, then use a Jacquard loom to weave the fabric.
3. User Testing: To get input on the usability and efficacy of the tactile fabric alphabet, do user testing sessions with people who are visually impaired.
4. Evaluation: Examine user testing input, the fabric's longevity and tactile usefulness, and how it affects learning objectives.
5. Refinement: Make use of the gathered information to enhance the instructional tool's design.

Research's limitations:

• **Scope**: The study will concentrate on creating and assessing a tactile fabric alphabet that is especially meant for learners who are blind or visually impaired. It won't address other facets of blind education, such using digital or audio learning resources.

•**Research Samples Implemented**

5 research samples were designed based on the first five letters of the English alphabet (A, B, C, D, E) and each sample consists of five elements as follows:
The letter.
• It's corresponding representation in Brialle.
• A word that begins with the letter.
• It's Braille representation.
• A simple image picturing the word.

•**The implementation method used**: Regular pattern
• **Sample Size**: Because of budget limitations, user testing will only involve a small number of visually challenged people.
• **Geographical Restrictions**: The study could only include participants from a restricted geographic area, which could have an impact on how broadly applicable the results are.

Mechanisms of Research

1. Digital Pattern Development: To produce accurate digital patterns for the tactile alphabet, use computer-aided design (CAD) software.
2. Material Selection: Pick ornamental yarns and materials that are both tactile and long-lasting.
3. Jacquard Weaving: To weave the intended patterns into the cloth, use a Jacquard loom
4. User Testing and Feedback Gathering: Hold organized user testing sessions, gather both qualitative and quantitative input, and do data analysis.
5. Data Analysis: Assess the feedback and ascertain the efficacy of the tactile fabric alphabet using statistical and thematic analysis techniques.
6. Refinement and Iteration: To provide the best possible educational usefulness, make design adjustments based on user input and retest.

Theoretical Framework

A good education is the key to success, and every person deserves an equal opportunity to receive a good education. Inherent in education is being literate. The ability to read and write means access to information, which in turn leads to understanding and knowledge. Knowledge is power—the power to achieve, to function in a family, to thrive in society, to succeed in work, and to contribute to society. (**1)** (The Braille Literacy Crisis in America, March 26, 2009)

Daily tasks can be exceedingly challenging for individuals with visual disabilities, impacting their ability to work, learn, travel, and maintain general health, especially for those living alone. The Vision Loss Expert Group has observed a consistent annual increase in cases of blindness and visual impairment worldwide, with the World Health Organization estimating that 2.2 billion people of all ages are affected. Effective communication, a fundamental human trait, is essential for maintaining relationships with neighbors, friends, family, and coworkers. However, significant concerns exist about how blind individuals engage with the world, communicate, and learn. The global prevalence of visual impairment in children is estimated at 0.78%, with blindness around 0.03%. These rates vary by region, with higher prevalence in low- and middle-income countries compared to high-income ones. Visual impairment and blindness are most common in children aged 0-15 years, particularly in the 0-5 age group, underscoring the importance of early intervention. The leading causes of visual impairment in children include refractive errors, congenital abnormalities, and retinopathy of prematurity (ROP), while cataracts, congenital abnormalities, and corneal scarring are primary causes of blindness. Regional disparities are pronounced, with sub-Saharan Africa and South Asia experiencing the highest prevalence, largely due to differences in healthcare access, socio-economic factors, and preventable conditions like vitamin A deficiency. (2) (Mohamed, Salah, & Farghal, March 2023)

(3) (Yekta, et al., january-March 2022)

The history of blind education begins with Valentine Howe's founding of the first school for the blind in 1784. The Braille system, invented by blind student Louis Braille in 1824, revolutionized the education of the blind by providing an easy-to-use method of reading and writing. Samuel Gridley Howe, founder of the Perkins School for the Blind, advocated an integrated approach that included music, physical education, and vocational training. Blind education techniques include individualized, multisensory curricula that combine tactile, auditory, and kinesthetic learning strategies. These developments have greatly expanded educational options for blind students. (4) (w. H. ILLINGWORTH, 1910)

Braille Method

- Braille is a tactile writing system invented by Louis Braille in the 19th century. It consists of patterns of raised dots arranged in a 3×2 grid, with each configuration representing a different letter, number, punctuation mark, or symbol.

The importance of Braille is evident as a tool for literacy and independence among blind individuals.

Braille Structure:

- The Braille system is based on groups of up to six dots per cell. Each cell can represent a single letter, number, or punctuation mark [(5)] (LOOMIS, 1934)[(6)] (Cooter, 2014)
- For example:

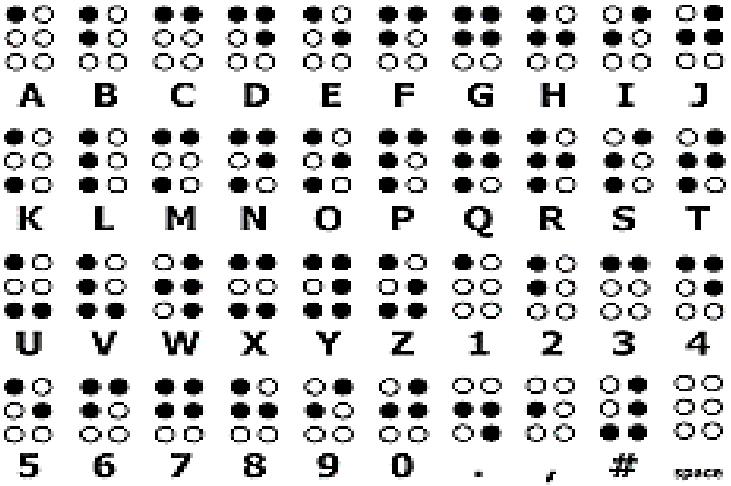

Figure (1) Braille Structure [(6)]

Multimedia learning involves integrating multiple forms of media, such as text, audio, graphics, and interactive elements, to create a rich, multisensory learning experience [(7)]. (Casey)

- For blind and visually impaired individuals, multimedia systems rely primarily on audio descriptions, tactile feedback, and sometimes haptic technology to convey information that may otherwise be presented visually.

