

## **CHAPTER II**

### **REVIEW OF LITERATURE**

#### **2.0 Introduction**

In the first chapter, Rationale along with Objectives and Hypotheses has been given. The present chapter is devoted to reviewing researches related to various aspects of Braille literacy for students with visual impairment. The researches have been classified for better understanding mentioned as follows. This chapter presents an overview of the available assistive technology for Braille literacy for students with visual impairment.

#### **2.1 Braille as a Literacy Medium for Visually Impaired**

Literacy skills, thus, have become necessities to living more fully in the social, economic and political realms of mainstream society (Dunlea, 1989; Paul, 1993). However, unlike sighted individuals who take seeing for granted, those whose vision is limited must intensively work on realizing the unique quality of the simultaneity of information that sighted persons could obtain with ease. As sighted persons capture information and knowledge through print, the individual with visual impairment uses Braille to access information and communicates with others through Braille literacy (Hung, 2008).

A quantitative comparison on Braille literacy and auditory literacy investigated if these two forms of captured information are equivalent to each other. Fifteen college graduates between the ages of 22 and 55 participated in the study: 5 of them were blind or with Visual Impairment and preferred the use of Braille to access text material; 5 of them were blind or with Visual Impairment and preferred to process textual material through audition; and 5 of them were individuals without Visual Impairment and preferred to access textual material through visual print. The results showed that there were no differences among the three groups in their recall of propositions from the texts based upon their preferred method of accessing print (Braille, audition, or print), or in their recall of propositions from the text after having listened to an auditory rendition of an equivalent text. When the scores on the two tasks were compared with each other for individuals, there were no differences for either group of individuals who were blind or

with VI, but the group of individuals without Visual Impairment did better on recalling propositions when they read as opposed to when they listened to the text. Empirical suggestions for a more inclusive definition of literacy are provided to empower individuals with blindness and Visual Impairment as well as other disabilities (Wang, Al-Said, Ye, Date, & Date, 2017).

Very different skills and knowledge are likely to be needed to support blind pupils with moderate or severe learning difficulties, and indeed to decide whether braille is the most suitable literacy medium (McCall & McLinden, 1997, 2001).

There is no single curriculum or right way to teach Braille literacy skills, but one need to know that meaningful instruction and motivation contribute significantly to children's success in learning to read (Gambrell & Marinak, 2009).

The learning medium and appropriate educational devices of students with visual impairment in Inclusive and Special schools were examined. Results indicate that nearly 52.38% of totally visually impaired students used Braille as their learning medium (Vaijayanthi, 2021).

## **2.2 Importance of Braille Literacy for Academic Achievement**

The literacy skills of high school students in grades 9-12 was analyzed and compared findings across four groups: (a) youth who were blind or visually impaired and who received "regular braille instruction" during their primary grades (at least four to five times per week); (b) youth who were visually impaired and who received "inconsistent braille instruction" (only two to three times per week); (c) youth who were visually impaired and who received "no instruction in braille" during their primary grades; and (d) "fully sighted" students who received print instruction on a regular basis (four to five times per week). Based on data from 60 youth it was demonstrated statistically significant differences between these groups on the Woodcock Johnson R and Stanford Achievement Tests of Literacy. Specifically, blind or visually impaired students who received braille instruction four to five times per week had achievement scores as high as the fully sighted students, but students who received inconsistent or no braille instruction were significantly behind their sighted and blind peers as measured by the Woodcock Johnson (Ryles, 1996).

All the youth with visual impairment who needed to use Braille but were not given any instruction in it were 1.5 years behind grade reading level after measurement by the Johns Inventory, whereas those who were receiving Braille instruction after they were assessed and confirmed to be in need of it were reading on same grade level with their sighted peers. The findings strongly support the need for early Braille instruction for learners with visual impairment (Bell, Ewell, & Mino, 2013).

### **2.3 Impact of Braille Literacy in Adulthood**

Braille literacy was very critical to the learners with visual impairment self-esteem and acceptance of their condition of vision loss (F. K. Schroeder, 1996)

Moreover, the students with visual impairment who learned Braille in adulthood increased their sense of independence in addition to accepting their condition of vision loss (Farrow, 2015).

A survey of 500 participants carried out by the National Federation of the Blind Jernigan Institute (2009) revealed a correlation between the ability to read Braille and a higher education level, higher possibility of employment and a higher income.

Acceptance of disability and positive disability group identification has been linked with higher subjective well-being (including life satisfaction and self-esteem) for people with various disabilities (Bogart, 2014; Nario-Redmond, Noel, & Fern, 2013). Braille usage may facilitate this positive identity development.

Many adults choose to use audio-recorded materials or screen readers in learning braille(Goudiras, Papadopoulos, Koutsoklenis, Papageorgiou, & Stergiou, 2009). Yet if early childhood braille learning benefits people in adulthood, there is reason to believe that taking the time to learn braille later in life could confer similar benefit. Learning braille in adulthood may also aid the psychological acceptance of vision loss (Omvig, 2002; F. K. Schroeder, 1996).

## **2.4 Braille and Employment Success**

Braille literacy has been linked to higher employment rates. Interview with 74 congenitally blind adults of working age found that among those who had used braille as their primary reading medium during childhood, 56% were employed, compared with only 23% of those who had grown up using print (Ryles, 1996).

Regular braille use in adulthood has also been associated with higher employment rates and earnings in a large sample of over 1,000 blind adults (Bell et al., 2013). This association is likely bidirectional; not only are competent braille readers more likely to gain high-quality employment, but employment demands warrant greater braille use (Spungin, 1989).

## **2.5 Current Status of Braille Reading**

Closely related to the debate about a perceived reduction in the numbers of children learning braille is the claim made by some people that there has been a decline in standards of braille teaching (Stephens, 1989).

The American Council of the Blind concerned about the “widely perceived erosion of standards in the teaching of braille” in mainstream and specialist residential schools (Stephens, 1989).

