



# A Comprehensive Study of Tactile Education System for Visual Impaired People

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**Abstract.** This study examines the tactile education system for individuals with visual impairments, with a particular focus on the Indian context. It evaluates existing frameworks and resources for education, highlighting both advancements and gaps in tactile and sensory-based learning approaches. The analysis encompasses e-learning resources such as audiobooks and Braille displays, as well as government and nonprofit initiatives within the Indian education system. The challenges faced by visually impaired individuals in India are explored, including limited access to technology, socioeconomic barriers, and a shortage of trained educators. Through stakeholder interviews and a thorough literature review, the article proposes strategies to enhance educational experiences. These strategies emphasize the integration of advanced technologies, the formulation of inclusive policies, and the improvement of teacher training. The aim of this research is to inspire innovative ideas in tactile learning and to advance the dialogue on inclusive education.

**Keywords:** Tactile Education, E-Learning tool, Visual Impaired People, Braille Language, Challenges for VIP

## 1 Introduction

Visual impairment constitutes a significant global health issue. According to The World Health Organization Globally it is estimated that approximately 285 million people are visually impaired, with 246 million having low vision and 39 million being blind. Visual impaired People (VIP) affects quality of life, increasing dependency and the risk of depression. Major causes of low vision include age-related macular degeneration, diabetic retinopathy, and glaucoma. Despite the availability of low vision services, barriers such as accessibility, cost, and availability limit their utilization. The integration of assistive technology is critical in improving the functionality and educational outcomes for those with visual impairments, aligning with global human rights principles that advocate for inclusive education within the general education system [1]. In today's educational environment, it is critical to offer equal learning opportunities. The traditional educational materials and methods—which are mostly visual in nature—present serious obstacles to learning and engagement for those who are visually impaired. With new ways to interact with

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knowledge, apart from examining technology, this research will investigate instructional strategies that might be enhanced or tailored to support tactile learning. To optimize the advantages of this technology for visually impaired learners, curriculum modification, teacher preparation, and instructional design must be carefully considered when integrating tactile displays into educational courses. Although the majority of study has concentrated on tactile graphics, teachers can deliver tactile materials as real items, 3D models, or tactile graphics. Raised surfaces and line drawings used to represent non-textual visual information, like maps, graphs, and diagrams, are referred to as tactile graphics. Toy automobiles, plastic animal replicas, and abacuses are examples of objects that are considered 3D models. 3D models can also refer to any other objects that are symbolic of real-world or abstract notions. Real things, also known as realia, are unaltered surfaces, textures, and natural objects like cloth, silverware, and tree leaves [2].

The present study highlights the significance of tactile education in supporting the academic progress, self-sufficiency, and sensory enhancement of visually impaired individuals. As educational technology develops, more complex tactile tools could be created, which would increase inclusivity and the efficacy of instruction. Curriculum developers, teachers, and legislators must keep supporting and providing money for these tools in order to guarantee equal educational opportunities and promote the academic and personal success of students with visual impairments. In addition to benefiting society, this dedication to inclusive education is an investment in the bright futures of these people.

## 2 Education System for VIP

Over time, education for those with visual impairments has undergone tremendous change as a result of the development of numerous systems and approaches tailored to meet their unique learning requirements. These educational systems use a variety of resources and techniques to support literacy, independence, and academic success. Below in Table No. 1 is a summary of some of the main kinds of educational programs available to students who are blind or visually impaired [3]:

**Table 1.** Table shows the education programs for VIP.

<b>Braille Education</b>	Braille instruction remains essential for students who are blind or visually impaired. It empowers them to read and write independently using raised dots to represent letters, numbers, and punctuation. Beyond reading, Braille education includes scientific and mathematical symbols, as well as music notation.
<b>Specialized School</b>	There are specialist schools for visually impaired kids in several countries. These schools provide specially designed classrooms with aids and trained teachers. These institutions offer mobility training, assistive technology use, and instruction in important life skills in addition to traditional academics.