The Importance of Multimedia Learning for the Blind:

- Enhanced accessibility: Multimedia systems make educational content more accessible by converting visual information into audio or tactile formats, enabling blind students to interact with the material effectively.
- Multisensory engagement: By leveraging different sensory media, multimedia learning can meet the diverse needs of visually impaired learners, enhancing understanding and better retention of information.
- Interactive learning: Interactive elements, such as audio quizzes, tactile graphics, and Braille interfaces, promote active participation and engagement, which are essential for effective learning [(8)]. (Iqbal, Ashraf, & Amjad, Vol. 8, No 2, June 2022)

Our Article on Tactile Learning Focuses on:

- Tactile graphics: Raised line graphics and tactile maps allow blind individuals to explore graphic information through touch. These tools are essential for subjects that rely heavily on visual content, such as geography and biology.
- Studies have shown that multimedia learning systems significantly improve educational outcomes for blind and visually impaired students. These systems support independent learning, enhance engagement, and facilitate a deeper understanding of complex material.

"Multimedia Systems for Blind and Visually Impaired People" emphasizes the transformative potential of multimedia learning in the education of blind individuals. By converting visual information into accessible audio and tactile formats, these systems create an inclusive learning environment that meets the unique needs of blind learners. [9] (Andreja Samčović & Čičević, 2017)[10] (Guerreiro, et al., 2013)

Textile industry is one of the oldest industries. Textiles play an important role in our daily life. They meet the basic human needs for clothing and protection and meet the basic demand for a variety of other uses. They are also used in industrial and scientific processes such as filtration, etc. [11] (Woven textiles, October 2013)

Computers have played an important role in developing designs easily. They reduce the cost of production. The visual appearance of the fabric can be seen by stimulating it on the computer. Computers and electronic devices are important in developing the design using advanced CAD. We will use this in our research paper as will be explained later. [12] (Zhang & Zhou, 2017)

One of the most significant developments in cutting-edge textile science and technology is digital textile design, namely in jacquard textile design. The creation of novel textile items is valuable both artistically and commercially. This is significant and difficult because digital processing of a woven structure is intricate. Jacquard fabric's woven structure is the only way to generate the color and pattern effect since it is made of interlaced warp and weft threads. Thus, the future design innovation of jacquard fabric depends heavily on innovations in fabric structure. The following is a list of the precise goals of using digital technologies to innovate jacquard fabrics.

1. Use digital technology to reimagine the notion, techniques, and protocols of jacquard fabric design, substituting the conventional one-level design pattern.
2. Using the concepts and techniques of digital design, investigate and broaden the creative potential of woven textile structures and their color expression.
3. Examine the best techniques for structural design in light of the multi-layer design pattern.
4. Provide a theoretical framework for designing digital jacquard fabrics. Using this framework, several fabric databases will be made, enabling the design and production of digital jacquard fabrics under a range of processing circumstances and textile technical requirements.
5. Make models of jacquard fabric to help explain and show how digital jacquard fabric design simulates and has creative effects.
6. Create a creative jacquard fabric with digital tools. (13) (Ng & Zhou, 2013)

Accordingly, jacquard weaving is a very important technique for the development of tactile textiles, as the use of jacquard offers many variations, especially for textiles used in educational tools designed for the blind. By taking advantage of the precision and adaptability of this weaving method, researchers can create tactile surfaces with patterns of different heights, such as letters or symbols that can be easily recognized by touch. This has significant implications for inclusive education, as tactile learning materials are essential for blind or

visually impaired students, allowing them to access information through touch, thus enhancing their learning experience.

Experiments of the Research

This work aims to produce a tactile fabric alphabet as a learning tool for visually impaired and sighted individuals.

Design of the Samples under Study

- 5 research samples were designed based on the first five letters of the English alphabet (A, B, C, D, E) and each sample consists of five elements as follows:
- The letter.
- It's corresponding representation in Brialle.
- A word that begins with the letter.
- It's Braille representation.
- A simple image picturing the word.

FIGURE (2) SAMPLE 1 DESIGN

FIGURE (3) SAMPLE 2 DESIGN

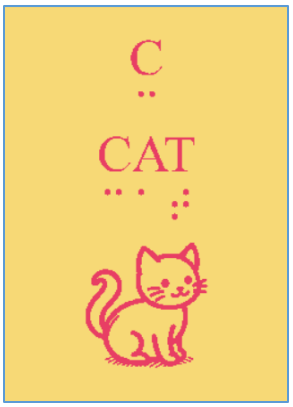

FIGURE (4) SAMPLE 3 DESIGN

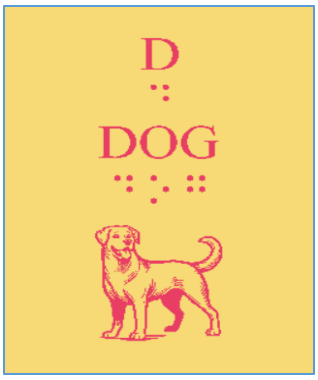

FIGURE (5) SAMPLE 4 DESIGN

FIGURE (6) SAMPLE 5 DESIGN

Technical Specifications

Specifications of the Loom

The produced samples were woven at Textile Design Center in the Faculty of Applied Arts, Helwan University. The loom specifications are indicated in Table (1).