A study on challenges to effective learning of English Braille for pupils with visual impairment in integrated primary schools in Bomet district in Kenya explored Braille reading levels of learners with visual impairment in class 3 to 5 and 6 to 8. It adopted a descriptive research design and targeted itinerant teachers, head teachers and teachers of Braille in the schools under study. The researcher presented 450 words to learners in class six to eight and out of the 450 words, the learners could not read 50 (11.1%) words at all. 140 words (31.1%) were read incorrectly and 260 (57.8%) were read correctly. The situation was worse for learners in class three to five. These learners were able to read 150 (42.9%) words out of the 350 words presented to them. 80 (22.2%) words were read incorrectly and there was no attempt at all to read 120 (34.3%) words (Kimeto, 2010).

Without appropriate instruction, learners with visual impairment maybe at risk for becoming low performing learners (Koenig & Robinson, 2001). The Canadian National Institute for the Blind (2014) noted that learners who do not read and write well have trouble succeeding in school and later in the work place. For learners whose eyesight prevents them from reading and writing print.

Braille literacy level among primary school children was rather low. However, the case was quite different among high school students. There was no uniformity in the way schools arranged to teach their students Braille. Braille literacy could be improved if strategies were set to teach children with visual impairment Braille and ensure that they were proficient in it (Wanja, Murugami, & Bunyasi, 2021).

## **2.6 Methods of Teaching Braille**

Various ways to learn writing and reading Braille include strategy, method, approach and media were examined. This systematic review of 13 articles analyzed using descriptive analysis. The results of the data analysis in this article content focus on the Braille learning to teaching reading and writing Braille for student to master reading and writing skills as basic asset in the learning process. However, there are various ways to learning Braille such as strategies, approaches, methods and media that can be used in reading and writing learning, including: word instruction vocabulary, oral Braille reading decoding, individual meaning centered approach, vocabulary flashcards, mangold systems, and short writing (Susanti & Rudiwati, 2019) .

Constant time delay is an evidence-based practice to teach sight word recognition to students with a variety of disabilities (Ivy, Guerra, & Hatton, 2017). Constant time delay is a promising strategy for teaching highly motivating words to early braille readers. Replication is required to establish constant time delay as an evidence-based practice for braille literacy.

Peer-Assisted Learning Strategies for Braille Readers: A Preliminary Study examined the effects of a modified peer-assisted learning strategies (PALS) intervention with two Braille readers. The investigation paired braille readers with print reading partners within their general education classroom to explore whether PALS had an effect on braille reading fluency and comprehension. Preliminary results from the

study indicated that braille readers benefit from PALS partner reading with retell intervention by increasing reading fluency and comprehension scores. The results further suggest that PALS interventions have the potential to increase socialization opportunities (Johnson & Stanfa, 2019).

## **2.7 Perceptions on Uncontracted and Contracted Braille**

It is generally believed that contracted Braille does not only enable Braille readers to process information faster, but also to take in large amounts of text at a time (Emerson, Holbrook, & D'Andrea, 2009). It can limit the unnecessary teaching of familiar words in both Grade One and Grade Two Braille.

There were no significant differences found between students using Uncontracted and contracted Braille in performance over a variety of skills such as: comprehension, reading accuracy, reading speed and spelling ability (Hong & Erin, 2004).

Uncontracted Braille is generally regarded as an additional option rather than a substitute for contracted Braille and that it is usually introduced on the assumption that learners will make the transition from uncontracted to contracted Braille at some stage in their future learning. In integrated classrooms uncontracted Braille is perceived as easier to teach and manage, but that there are concerns that staff members who have only uncontracted Braille knowledge may be unable to facilitate children's move to contracted Braille". The policy of producing all materials in uncontracted Braille has increased the number of users and made the cost of production more economical and viable. The place of uncontracted Braille is growing within the range of options on offer to blind reader and suggested that new groups such as very young learners, those in mainstream education, older learners, children with learning difficulties, those who are adventitiously blind and people who study English as second language are finding it easier to learn(Clunies-Ross, 2005).

Ordinary Braille learners gradually move from uncontracted Braille to contracted Braille at some point and at different rates. However, sometimes teachers may report using "uncontracted" Braille throughout, but it is unlikely that no contractions get into the child's reading and writing (McCall, McLinden, &

Douglas, 2011) This has a perplexing effect on research in this area because of the difficulties of identifying a group or cases of Braille learners who can read uncontracted English or American Braille fluently without knowledge of contractions. This perplexing effect was reflected in a five year longitudinal ABC Braille Study (Alphabetic Braille and Contracted Braille) which followed the progress of 42 children in Canada and the USA who were introduced to literacy through Braille (Emerson *et al.*, 2009). The children's teachers had settled for their approach at the beginning of the study as "contracted" or "uncontracted". Most students in the "uncontracted" group learned contractions but not as many as those in the "contracted" group. What differentiated the two groups was the degree of "contractivity" involved in their instruction. The progress of five children who had learnt less than 25 contractions was compared with the five children who had been taught all the 189 contractions (Emerson *et al.*, 2009).

The study indicated that students who were reading primarily uncontracted Braille demonstrated slow reading pace and low levels of vocabulary acquisitions and spelling skills than the children in the higher contractivity group.

A mixed qualitative and quantitative design, compared the social experiences of beginning Braille readers in literacy activities. The study reported that there were no significant differences in both the quality and quantity of social experiences over time between students who read and wrote in Grade one English Braille and those who were introduced to Grade two English Braille. However, children's level of achievement in obtaining literacy skills was strongly correlated with the frequency and quality of their interactions with their sighted peers (Sacks, Kamei-Hannan, Erin, Barclay, & Sitar, 2009).

Effective Teaching Strategies: Case Studies from the Alphabetic Braille and Contracted Braille Study discussed some of the qualitative data that were documented during the Alphabetic Braille and Contracted Braille Study. Two case studies of students were described, indicating various effective teaching strategies used by their teachers of students with visual impairments that resulted in the students' successful academic progress (Barclay, Herlich, & Sacks, 2010).

A current debate in literacy instruction for children who are blind revolves around whether reading and writing in braille is best introduced through uncontracted braille or contracted braille. Since the 1970s contracted braille has been commonly used in the UK as the medium of instruction for young braille readers. However, as increasing numbers of young children who use braille as their main medium for literacy receive their education in mainstream settings, their literacy skills are developed within the context of a national framework for the introduction of literacy with a predominant focus on the teaching of reading through print. It is argued by some teachers that the 'letter-for-letter' correspondence with print that uncontracted braille offers, allows greater opportunities for literacy learning alongside sighted children. Another argument is based around the fact that in mainstream settings, literacy instruction in braille is often delivered by a range of non-specialists professionals (e.g. mainstream class teachers or Teaching Assistants) who may have little or no experience of supporting a braille reader (Keil & Clunies-Ross, 2002). As such, it is argued that uncontracted braille allows for greater participation of non specialists in the teaching process.