<b>Mainstreaming &amp; Inclusion Programs</b>	Through the integration of visually impaired pupils into regular classes, inclusion programs foster social integration and inclusivity. These schools alter the curriculum and classroom environments for visually challenged students by utilizing resources such as instructional assistants, specialized teachers, and adaptable tools.
<b>Distance &amp; Online Learning</b>	Students who are visually impaired can now more easily access online and remote learning thanks to technology advancements. Through online platforms and accessible courses, they can make use of text-to-speech software, screen readers, audiobooks, and other electronic learning aids.
<b>Vocational Training</b>	For those who are blind or visually impaired to develop employable skills and get ready for the workforce, vocational education is crucial. This education, which is frequently made possible via alliances with companies and specialized training facilities, focuses on particular job skills and real-world applications.
<b>Orientation &amp; Mobility Training</b>	Although orientation and mobility (O&M) is not covered in the regular academic curriculum, it is essential for individuals with visual impairments. O&M training gives these pupils the confidence and safety to explore their surroundings with the aid of items like white canes and electronic mobility gadgets.
<b>Assistive Technology &amp; Adaptive Devices</b>	The use of adaptive devices and assistive technologies in visually impaired education is growing. These consist of screen reading software, haptic graphics, speech-to-text tools, and magnifying glasses. These resources offer crucial assistance for information access and active participation in educational events.
<b>Multisensory Approaches</b>	Multisensory learning strategies involve using several senses to improve understanding and are frequently used in teaching methods for kids with visual impairments. These techniques, which aim to create a richer, more inclusive learning environment, can include kinesthetic activities that require physical movement, auditory teaching for listening-based learning, and tactile equipment to encourage hands-on interactions.
<b>Tactile Display Technologies</b>	Tactile screens and other more recent technologies are becoming more and more significant. By transforming visual information into a tactile format, these gadgets enable visually challenged students to interact through touch with intricate diagrams, drawings, and other visual data.

All of these educational programs are made to accommodate the various requirements and learning preferences of students who are blind or visually impaired, with the goal of offering a thorough, easily accessible, and inclusive education.

### 3 Related Work

We review earlier research on tactile materials and examine both traditional and modern production techniques. The literature on teaching strategies for visually impaired students is discussed. Our study is the first to cover the full range of tactile materials, including real objects, 3D models, and tactile graphics. We address issues with TVIs' acceptance of technology and highlight the gap between tactile material research and practical application.

#### 3.1 Uses of Tactile Materials

Researchers have looked into how teachers and students use a particular kind of tactile material called tactile graphics. Through focus groups and surveys, they discovered that when working with sophisticated tactile graphics, students with visual impairments frequently lose interest and excitement. Misplaced braille labels and an excessive amount of tactile input are common problems mentioned by these students, which make learning more difficult [4]. Teachers of the Visually Impaired (TVIs) were surveyed by Sheppard and Aldrich to get their opinions on the development and use of tactile graphics. The teachers who were polled underscored the noteworthy worth of tactile graphics as efficacious pedagogical instruments, underscoring their centrality in the educational journey of visually impaired pupils. They did, however, also highlight a number of shortcomings. The labor-intensive process of creating these visuals, which takes a lot of time and effort, was one of the main issues. Teachers also said that it was difficult to explain cluttered or excessively complicated tactile images to children since they can be hard for them to read and comprehend [5]. Following a comprehensive review of the literature on tactile maps and three-dimensional models, Wright et al. developed a theory. They suggested that visually impaired pupils' comprehension of symbolic representations and spatial awareness could be greatly improved by teaching them how to handle tactile objects more easily [6]. Holloway et al. [7] carried out the first extensive study comparing the usage of 3D models with tactile graphics. Significant results from their research showed that 3D models were very helpful and notably good for orientation and mobility training. According to the study, 3D models offer people—especially those who are visually impaired—a more efficient and natural approach to comprehend spatial relationships and navigate their surroundings. The adoption of assistive technology by teachers of the visually impaired (TVIs) has been the focus of much research. TVIs must be adept in the most recent tactile material manufacturing techniques, particularly when it comes to new hardware and software. Only 40% of TVIs include contemporary technologies in their lesson plans, according to earlier studies. Current initiatives show that incorporating novel tactile materials with Assistive Technology (AT) is still a major difficulty. In response, Siu et al. [8]. Created a test to gauge TVIs' technical proficiency with assistive technology. Their results highlight how crucial it is to establish a social practice community in order for TVIs to remain knowledgeable about the most recent developments in AT.

### 3.2 Resources & Techniques

In order to obtain a thorough grasp of the procedures entailed in creating tactile graphics, Rowell and Ungar [9] surveyed academics, instructors, and tactile map manufacturers from a range of foreign countries. They came to the conclusion through their investigation that most creators of tactile graphics operated alone and did not formally share their knowledge. The researchers came to this conclusion because they were unable to find any noteworthy patterns or shared techniques in the creation of tactile graphics across various geographic locations.

Braille embossing and the usage of swell paper are the two most common traditional techniques used in the production of tactile images. In particular, microcapsules containing alcohol are applied to swell paper; these capsules expand when heated. Raised lines and different patterns are produced when black ink drawings on swell paper are heated in a Pictures-in-a-Flash (PIAF) machine. Conversely, raised dots are created with braille embossers. Teachers of the Visually Impaired (TVIs) can use software linked to either of these technologies to create and edit tactile images.