TABLE (1) LOOM SPECIFICATIONS USED FOR PRODUCING FABRICS UNDER STUDY

No.	Item	Specifications
1	Loom Model / Type	SMIT
3	Country of Manufacturing	Italy
4	Year of Manufacturing	2008
5	Width of Machine	190 cm
6	Speed of Machine	300 Picks/ Min.
7	Method of Weft Insertion	Rapier
8	Weft Selector	8 Fingers
9	Reed Used (Dents/ cm)	9 Dents/ cm
10	Denting	8 Ends/ Dent
11	Color of Warp Threads	White

Specifications of the Jacquard Used for Producing the Fabrics

The jacquard specifications that were used for producing the samples under study are shown in Table (2).

No.	Item	Specifications
1	Jacquard Model	STAUBLI
2	Number of Hooks	3072 Hooks
3	Design Hooks	2560
4	No. of Repeats	4
5	Repeat Width	35.5 cm

Specifications of the Produced Samples

The specifications of the produced fabrics are represented in Table (3).

TABLE (2) PRODUCED FABRICS SPECIFICATIONS

No.	Property	Specifications
1	Material of Warp Yarn	Polyester
2	Material of Weft Yarn	Polyester, Chenille
3	Warp Yarns Count	150/1
4	Weft Yarns Count	150/1 for Polyester, 4 Metric for Chenille
5	Warp Sett	72
6	Weft Sett	25

Materials Used for the Produced Fabrics

The produced samples were woven using Polyester for both warp and weft threads as the base of the fabric, and the protruding effect was accomplished using the Chenille yarn.

Reasons for Selecting Chenille Yarn

- The Chenille yarn is distinguished for its bulky texture and soft handle that contribute to a more tactile effect in the fabric.

- It is known for its durability, making the fabric to be sustainable in the long run of repeated handling.
- Its softness makes the fabric to be comfortable when touched, and this enhances the tactile experience.

Weave Structure Used

Two weave structures were used in the produced fabrics, one for the Polyester ground (weft satin 5) as indicated in Figure (8), and the other for the Chenille patterns (weft satin 20) pictured in Figure (7).

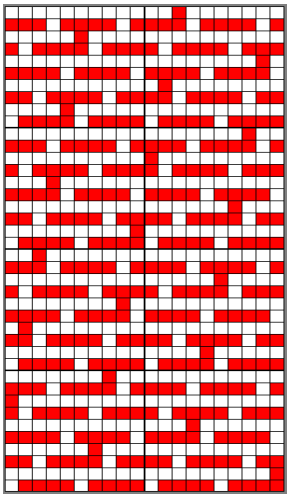

FIGURE (7) A WEFT SATIN 20 WEAVE FOR THE CHENILLE GOUND

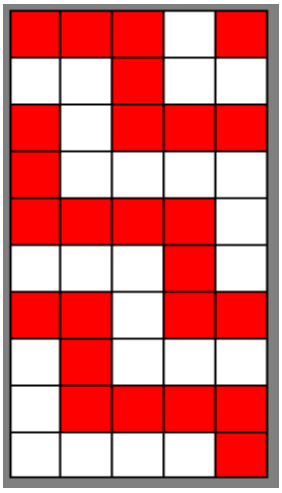

FIGURE (8) A WEFT SATIN 5 WEAVE FOR THE POLYESTER GOUND

The Produced Fabrics

Figures from (8) to (13) picture the woven fabrics under study, and Figures from (14) to (19) Illustrate the samples throughout the weaving procedure.

FIGURE (9) PRODUCED SAMPLE 1

FIGURE (10) PRODUCED SAMPLE 2

FIGURE (11) PRODUCED SAMPLE 3

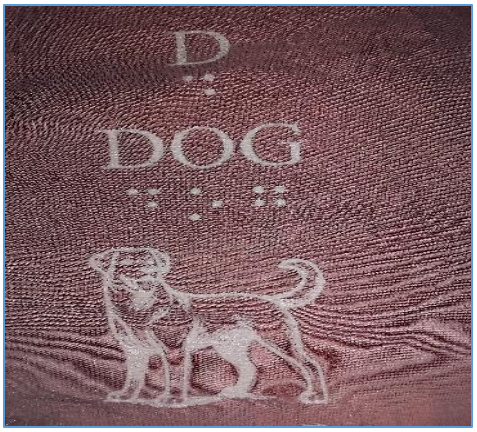

FIGURE (22) PRODUCED SAMPLE 4

FIGURE (33) PRODUCED SAMPLE 5

FIGURE (44) RESEARCH SAMPLES DURING WEAVING PROCESS (A)

FIGURE (55) RESEARCH SAMPLES DURING WEAVING PROCESS (B)

FIGURE (66) RESEARCH SAMPLES DURING WEAVING PROCESS (C)

FIGURE (77) RESEARCH SAMPLES DURING WEAVING PROCESS (D)

FIGURE (88) RESEARCH SAMPLES DURING WEAVING PROCESS (E)

FIGURE (99) RESEARCH SAMPLES DURING WEAVING PROCESS (E)

Interpretation of Results

A field study survey was conducted to collect participants' views on the produced fabrics, with the collected data subsequently analyzed.