Arguments used by professionals for the use of an uncontracted alphabetic braille code are generally linked with the perceived increased opportunities for inclusion, and stress the benefits it affords for learning alongside print readers and the concomitant social benefits that arise from co-learning. It is also argued that uncontracted braille improves spelling because children learn words in the original uncontracted form, (seen as a particular benefit when writing using Qwerty keyboard technology. On the other hand, proponents for the early introduction of braille contractions argue that it can allow 'beginning readers to take in larger chunks of text at a time and thus help them to process information faster' (Emerson et al., 2009), as well as helping to avoid the teaching of familiar words in two different forms - uncontracted and contracted braille.

The reading and spelling skills of students who were taught to read using uncontracted braille with those of students who were taught to read using contracted braille were compared. It was found no significant differences in performance over a range of skills, such as reading speed, reading accuracy, comprehension, and spelling ability, between initial instruction in the two types of braille (Hong & Erin, 2004).

Nor did they find any evidence that ‘changing to contracted braille later in school will impede the speed and efficiency of reading’. While acknowledging that contracted braille takes up to around a quarter less space, they questioned the assumption that it increases reading rates (Troughton, 1992).

## **2.8 Hand Movements and Braille Reading**

Two handed reading is more efficient (faster) than single handed reading and that most fast readers used two hands in a scissors movement. Frequency of characteristics such as hand pauses, ‘scrubbing’ of dots and regressions affected reading speed, and although most of these were present in all readers, they were infrequent in proficient readers (Wright, Wormsley, & Kamei-Hannan, 2009)

. The ABC longitudinal braille study sought to investigate whether there was a difference in the patterns and characteristics of the hand movements of children who used contracted braille and children who used uncontracted braille; whether hand movement patterns and characteristics differed according to the number of contractions introduced; and whether hand movements generally had an effect on reading rates. The results were drawn from video sequences of 38 children reading orally.

However, the data from the ABC study did not support the argument that teaching contracted braille from the start increases inefficient erratic hand movement characteristics such as scrubbing or regressions. There was no significant evidence that children who used contractions had greater difficulty recognising characters (i.e. no evidence of increased scrubbing) or context (i.e. no evidence of increased regressions). Interestingly, regressions by the left hand in two handed readers were not necessarily seen as evidence of inefficiency. In short, there is no evidence from the literature to support the view that the introduction of the additional complexity of contractions has a negative effect, and makes hand movements less efficient for beginning braille readers, but similarly there is no evidence that uncontracted braille improves efficiency of hand movements.

## **2.9 Spelling and Braille**

Braille writing of 20 braille reading students in the USA from across the school age range with no identified additional disabilities was examined. Fifteen of the

students used contracted braille and five used uncontracted braille. They concluded that the children's spelling skills were similar to those of sighted students. The assessment focused on the number of words spelled correctly and used an error analysis to describe patterns of spelling errors. A distinction was made between spelling errors that were the result of 'braille errors' (e.g. braille-specific errors such as cell reversals, missing dots) and spelling errors that are not the result of braille errors. It was noted that remediation of spelling errors depends on identifying a pattern to the errors and analysing it. They also suggest that improved phonological skills can help reduce misspellings (Clark-Bischke & Stoner, 2009).

The ability to identify and correct braille errors increases children's accuracy in spelling, and argued that proofreading should be encouraged from an early age (Clark & Stoner, 2008). It was found that there is no significant difference in spelling ability for words in isolation between print and braille users. It can be noted that spelling was a strength for the children in the study, regardless of whether they used contractions or not and 84% of the children in the study were 'at or above grade [age] level' in spelling'. While children who had been introduced to higher number of contractions tended to do better in spelling than the children who had been introduced to fewer contractions, the group with fewer contractions were not necessarily poor spellers, but the 'top spellers' were all students who had learned 'many' contractions (Emerson et al., 2009).

The good spelling performance of the 'high contraction' group may be linked to the fact that when young braille readers are taught through contracted braille 'emphasis is usually placed on teaching the letters of which contractions are composed' (Millar, 1997), i.e. there is an element of uncontracted braille in every child's learning.

## **2.10 Braille Reading accuracy vs Reading Fluency**

Braille reading accuracy relies mainly on systematic and active exploratory movements rather than passive perception (Millar, 1997). Braille reading accuracy is highly related to phonological awareness (Gillon & Young, 2002). In addition, due to the complexity of the braille code, the correct identification of the relative spatial position of the braille dots is critical for decoding braille characters.

Some studies indicate that braille readers read slightly less accurately than do print readers (Veispak, Boets, & Ghesquiere, 2012; Veispak, Boets, Männamaa, & Ghesquiere, 2012), while the braille readers who participated were approximately 10 months behind the level of accuracy of their sighted peers (Dodd and Conn, 2000). The above inferences may be attributed mainly to (a) the nature of the Braille code, since the high degree of similarity between the letters leads braille readers to be error prone (Millar, 1997); (b) the inability of students who are blind to practice braille reading outside school hours (Vakali & Evans, 2007); and (c) the lower resolution of tactile processing, which demands a conscious effort to maintain braille accuracy (Veispak, Boets, & Ghesquiere, 2012).

Furthermore, as students who have visual impairments become more experienced readers, they also become more accurate readers (Vakali & Evans, 2007). Nevertheless, students who were introduced to more contractions earlier in instruction performed better on decoding (Emerson et al., 2009). Braille readers read meaningful words more accurately than pseudowords (Millar, 1997).

The length of and familiarity with words may influence accuracy in reading. It seems that the length of words affects the reading performance of braille readers more than that of print readers. The impact of sufficiently sensitive fingers on reading accuracy becomes apparent when the words are short enough not to overload verbal short-term memory and when semantic information cannot be used to aid comprehension (Veispak, Boets, & Ghesquiere, 2012).