Previous studies have sped up the creation of tactile graphics in a variety of contexts. For instance, Brown, Hurst, Braier, et al. [10]. Created automated tools to produce haptic representations of data based on tables and coordinate spaces. Way and Barner developed a method to transform images into tactile form by utilizing edge recognition, image processing, and swell paper. Researchers have continuously attempted to automate the use of sophisticated methods to transform visual images into haptic graphics. By using computational geometry and machine learning on textbook images, Were able to obtain an average translation time of less than ten minutes. These developments lessen the work required to create tactile images, but it's unclear if educators of kids with visual impairments employ comparable techniques in the classroom.

The goal of the research was to improve the comprehension of tactile maps by using 3D legends and multimodal output. Speaking tactile maps were created by Minhat et al. [11], to offer precise navigational guidance and environmental data. In order to enhance pupils' mobility and direction abilities, we developed an interactive tactile map. Celani and Milan [12], created enduring, high-resolution 2.5D maps with additional references, such as elevators and stairs, using laser cutting, which users found easier to comprehend. Researchers have also created web and mobile applications for editing and printing three-dimensional tactile map representations.

The increasing use of 3D printing technology has led to an increase in the frequency of rapid prototyping and 3D model development. Research conducted by Stangl et al. [13] and Giraud et al. [14] revealed that inexperienced designers required help and would profit from an online resource for creativity support. Studies have indicated that rapid prototyping technologies improve course accessibility across a range of disciplines, such as computer science, astrophysics, and graphic design theory. Furthermore, earlier research produced software that enables users to annotate particular 3D model features with audio.

## 4 Indian Education System for VIP

The Rights of Persons with Disability Act of 2016 was passed by the Indian government after it accepted the UNCRPD, acknowledging that people with disabilities have the right to equal opportunities and the ability to engage in political, social, and economic life as well as activities that promote their own development in all spheres of life. Existence the Maharashtra government has taken a number of steps to align with the national agenda in line with events occurring on both the national and international fronts. This includes the creation of the 2001 Action Plan, the Workshop and Special School Code, the Guidelines for the Accreditation of Institutions Serving PwDs, etc. The Government of Maharashtra's policy initiative is a logical development of the legal framework and instructions for the establishment of institutional infrastructure [15]. To improve the quality of their life, education, training, and rehabilitation are the three most crucial components for blind people. In the state of Maharashtra, there are seventy schools that provide special education for visually impaired students. There are about 6000 learners enrolled in these special schools [16]. The government and non-governmental groups work toward an inclusive approach to education, where students with disabilities are enrolled in the same schools as those without impairment, in accordance with the terms of The Persons with Disabilities Act.

The Institute ensures that children with physical, emotional, intellectual, cognitive, and social impairments are completely understood and accepted in the school community by extending a warm welcome and embrace to students from a range of backgrounds. The Institute still provides free education up until the Secondary School Certificate test, beginning at the nursery level. In addition to instruction, the Institute offers its students a number of free extra services. These services guarantee that every student has the resources they need to excel in their academic endeavors, and they include free boarding and accommodation, textbook access, medical care, and more.

### 4.1 Pre-Primary

However, a common pattern among visually impaired kids is that they attend blind schools for their elementary education before being admitted to inclusive schools on the basis of their academic potential. As per the present guidelines, a visually impaired student who has completed up to class 8 must be proficient in the Braille language. In most schools, students with visual impairments receive their primary education through Braille texts. In primary education, kids with visual impairments are taught to be proficient in the Braille language and are also given a rudimentary understanding of computers. Due to the limits of Braille books in secondary schools, education is mostly provided to students through audio books at this level. Additionally, high school students with visual impairments are trained to operate computers proficiently using screen reading software like JAWS. The National Association for the Blind produces audio books, which are given to educational institutions that are part of the organization's library. Educationists prefer a more inclusive approach to education when it comes to higher education, even though

studying in blind schools offers students with visual impairment a protective setting [17].

Institute provides Preschool and Braille instruction in this division. These carefully planned classrooms come with a plethora of resources to aid in the sensory development of young learners. To improve learning, the surroundings are enhanced with a variety of toys and interesting activities that may be done both inside and outside. The school offers a planned curriculum of activities designed to guarantee the kids' full physical and mental development. As part of our integrated education system, learners go from attending special education programs at age five to mainstream schools until they finish the tenth grade. They adhere to a curriculum during this time that is comparable to that of their peers in regular schools, covering the same academic material and disciplines [18].

#### 4.2 Vocational Training

The institute offers comprehensive vocational training for blind women, focusing on practical skills to enhance independence and employability. Men's training includes cane work, candle making, and chalk making, promoting income and self-reliance. The women's curriculum is equally diverse and robust [19].