Data Collecting

Survey Participants

Three categories of participants were selected for the survey as follows:

- **Visually impaired and sighted teachers:** These participants were included because they are familiar with the needs and challenges of visually impaired learners, and they can offer valuable insights on how the tangible fabric alphabet might be combined into classrooms.
- **Visually impaired individuals:** These individuals can provide a crucial assessment of the overall design effectiveness, usability and clarity of the tactile fabric alphabet.
- **Blind students:** Since blind students are the primary target audience, they can evaluate the efficiency of the tactile fabric alphabet in facilitating their learning.

Questions of the Survey

Table (4) indicates the survey questions. The survey is divided into three parts:

- **Demographic information:** Collecting details about the contributors to better understand the target audience.

- **Assessment of the samples:** Evaluating participants' opinions about the samples under study. This section was separated into two parts: Design and clarity evaluation and assessment of the effectiveness.
- **Feedback and suggestions:** Gathering participants' feedback and any recommendations for improvement.

TABLE (4) THE SURVEY QUESTIONS

No.			
1	Demographic Information		Age.
2			Gender.
3			Level of visual impairment (visually impaired / blind).
4			Current educational level.
5			Do you know Braille? (Yes/No).
6	Assessment of the Samples	Evaluation of Design and Clarity	The influence of weft yarn material in clarifying the design elements.
7			To what extent could the raised letters on the fabric be recognized?
8			The clarity of Braille letters.
9			The clarity of the shape and writing of the APPLE.
10			The clarity of the shape and writing of the BIRD.
11			The clarity of the shape and writing of the CAT.
12			The clarity of the shape and writing of the DOG.
13			The clarity of the shape and writing of the ELEPPHANT.
14		Assessment of the Effectiveness	Does the tactile textile alphabet achieve innovation and creativity?
15			The suitability of tactile textile alphabet as a teaching tool.
16			The achievement of the tangible effect.
17	Feedback and Suggestions		What did you like most about the tactile alphabet?
18			What did you like least about the tactile alphabet?
19			Any suggestions to improve the tactile alphabet?
20			Any comments?

The Field Visit to the Visual Impaired Individuals

As part of the research methodology, a field visit was conducted to gather the feedback from the blind individuals. Figures from (20) to (25) illustrate the assessment of the research samples meanwhile the visit.

FIGURE (20) FIELD VISIT (A)

FIGURE (21) FIELD VISIT (B)

FIGURE (22) FIELD VISIT (C)

FIGURE (23) FIELD VISIT (D)

FIGURE (24) FIELD VISIT (E)

FIGURE (25) FIELD VISIT (F)

.Survey Results

The Assessment of the Samples

Table (5) illustrates participant's results regarding the assessment of the samples part with its two sections: Evaluation of the design and clarity, and the assessment of the effectiveness.

TABLE (5) RESULTS OF THE QUESTIONNAIRE REGARDING THE PART OF THE ASSESSMENT OF THE SAMPLES

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Evaluation of the Design and Clarity					
The influence of weft yarn material in clarifying the design elements.	50%	30%	20%	0%	0%
To what extent could the raised letters on the fabric be recognized?	50%	50%	0%	0%	0%
The clarity of Braille letters.	0%	80%	20%	0%	0%
The clarity of the shape and writing of the APPLE.	0%	70%	30%	0%	0%
The clarity of the shape and writing of the BIRD.	0%	80%	10%	10%	0%
The clarity of the shape and writing of the CAT.	0%	80%	20%	0%	0%
The clarity of the shape and writing of the DOG.	10%	70%	20%	0%	0%
The clarity of the shape and writing of the ELEPPHANT.	0%	80%	10%	10%	0%
Assessment of the Effectiveness					
Does the tactile textile alphabet achieve innovation and creativity?	100%	0%	0%	0%	0%
The suitability of tactile textile alphabet as a teaching tool.	100%	0%	0%	0%	0%
The achievement of the tangible effect.	100%	0%	0%	0%	0%

Survey Data Discussion

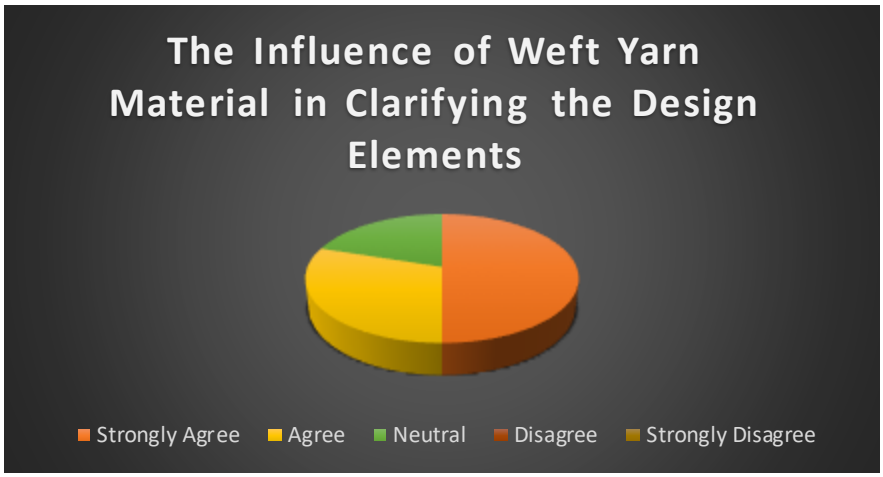

FIGURE (26) PARTICIPANTS RESPONSES REGARDING THE PART OF EVALUATION OF DESIGN AND CLARITY (A)