Some researchers hold the view that the recognition of braille characters seems to be affected by the position and the density of the braille dots (Nolan & Kederis, 1969) (Challman, 1978, in Papadopoulos, 2005; Nolan & Kederis, 1969), while others believe that the majority of errors in recognizing braille characters may fall into two over-all categories; that is, reverse and mirroring.

Errors are highly frequent due to the nature of braille, in which all characters derive from the same matrix and differ only in the presence or absence of dots, and almost all characters are developed as rotations of some other braille cell (Millar, 1997).

Students who were introduced to more contractions earlier in instruction performed better on reading measures, such as vocabulary, decoding, and comprehension, but all students did well in spelling (Emerson et al., 2009).

Braille readers outperformed sighted readers in phonological tests (Greaney, Hill, & Tobin, 1998). The Phonological-awareness skills of nineteen New Zealand children aged 7-15 years who were using braille as their reading medium was compared, with those of a control group of sighted children who were chronologically three years younger but of the same reading age. It was found that children who had difficulty reading braille were also delayed in their development of phonological awareness, demonstrating strengths and weaknesses that were similar to those of the younger sighted children (Gillon & Young, 2002).

## **2.11 Challenges in Braille Literacy**

A qualitative and subsequent quantitative inquiry to understand the academic challenges faced by BVI students in high school and college, their resolution strategies and the use of technology to resolve their problems. The pilot study and the subsequent survey identify the extent of visual disability, knowledge of Braille, availability of materials in Braille, availability of alternative formats such as tactile models, availability of human assistance reader/scribe, affordability of the solution technology and perceived use of the solution technology as antecedents for the choice of the resolution strategy (Sahasrabudhe & Palvia, 2013).

Investigation on challenges faced by visually impaired students in Makerere and Kyambogo Universities followed a cross-sectional survey design and involved 200 respondents (50 visually impaired students, 50 lecturers, 50 university administrators and 50 students who were not visually impaired). Data was collected using questionnaires, interviews and document review. The findings revealed that the visually impaired students receive bursaries and allowances from government and non-government organizations; meals, accommodation and scholastic materials from their universities; extra time during examinations; oral examinations; and buddy support. However, constraining limitations in the methods of instruction and assessment used and the instructional materials provided were noted. On the basis of these findings,

recommendations towards the better education of the visually impaired students are made (Otyola, Kibanja, & Mugagga, 2017).

Investigation on challenges of effective learning to read and write English Braille for students with visual impairment in the integrated primary schools of Bomet District in Kenya established that performance in braille was low for learners with visual impairment. Several measures were recommended which when implemented will alleviate the situation and enhance reading efficiency (Kimeto, 2010)

Challenges in learning Braille for Learners with Visual Impairment-Perception of Special teachers and Parents revealed that the Special teachers expressed that learners with visual impairment use print as an easier solution than attempting to provide Braille instruction and Braille material and highly dependent on technology as the main challenge faced by the learners with visual impairment. The Parents expressed that learner with visual impairment access to many of the same visual materials as her /his peers. The second challenge is that the parents felt that Braille is a valuable tool but needs to be taught during the early grades and deciding to teach Braille to a learner should be based on the individual needs of the child (Vaijyanthi, 2021).

## **2.12 The Role of Teachers on Braille Literacy**

Research carried out by RNIB (Franklin, Keil, Crofts, & Royal National Inst. for the Blind, 2001) indicated that learning support assistants (LSAs) played a significant role in teaching braille to primary aged pupils. Of 30 children aged between five and 11, five were apparently being taught braille solely by a learning support assistant.

No systematic approach followed to teach English Braille. Many teachers had not received guidance on methods or approaches to teaching braille and that, some teachers claimed to have had no knowledge of braille at all when they started to teach, a number going so far as to claim that this had been no disadvantage since they believed that all that was required was to be one or two steps ahead of their pupil (Norris,1972).

The quality of training provided to trainee teachers of visually impaired pupils is most important, both in terms of the students' own braille proficiency and in teaching reading and writing in braille. (Rex, 1989).

Teaching programmes that emphasised the methodology of teaching reading and writing through braille produced teachers who were more confident in their own braille skills and in their ability to pass this knowledge on to their visually impaired pupils. Teacher training courses should not concentrate simply on teaching braille, but should include literacy skills and braille reading methods. (Wittenstein, 1993)

Braille must be taught by teachers who understand both the demands of reading by touch and the additional complexities caused by the braille code. Without this knowledge there may be a risk of misattributing reading errors to a child's literacy difficulties rather than to incorrect finger positioning for example (Rex, 1989; Juliet Stone, 1995).

As a compensatory academic skill, Braille is the learners' major literacy medium, and as such it must be taught effectively by a competent teacher (Hatlen, 1997). It is essential for many learners that they have an aide or support person who is competent, enthusiastic and is highly committed to Braille (Gentle, 2000). In most cases this support person is the Braille transcriber and the Braille teacher. This is not the case in Kenya where a study by (Nzoka, 2011) found that learners with visual impairment were being taught by teachers who were not competent in Braille.

A study by the Canadian Braille Authority (2002) on the status of Braille literacy found that in Canada, Braille standards were really low. The study further concluded that there were no national standards for teachers of learners with visual impairment and also there were no educational prerequisites for these teachers (CBA, 2002).

Enhancing competency in learning contracted Braille among student teachers enunciated the role of special teacher to be competent in braille codes to train the learners with visual impairment. The analysis of the performance of scores of student teachers revealed that there was a notable impact of learning of contracted braille among student teachers (Vaijyanthi, 2021)

A study grouped 230 teachers of blind and visually impaired learners according to self-assessment of Braille competency and agreement or disagreement with statements about Braille, Nemeth Code, slate and stylus, and computer technology.

Group 1 reported training in transcription, rule knowledge, formatting, and proofreading. Group 2 had the same training and spent 10% of class time on methodology for teaching Braille reading. Group 3 had Group 1's training plus an emphasis (more than 10% of class time) on methodology. All the groups reported a strong commitment to Braille reading and writing and continued professional growth. Results indicate that emphasis on methodology during training is a key factor in long-term retention of Braille skills and acquisition of positive attitudes toward Braille (Wittenstein, 1993).