**Table 2.** Table shows the institute vocational training for blind women.

<b>Rescanning</b>	Teaching women to repurpose and reuse materials effectively.
<b>Weaving</b>	Instruction in creating woven goods, which can range from simple mats to more intricate textile products.
<b>Handloom Items</b>	Training on using handlooms to produce various fabrics and garments.
<b>Chalk Making</b>	Techniques for producing high-quality chalk often used in educational settings.
<b>Candle Making</b>	Skills for crafting different types of candles, which can be sold commercially.
<b>Knitting</b>	Lessons in knitting garments and accessories, providing an avenue for creative expression and income
<b>Basic Sewing</b>	Foundational sewing skills to mend and create clothing and household items.
<b>Job Work</b>	Opportunities to engage in small contract jobs that can be completed within the institute.
<b>Envelope Manufacturing</b>	Instruction on producing envelopes, which can be sold in bulk to businesses or individuals.

Beyond standard academics, the training program for blind women (Table 2) includes housekeeping, practical life skills, and home arts. This comprehensive approach

ensures they are equipped for independence, creativity, and success in all aspects of life.

## 5 Different E-Learning Tools

When selecting e-learning materials for visually impaired students, consider their individual needs and the features of available technical tools. We provide an overview of key e-learning resources and briefly investigate the primary challenges faced by these students.

### 5.1 Digital Learning Tools

According to Anohina [20], "e-learning" as any learning activity carried out electronically. Globally speaking, this phrase refers to any educational project that makes use of technology or electronic media. These platforms include learning management software, educational animations, simulations, games, and web-based teaching materials. They also include hypermedia and multimedia resources like CEFOMs, websites, discussion forums, email, wikis, and collaborative software. As a result, the phrase "e-learning tools" refers to a wide range of materials used in education.

Online learning is the use of instructional resources within an educational setting that are available over networked computers, including synchronous and asynchronous communication technologies. When the user's PC isn't linked to a network, computer-based learning materials are kept locally on the device and used for instruction. Educational resources that can be accessed using mobile devices, such as cellphones, PDAs, tablet PCs, or palmtops, are part of m-learning. For connectivity, these instruments could make use of wireless transmission. The phrase "e-learning tool" refers to both the software programs and hardware tools utilized to support the learning process.

Software tools for e-learning fall into the following categories:

**E-learning platforms:** are web-based settings with integrated electronic learning materials and activities that are managed to achieve predetermined goals.

**Web-based applications:** Programs that are instantly available via any browser and don't need to be installed on the user's computer; they are made with education in mind and are in line with the goals of education.

**Applications that operate independently:** Products that need to be locally installed on the user's computer in order to be accessed, both educational and non-educational. Products that can be downloaded from the internet and still require computer installation fall under this category.

## 5.2 Need of E-learning tools for VIP

The following lists instances of accessibility and usability problems that occur in different software application categories; it does not include problems related to common computer configurations or particular hardware. It is important to recognize that these challenges are closely related to the kind of user impairment. People with low vision, for example, have different challenges than those who are blind. The former usually use screen readers to access content, while the latter may use customized settings or optical aids to navigate a wider variety of software applications, including those with graphical interfaces. The wide range of visual impairments that low vision kids experience emphasizes even more how different their needs are [21].

## 6 Challenges for VIP

Like many other regions of India, Maharashtra's blind and visually impaired population faces a variety of difficulties and constant attempts to enhance their standard of living. Here's a summary of the circumstances:

### 6.1 Education

- **Access and Inclusion:** Despite advancements in the inclusion of visually impaired pupils in regular classrooms, many schools continue to lack the required resources, including qualified teachers.
- **Materials and Resources:** One major obstacle continues to be the lack of readily available educational resources, such as assistive devices and braille texts.

### 6.2 Employment

- **Limited Opportunities:** Due to cultural biases and a lack of job openings, visually impaired individuals continue to experience high rates of unemployment and underemployment despite affirmative action regulations.
- **Vocational Training:** The effectiveness of many vocational training programs is limited since they are not specifically designed to meet the needs of visually impaired people.

### 6.3 Health Care

- **Accessibility:** It might be difficult to obtain specialized eye care and rehabilitation treatments, especially in remote locations.
- **Preventive Care:** The frequency of visual impairment may be decreased if more people were aware of and had access to preventive eye care services.

## 6.4 Mobility & Accessibility

- **Public Infrastructure:** Independent mobility is hampered by the fact that many public areas and transit systems are not fully accessible.
- **Assistive gadgets:** The restricted availability and high cost of these gadgets prevent their widespread use.

## Conclusion

The study underscores the critical necessity of establishing a robust tactile education system tailored for visually impaired individuals in India. Despite concerted efforts by governmental bodies and organizations, substantial barriers remain, notably the scarcity of accessible technology and adequately trained educators. To effectively confront these challenges, it is imperative to implement forward-thinking policies, enhance teacher training programs, and integrate cutting-edge technologies. These measures are pivotal in advancing tactile learning methods, thereby guaranteeing equitable access to education for visually impaired individuals. Such initiatives promise to elevate their educational achievements and expand their prospects for future success.

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