It can be seen from Figure (26) and Table (5) that half of the participants agreed very strongly that the weft yarn material has a crucial influence in clarifying the design elements, and another 30% agreed with the statement, while a smaller portion, 20%, were unbiased. This means that 80% of the respondents found the weft yarn material beneficial.

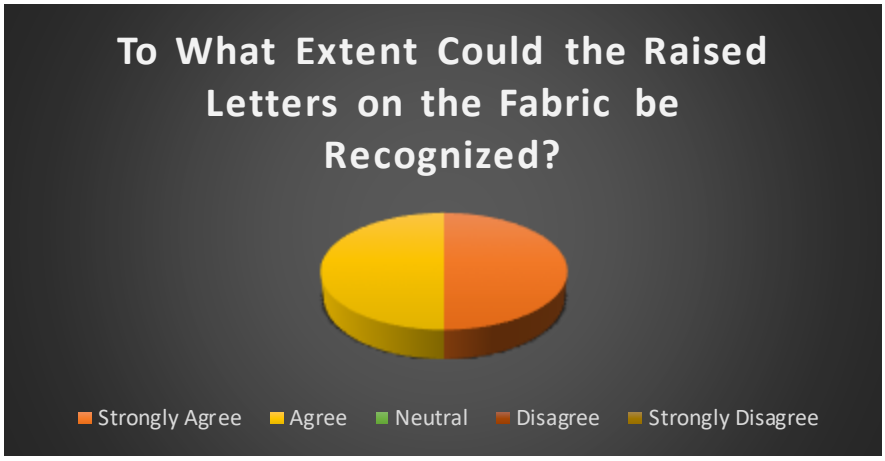

FIGURE (27) PARTICIPANTS RESPONSES REGARDING THE PART OF EVALUATION OF DESIGN AND CLARITY (B)

Figure (27) and Table (5) show respondents percentages regarding the recognition of the raised letters. It is clear that there is a unanimous positive reaction, with all participants realizing the raised letters on the fabric to be recognizable.

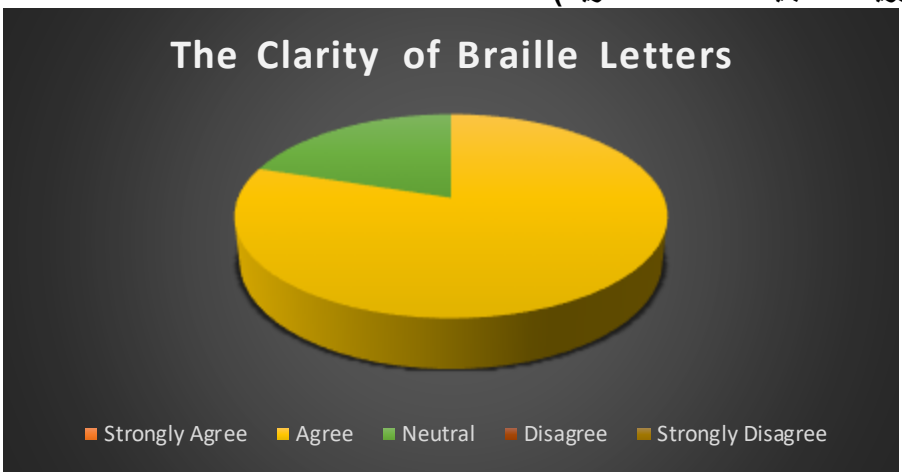

FIGURE (28) PARTICIPANTS RESPONSES REGARDING THE PART OF EVALUATION OF DESIGN AND CLARITY (C)

It can be noticed from Figure (28) and Table (5) that the participants have a positive reception to the Braille letters' clarity with majority agreeing (80%), and 20% remaining neutral. This implies that the majority of users find the Braille letters to be obvious and understandable.

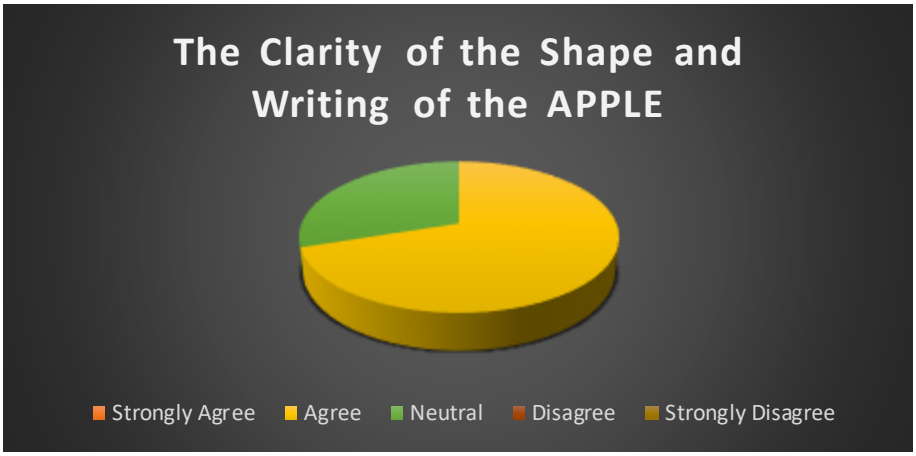

FIGURE (29) PARTICIPANTS RESPONSES REGARDING THE PART OF EVALUATION OF DESIGN AND CLARITY (D)