### **2.13 Teacher Attitudes towards Braille**

Another reason given in the American literature for the perceived decline in braille literacy is a negative attitude towards braille held by teachers of visually impaired pupils (F. Schroeder, 1989; Stephens, 1989). While informal discussions with teachers did not find them opposed to braille, and for various reasons, their statements were often not supportive of braille usage (Rex, 1989).

There is no hard evidence upon which to base the claim that a decline in braille use is attributable to negative attitudes of teachers. Survey of teachers of visually impaired pupils in the USA found positive attitudes towards braille, and that teachers cared deeply about the literacy skills of their students (Wittenstein, 1993).

A positive attitude to braille found overall amongst teachers of visually impaired children in the UK. Some teachers commented that mainstream placements tended to favour print or technology while special schools were more likely to accept braille as the norm. There was a need for clearer guidelines for teachers to help them decide whether print or braille (or both) was the most suitable medium for pupils on the print/braille borderline (Jennings, 1999). The type of school a teacher worked at could influence their decisions about a pupil's literacy medium (Craig, DePriest, & Harnack, 1997).

### **2.14 Braille Writing Technology**

No-Look Notes No-Look-Notes is a soft keyboard for eyes-free texting on a touch screen. The interface divides the screen into eight wedge shapes, as opposed to 26 or more on a QWERTY keyboard. The eight wedges equally utilize

the full screen of the phone, dividing it into eight radial segments. Users enter text through two-finger interaction, where one finger finds the appropriate wedge and the second finger manipulates a scroll window to find a letter in the group. The device provides speech feedback. No-Look Notes showed a marked improvement in input speed, error rate, and positive feedback from the participants as compared with the current accessibility application from Apple, VoiceOver. Visually impaired users were able to input an average of 1.32 wpm with No-Look Notes, as compared to 0.66 wpm with VoiceOver (Bonner, Brudvik, Abowd, & Edwards, 2010).

Graffiti and Unistrokes were evaluated and compared, which are two different stylus-based (or potentially finger-based) text entry technologies for touch screens. Graffiti, so named because it closely resembles the handwritten Latin alphabet, was far easier for novices to become familiar with. Unlike Graffiti, Unistrokes does not closely resemble the Latin alphabet. Its design maps simple gestures into characters. Unistrokes, once mastered, showed consistently better results in both wpm and error rate. Both input technologies started at about 4 wpm, with Graffiti reaching just over 12 wpm and Unistrokes reaching just below 16 wpm over the course of 20 sessions (Castellucci & MacKenzie, 2008). The correction rates remain steady for Graffiti, while they dropped from 43.4% to 16.3% for Unistrokes. Slide Rule was created at the University of Washington's DUB group. It was accepted and presented at ASSETS 2008. Slide Rule is a system for general operation of a touch screen mobile device by the visually impaired, with applications that include playing music and navigating through menus. While greatly increasing accessibility in some areas, Slide Rule continues to use a QWERTY soft keyboard, a standard keyboard visually rendered on the screen, for text entry. (Kane, Bigham, & Wobbrock, 2008).

## **2.15 Computer Based Braille Reading Instruction**

The comparative analysis of computer software and Braille literacy to educate students having visual impairment compared the feasibility and usage of Braille literacy and computer software to educate children with visual impairment. Main objectives of the study were to identify the importance of Braille and Computer literacy by the perceptions of male and female students with visual impairment, to identify the importance of the Braille and Computer literacy in different classes of students with

visual impairment and to identify the difference of Braille and Computer literacy importance in different schools of students with visual impairment. Five special education institutions were selected where students with visual impairment were studying. A convenient sample of 100 students was taken from these schools. A three point rating scale was used as research instrument. Researchers personally collected data from the respondents. The students were more interested in Braille system than computer software. Braille system and required material was present in all the schools while computer teachers with required experience were not available in these institutions. Teachers were found expert in Braille literacy as compare to the computer software- It was recommended that proper awareness about most recent technologies were necessary for teachers in special education institutions. Students as well as teachers should be provided chances of hands on practice to create interest in computer software use in special education (Bano, Naqvi, Hashmi, Raza, & Shaikh, 2011).

On the Efficacy of A Computer-Based Program To Teach Visual Braille Reading, an efficient computerized program that taught 4 sighted college students to select text letters when presented with visual depictions of braille alphabetic characters and resulted in the emergence of some braille reading. The current study extended these results to a larger sample ( $n=81$ ) and compared the efficacy and efficiency of the instructional program using 2 different response modalities. One variation of the program required a response in a multiple-choice format, and the other variation required a keyed response. Both instructional programs resulted in increased braille letter identification and braille reading. These skills were maintained at a follow-up session 7 to 14 days later. The mean time needed to complete the program was 22.8 min across participants. Implications of these results for future research, as well as practical implications for teaching the braille alphabet, are discussed (Scheithauer & Tiger, 2012).

## **2.16 Technology Based Braille Reading and Writing**

Braille literacy may become obsolete due to advancements in technology such as speech recognition software (Kent, 1997; Paul, 1993; F. Schroeder, 1989; J Stone, 1995).

Braille technology has in fact increased the availability of braille. Specialist equipment is considered important for pupils who use braille because it provides the means by which they access the curriculum (Mason & McCall, 2013).

The use of electronic devices and Braille notetakers provided added motivation for students, and greater gains in fluency and proficiency were noted during instructional phases using the electronic notetaker than during instructional phases utilizing traditional techniques (Caton, 1982).

Electronic brailers were provided to 20 students in Texas, spanning kindergarten through grade 2. The participants with delayed motor skills and limited finger strength were able to produce braille for a longer period of time and with less fatigue. In addition, the electronic brailers were viewed as less disruptive than traditional mechanical braille writers, and the audio feedback provided greater motivation to students, assisting them in staying on task and learning braille letters at a faster rate than many teachers felt they could with conventional technologies alone (Cooper & Nichols, 2007).

Three students in grades 5-7, where improved stamina and higher quality writing, both in terms of content and technical form, were found when using an electronic braille notetaker (Kamei-Hannan & Lawson, 2012)

The early introduction of braille technology for use across the curriculum is both appropriate and increasingly necessary (Presley & D'Andrea, 2009)

Advantages of using braille display technologies are portability and the ability to access the Internet and a variety of reading materials. On the other hand, the limitations to existing braille technologies for the learning and use of braille, are cost and the perceived reduced speed of single-line braille displays, and suggested that multi-line braille displays would provide access to tactile graphics and greater context while reading (Cryer & Home, 2011).

A number of new braille-related technologies are currently under development to increase learner motivation and to address limitations inherent to current braille devices, including educational “app-based” learning tools, multiple-line braille

displays, and distance learning platforms Cryer (Cryer & Home, 2011; Frey, Rosier, Southern, & Romero, 2012; Kamei-Hannan, McCarthy, & Pomeroy, 2015).

Students with visual impairment use technology to reinforce their learning and support their skill development in academic areas like reading, writing, and math. Students can also use technology to access a broader range of information, like electronic texts and audio and video resources (Presley & D'Andrea, 2009) As assistive devices for reading and writing become commonplace in the classroom, students' proficiency with these devices is another expectation for what it means to be literate.

Filipino Braille One-Cell Contractions Recognition Using Machine Vision proposes a system that uses machine vision in recognizing one-cell Filipino Braille contractions. Scanned Braille images undergo image processing and HOG feature extraction to train the system classifier thru SVM. Performance evaluation results reflect a high accuracy of recognition (Loresco & Neyra, 2019) .

Design and Developing Methodology for 8-dot Braille Code Systems proposed a language-independent methodology for the systematic development of an 8-dot braille code. Moreover, a set of design principles is introduced that focuses on: achieving an abbreviated representation of the supported symbols, retaining connectivity with the 6-dot representation, preserving similarity on the transition rules applied in other languages, removing ambiguities, and considering future extensions. The proposed methodology was successfully applied in the development of an 8-dot literary Greek braille code that covers both the modern and the ancient Greek orthography, including diphthongs, digits, and punctuation marks (Kacorri & Kouroupetroglou, 2013).

## **2.17 Braille to Speech Technology**

The Development of an adaptive algorithm for conversion of Hindi Braille to speech concentrates on developing the Braille to speech synthesis system for inter-point Hindi Devanagari Braille and the issues in the present OBR system have been addressed through developing data inherent adaptive algorithms. This effort on the development of adaptive OBR system for inter-point Hindi Devanagari Braille is very first of its kind, paving a way for the development of adaptive OBR systems for any

other languages of Braille. In addition a well characterized Hindi Devanagari Braille database has been developed that includes documents with varying spatial resolution. The developed database will be a useful aid for the future researchers in carrying any new investigations in the study of Hindi OBR. Of many TTS systems available for Indian languages, the system based on waveform concatenation technique using syllables as basic units is the state of the art speech synthesizer. Selecting syllable as a basic unit is due to the fact that, the Indian languages are syllable centred. Waveform concatenation technique is preferred due to the naturalness in the synthesized speech relative to other available techniques. The existing waveform concatenation based TTS systems for Indian languages do not capture the variation in the duration of syllables with respect to their position occurrences; this could have further increased the intelligibility in the synthesized speech. This issue has been taken care of in the present work by developing a speech database formulated on the basis of the duration of the syllable in accordance with its position of occurrence. This augments to the enhanced naturalness in the synthesized speech. A novel text processing algorithm has been designed in support of this. The main objective of this work is to extract the true Braille dots and obtain a more natural sounding speech corresponding to the Braille character and thereby leading to a system that is useful for the real life scenario. Hence the developed Hindi OBR system and the Hindi TTS system are integrated to form a composite system that converts the Hindi Braille text to the equivalent Hindi speech. This development of Hindi Braille to speech system is a kind of its own. The entire system was implemented in MATLAB and evaluated using the developed database. The accuracy of the Braille character recognition was evaluated through the comparison between the decoded Braille document and the system results. The quality of the synthesized speech was evaluated using the parameter called Mean Opinion Score (MOS) to test for the naturalness in the synthesized speech and the intelligibility in the synthesized speech was evaluated using Diagnostic Rhyme Test (DRT). From these tests, it is concluded that the Hindi Braille to speech conversion is much accurate and natural (Shreekanth & Udayashankara, 2015).

Investigation and development of Robust Algorithms for recognizing and analyzing printed and hand embossed Kannada braille characters: novel approaches was developed based on OCR. Algorithm for pre-processing to binarize the Braille

document has been developed. To eliminate the noise introduced in the Braille document while scanning, novel algorithm has been developed. Novel algorithms for complex skew detection have also been designed. Skew detection algorithms used for conventional document images cannot be applied to Braille documents. Looking into the nature of Braille character, most efficient algorithm in skew detection has been designed to its perfection. In the second novel contribution, algorithm for Mosaicing the Braille document has been developed. Inter-point and novel Inter-line Braille document analysis has also been designed. In the third novel contribution analysis and recognition of Kannada Braille characters has been taken up. Kannada being one of the major Dravidian languages of Southern India and one of the earliest languages evidenced epigraphically in India uses forty-nine phonic letters, divided into three groups: swaragalu (vowels - thirteen letters); vyanjanagalu (consonants - thirty-four letters); and yogavaahakagalu (neither vowel nor consonant-two letters: the anusvara and the visarga), similar to the vowels and consonants of English. The character set is almost identical to that of other Indian languages. Kannada Braille is used widely at schools for blind in the Karnataka state of India. Further the consonant-vowel combined characters called Kagunitha characters, consonant-consonant combined characters called Ottakshara characters and Kannada numerals recognition and analysis is a complex problem. Algorithms presented in this thesis have addressed analysing and recognizing such Kannada Braille characters, which numbers to several thousands. In the fourth Contribution algorithms have been developed to analyse and recognize Bilingual Braille characters considering English and Kannada as the case. Complex algorithms are designed to analyse the English Braille words represented by Grade-2 Braille notations having contractions. The developed methods are tested against both Hand embossed and Machine embossed Braille documents. These several novel algorithms in recognizing Kannada and Grade - 2 English Braille characters after the document has been preprocessed to address various issues (Jadamali, Jadamali, Shirsat, & Basavaradder, 2014).

The prototype of Image and Speech Processing for Tamil Braille Patterns Using Dot Part Detection Technique helps the students with visual impairment to read Braille document or Text books. The present implementation is only for the conversion of Tamil Thirukkural both in single side embossed Braille document and Printed text.