It is noticeable from Figure (29) and Table (5) that the majority of respondents (80%) agree with the clarity of the shape and writing of the APPLE, while 20% are neutral on the matter. This implies that most of the surveyed group find the design and legibility of the APPLE to be reasonable, with a significant segment being positive about it.

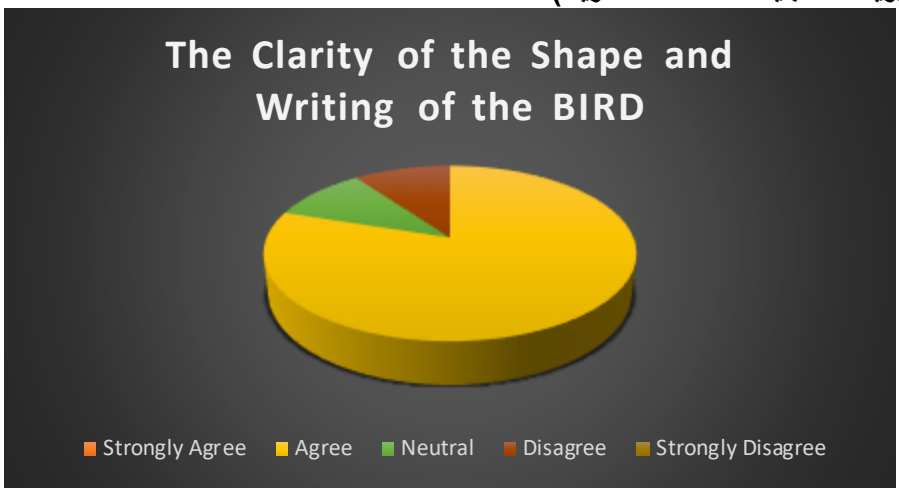

FIGURE (30) PARTICIPANTS RESPONSES REGARDING THE PART OF EVALUATION OF DESIGN AND CLARITY (E)

The survey results pictured in Figure (30) and Table (5) indicate that most of respondents (80%) agree that the shape and writing of the BIRD are clear. However, a small percentage does not find it clear, as reflected by the neutral (10%) and disagreeing (10%) responses.

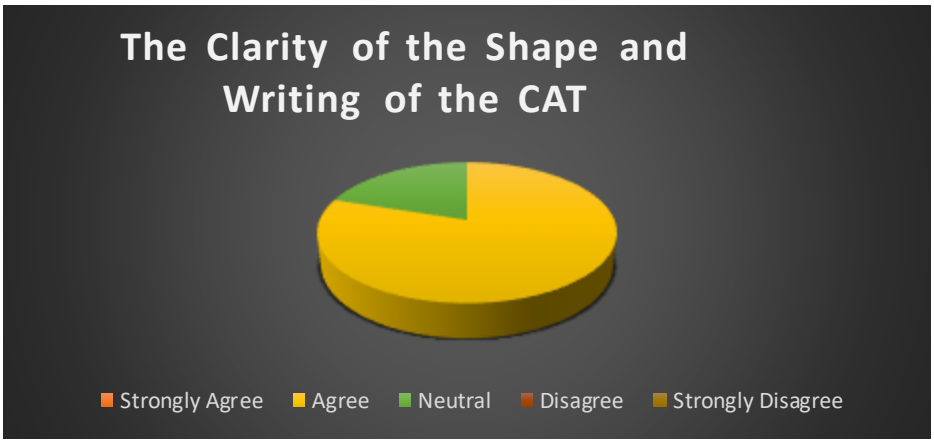

FIGURE (31) PARTICIPANTS RESPONSES REGARDING THE PART OF EVALUATION OF DESIGN AND CLARITY (F)

It is clear from Figure (31) and Table (5) that 80% of respondents agree that the shape and writing of the CAT is clear, while 20% are neutral. This indicates that the majority of participants find the CAT's shape and writing to be easily understandable and clear.

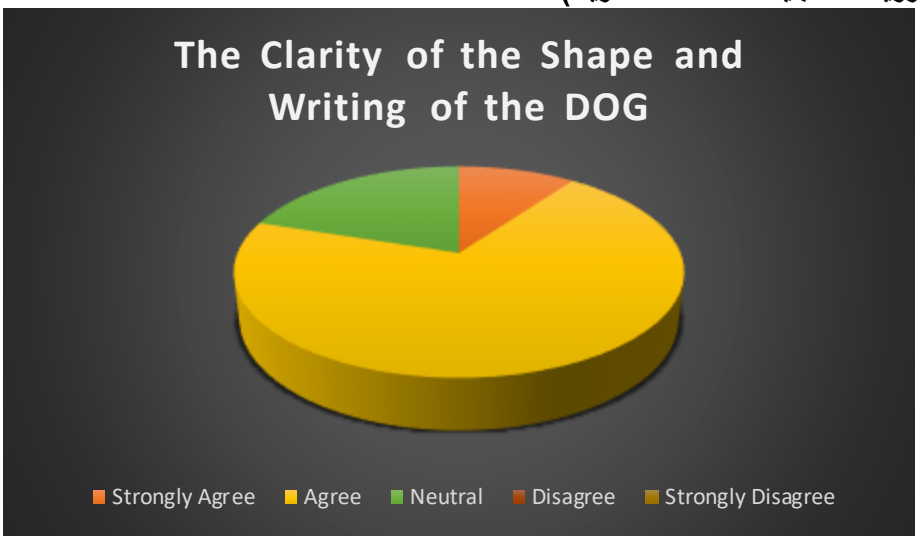

FIGURE (31) PARTICIPANTS RESPONSES REGARDING THE PART OF EVALUATION OF DESIGN AND CLARITY (G)

Figure (31) and Table (5) suggest that feedback about the tactile representation of the shape and writing of the DOG is quite positive, as the majority of the respondents (80% agree) find it to be clear.

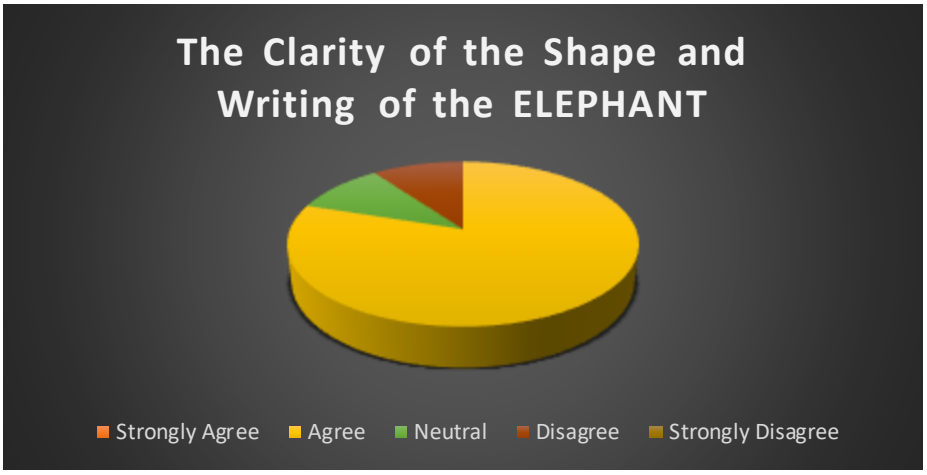

FIGURE (32) PARTICIPANTS RESPONSES REGARDING THE PART OF EVALUATION OF DESIGN AND CLARITY (H)

Figure (32) and Table (5) show quite positive results about the clarity of the shape and writing of the ELEPHANT with 80% agree and 10% neutral, however, another 10% oppose with the clarity, implying that they find the illustration of the "ELEPHANT" to be not easily discernible.

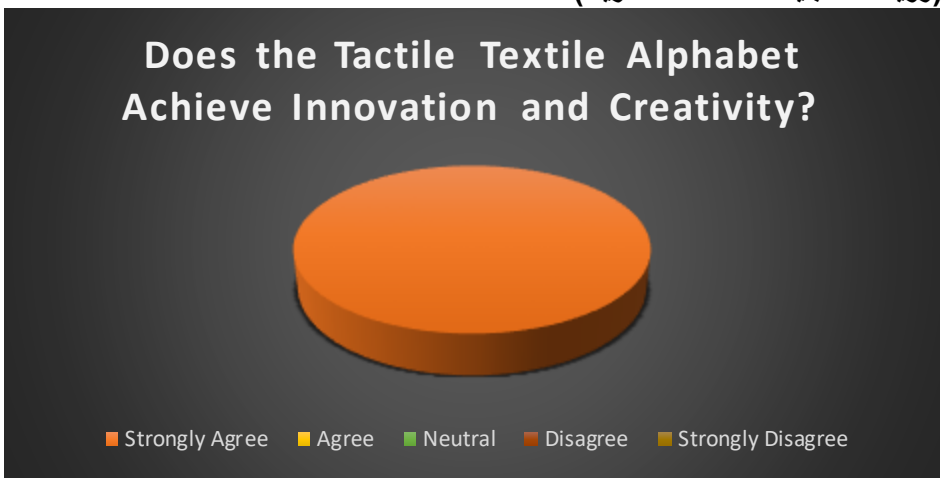

FIGURE (33) PARTICIPANTS RESPONSES REGARDING THE PART OF ASSESSMENT OF THE EFFECTIVENESS (A)

It is obvious from Figure (33) and Table (5) that all of respondents are convinced that tactile textile alphabet achieves novelty and creativeness, with 100% strongly agree. It is crystal clear from the overwhelming response that the designs bring something new and original to the field of tactile learning tools.