The device will be held like an image capture camera and captured over the Documents. The input is taken by a camera in the hand-held prototype device and the output is given as speech through microphone using the above hardware interface. The software implementation and the hardware interfacing were done using Embedded Linux. This thesis is focused towards the algorithms developed for Tamil Character recognition and the results demonstrate the potential of the algorithms developed herein. Two novel feature extraction algorithms were developed with the first one working on the geometrical features and their relative spatial distribution and the second on the Wavelet domain based features. The performances of these two novel feature extraction techniques were tested with the two popular classifiers viz. BPNN and SVM. Further, a novel Tree Classifier was proposed which works in conjunction with the slope method of feature extraction, which demonstrates superior performance compared to all other algorithms and is found to be the most promising candidate for Tamil Character Recognition. Thus, it has added value to the field of Tamil Character Recognition. This implementation of Speech Recognition System has been build on small data, domain based and trained with only 6 speakers, whereas for a general Speech Recognition System at least 50 Speakers are needed. Its performance is independent on speaker, environment, microphone, distance between speaker and microphone, stress. It recognizes the sentences better when said together and it do make mistake to recognize some words if said in a slow speed or if broken down (Ajantha Devi.V & S Santhosh Baboo).

Conversion of English text to Braille code vibration for visually impaired is the software algorithm which is coded in Visual Basic 6.0 reads the sentence from the Input box of the Braille software tool and breaks them into characters and are counted up to the value of the enter key. The Braille code equivalent of each character is generated in the output box of the tool. The hardware algorithm which is coded in Hi-Tech C language reads each character from the Input box of the Software tool and converts into ASCII value. The procedure for the corresponding ASCII value is called and each procedure number is linked with a six digit binary number. The presence of 1's in a six digit binary value is nothing but raised position on the Braille symbol. This activates the corresponding vibration motors in the hand glove. Through this vibration signal the blind person can infer the corresponding English letter. In order to interact

with the blind or blind and deaf person, the visible person types on the Input box of the software tool and this interaction is sent as vibrating signal to the blind or blind and deaf. The statistical analysis of Braille glove reports that it is a suitable kit for blind people because they start their education with Braille code notations. At the same time it is little difficult for visible and deaf and blind people, because the vibration is initially felt difficult to recognize the six positions inside the hand glove, but once they get experience or few repetitions, anyone can use this system for effective communication purpose. Most of the blind users feel that no difference is found between the Braille cell position inside the glove and Braille impressed sheet. The Braille code vibration process is a single step and the data transfer rate is normal and it is controllable. It is the best tool for visually impaired people to have more accurate sensing, low error rate, small electronic product and it proposes a new approach to blind persons to know about computer oriented technologies. This tool can also be extended by introducing online chatting which would help the blind person in socializing (Shivakumari & Rajasenathipathi, 2013).

### **2.18 Assistive Technology for Literacy of Students with Visual Impairment**

Accessing print information through auditory means often initiates concerns among specialist teachers of pupils with visual impairment about ‘giving up’ on the students’ use of braille. Speech access should be regarded as a useful tool to support learning ‘once literacy skills are firmly established’ and note the limitations of speech as a primary learning medium. As an example, the use of compressed (speeded) electronic speech may be useful for reading a chapter in a history textbook, but is unlikely to be of similar value when reading a maths textbook. However computer-based speech access alone would not be an appropriate or satisfactory route to literacy for any child, the position that children who are blind should have limited access to digital technology until braille literacy is established is unrealistic (Presley & D'Andrea, 2009). Providing braille readers with access to electronic text through the use of a refreshable braille display can, even at a young age increase their library from just a few books to hundreds.

The braille notetakers (portable braille computers) with inbuilt refreshable braille displays are in more common use. The braille displays on notetaker devices are

normally shorter (18-30 cells), but the notetakers often allow for the option of speech or braille outputs.

In an investigation of the use of technology in early literacy teaching, found that most preschool children with visual impairment were not given access to assistive technology devices that may potentially facilitate literacy development, with only 3% always, or almost always, providing access to electronic text from the internet e.g. digital books, 15% providing regular access to screen reading software, and 20% to CCTVs on a regular basis( Murphy, Hatton and Erickson, 2008).

Young people with visual impairment used computers and telephones for social purposes not only less often than sighted children but also less often than some other disability groups. They identified the use of assistive technology devices and software to access digital social networking forums as a ‘component of the specialised Expanded Core Curriculum that is taught to students who are visually impaired’. (Kelly & Smith, 2011)

In USA 59% and 71% of the students with visual impairments who were most inclined to benefit from assistive technology did not have the opportunity to use it. Access to information and social networking web sites through mobile devices via adaptive hardware and software is vital if children and young people who are visually impaired are to connect fully with others academically, professionally, and socially. It was recommended that immediate attention should be given to this area which has the potential to re-orient the education of students who are visually impaired (Kelly & Smith, 2011).

A major barrier hindering the use of technology in school was the lack of skills and knowledge by teachers of pupils with visual impairment (Zhou, Parker, Smith, & Griffin-Shirley, 2011).

In an attempt to understand the specific deficits in knowledge and skills of qualified teachers of pupils with visual impairment, they asked 165 teachers in Texas to compare the levels of expertise they perceived they possessed against the levels of expertise they perceived they were expected to possess across 74 competencies for teachers of pupils with visual impairment related to Assistive technology defined

(Smith, Kelley, Maushak, Griffin-Shirley, & Lan, 2009). The survey revealed a self assessed deficit in 55 of the 74 competencies. It was also found that only 41% of the teachers surveyed felt confident or very confident that they could teach most or all forms of assistive technology. Among the competencies where teachers felt they were lacking were: assistive devices relating to braille literacy and its application, use of screen reading software, use of braille translation software, refreshable braille displays and related software, electronic braille devices, and sourcing funds for technology devices. It was concluded that training in this area needed strengthening through increased emphasis on the topic in specialist teacher preparation programmes and through better in-service training for qualified teachers of pupils with visual impairment.