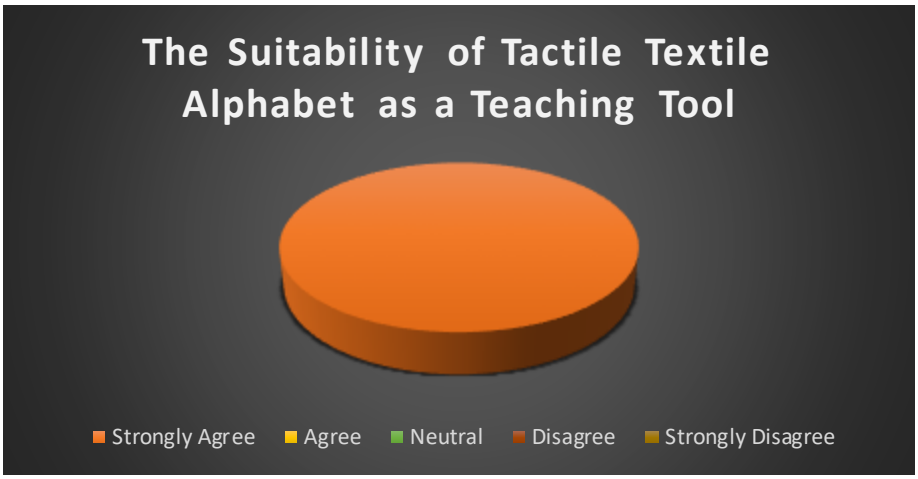

FIGURE (34) PARTICIPANTS RESPONSES REGARDING THE PART OF ASSESSMENT OF THE EFFECTIVENESS (B)

Figure (34) and Table (5) indicate that all participants believe that the tactile fabric alphabet is an appropriate resource for teaching visually impaired individuals, with a consensus of 100% strongly agreeing.

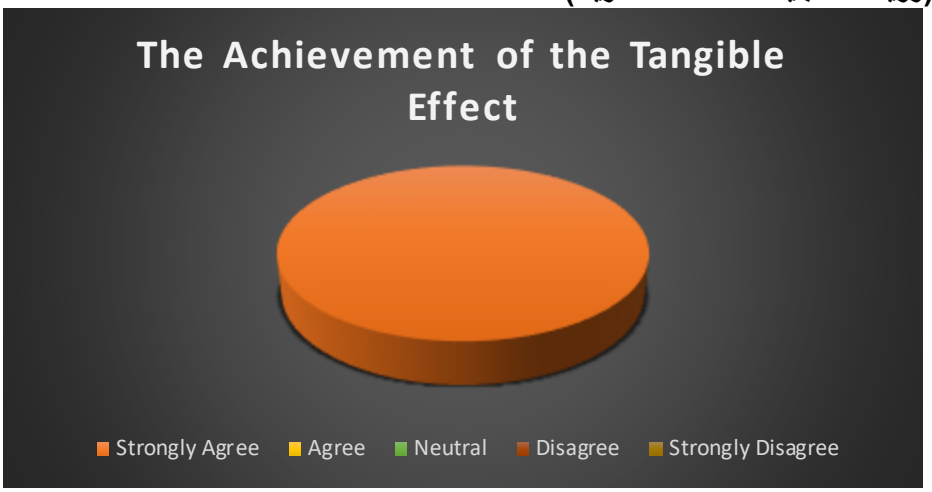

FIGURE (35) PARTICIPANTS RESPONSES REGARDING THE PART OF ASSESSMENT OF THE EFFECTIVENESS (C)

It can be recognized from Figure (35) and Table (5) that the respondent's results are extremely positive, with 100% strongly agreeing that the tactile fabric alphabet successfully achieves a tactile effect. This reveals that the designs effectively communicate the intended concepts.

Feedback and Suggestions from Visually Impaired Individuals

Regarding the question of: **What did you like most about the tactile alphabet?** The tactile fabric alphabet was widely accepted among the participants for several reasons:

- **Innovative Learning Method:** Participants appreciated the tactile fabric alphabet as an innovative learning tool that merges visual learning and tactile education through combining the English alphabet with corresponding Braille characters.
- Originality of the Design: They ensured the originality of the design idea that combines the image with the letters, enhancing the learning experience.
- Durability: The participants also focused on the durability of the fabrics as a practical educational material that can withstand prolonged touch and repeated use in addition to the potential for being sterilized and washed multiple times.

On the other hand, the question of: What did you like least about the tactile alphabet? Participants identified the following issues with the research samples:

- The spaces between Braille cells in the word are wide.
- The Braille dots and raised letters were less distinct to the touch since they were not projected enough.

The participants provided the following suggestions for improvement:

- Adding some descriptions to the attached images such as: "The elephant is a big animal with rough skin", or "the apple is a fruit with a sweet taste that can be red, green or yellow.
- Reducing the spaces between Braille cells in the word to be easily recognized by students.
- Incorporation of the small letter alongside the capital letter, such as "A" and "a" to provide more comprehensive learning experience.
- Increasing projection of the patterns to make the tactile elements more pronounced and easier to identify.

Conclusion

- The weft yarn material played a crucial role in clarifying the design elements.
- The participants were able to recognize the raised letters on the fabrics.
- The majority of Participants have a positive reception to the Braille letters' clarity.
- The shape and writing of all samples recorded a satisfactory level of recognition.
- There was an overwhelming response among all participants about the achievement of innovation and originality in the tactile fabric alphabet.
- All participants believe that the tactile fabric alphabet is a suitable means for teaching and enhances the learning experience.
- There was a consensus among participants that the tactile effect was achieved successfully.

Recommendations

- Including some captions with the associated images.
- Decreasing the distances between Braille cells in the word.
- Merging small letters with capital letters in the tactile fabric alphabet.
- Increasing the patterns' projection.

Acknowledgement

The researchers are truly appreciative of Noor Al Basira Association for the Care of the Blind's invaluable cooperation and support throughout this research.

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