Assistive technology tends to be developed faster than researchers can evaluate it, so evaluating its effectiveness on educational performance is very difficult. While acknowledging that there was a wide knowledge base relating to technology in the field of education and visual impairment, and concluded that ‘the extent to which the field has researched the effectiveness of assistive technology used by students who are visually impaired using rigorous, scientific-based methods is close to non-existent’ (Kelly & Smith, 2011).

Children whose parents were confident that their children would get a paid job were 1.5 times more likely to use assistive technology, and children of parents who took an active part in parent meetings or parent training sessions were 1.4 times more likely to use assistive technology. In addition to the importance of parental involvement and expectations as predictors for technology use was found that placement was also a salient factor in determining likelihood of the use of technology. She found that high school students with visual impairment who attended residential schools were 1.8 times more likely to use assistive technology devices than those who did not attend such schools (Kelly & Smith, 2011).

A comprehensive assistive technology assessment forms a ‘critical part of the education’ for each child with a visual impairment, and should follow on naturally from a clinical low vision evaluation, a functional vision assessment and a learning media assessment. These assessments are essential to determine which sense the student can

most effectively utilise to obtain information from the environment (Presley & D'Andrea, 2009).

## **2.19 Technology Aided Braille Tutoring**

The technological advancements have changed radically the way of teaching of the people with Visual impairment who are assisted with various devices. A novel method of teaching braille Codes is designed with solenoid actuators was developed. The tutor transmits the characters wirelessly to the students panel which is received by Bluetooth module. The corresponding Braille Codes are represented by energizing the solenoids providing a tactile interface and the voice output of the character is given through speaker. Thus any tutor can teach the Visually Impaired (D. Kavitha & Radha, 2020; K. Kavitha, Privadarshini, & Saradha, 2018)

Braille Key is An alternative Braille text input system for the visually impaired (Subash, Nambiar, & Kumar, 2012) it explores the efficacy of using an alternate text input system for the blind, based entirely on Braille alphabets for touch-screen mobile devices. A comparative study was performed wherein a prototype application developed by the authors was compared against the Voice-Over technology developed for iOS (Apple's mobile operating system. The study conducted on five blind subjects show that this system can be used as a viable alternative to the existing input methods that have been developed for this purpose.

Design, Development, and Evaluation of an Automated e-Learning Tutorial System to Instruct Pre-Service Special Educators in the Malay Braille Code employed the technological pedagogical content knowledge framework(TPACK) to integrate expertise in content, pedagogy, and technology to design and develop the system. A directive, automated e-learning architecture was created from applying the principles of TPACK. Evaluation of the system was carried out using a multi-step evaluation framework. Seventy seven pre-service special educators at a university in northern Malaysia learnt braille through this system and evaluated the system using a survey instrument. The findings showed that the learners were satisfied and confident of using the system, and the system was also well accepted in terms of perceived usefulness and ease of use. In terms of design, features that apply mastery learning, extrinsic motivation, practice-feed back in direct instruction, and clarity of graphical interface

were the most highly rated. Content-based features, ease of use and perceived usefulness together, explain 65 % of the variance in learner satisfaction. Content- and pedagogy based design features together significantly predicted learner confidence. The findings indicated that the system(<http://ekodbraille.ses.usm.my>) is viable to support independent braille code instruction online. This work also suggested that TPACK can be a powerful framework for e-learning systems development. The design steps described in this paper also serve as a prescriptive template for future designers attempting to use TPACK for design purposes (L. W. Lee, Mohamed, & Altamimi, 2015).

An Artificial Intelligence Tutor: A Supplementary Tool for Teaching and Practicing Braille evaluated the usability and effectiveness of an artificial intelligence Braille Tutor designed to supplement the instruction of students with visual impairments as they learned to write Braille contractions. A mixed-methods design was used, which incorporated a single-subject, adapted alternating treatments design as well as qualitative teacher interviews and surveys. Results showed that Students seemed to reach 100% accuracy faster when using Braille Tutor (average \_ 7.0 sessions; range 1.0 to 12.0 sessions) than when they did not (average 9.6 sessions with a teacher of students with visual impairments; range 3.0 to 16.0 sessions). Also, students who used Braille Tutor more often tended to learn more contractions overall during the study (average \_ 21.25; range 13.0 to 30.0) than students who used it less (average 9.0; range 9.0 to 9.0). *Discussion:* The first trend noted was that students in the teacher of students with visual impairments plus Braille Tutor phase tended to learn contractions more quickly. A second trend surfaced: The students in the TVI Tutor phase tended to get more frequent reinforcement as opposed to students in the TVI Only phase. A third trend was noted: Students in the TVI Tutor phase saw a quicker initial jump and tended to be more consistent in that initial jump. Although the prototype version of Braille Tutor in this study needs further development to broaden its capabilities, some students found its use highly motivating. Although there is strong evidence that advanced technologies are not suitable replacements for braille literacy instruction, technology can be used along with quality instruction by a teacher of visually impaired students to enhance proficiency in braille literacy (McCarthy, Rosenblum, Johnson, Dittel, & Kearns, 2016).

Electronic Progressive Braille Learning Kit for Blind is for helping them out with the more difficult stages of learning Braille to expand their knowledge and assistance in orientation and mobility. Braille Keypad, which can be used to help users learn Braille by tactile signals, and also hearing it read out to them. The keypad allows visually impaired users to enter Braille characters into the system easily for different use and works (Jadamali et al., 2014) The integration of physical activity and hearing can facilitate easy learning of Braille Script (all languages). It consists of a keypad same as Braille Cell which is based on the Braille matrix (3\*2 matrixes) with two extra control keys. The user first listens to the instructions and gets the training from the kit, then enters the combination of keys in compliance with internationally accepted Braille matrix/script, the device in turn pronounces corresponding output of letter/word/symbols/contractions (flexible for all languages).

E-Braille: A Study Aid for Visual Impaired made an idea to design and develop user friendly cost effective learning aid for visually handicapped children in English language which infuse a sense of playing while learning. The proposed idea was implemented on Arduino Microcontroller interfaced with Speaker, LCD and Braille Cell as output devices. The proposed model develops a character followed by number on Braille cell sequentially hence aids the visual impaired to learn the language (Kavalgeri, Chakraborty, Naz, & Chaitanya)

Blind Aid: A Self-Learning Braille System for Visually Impaired designed as a low-cost, low-power, portable, self-learning, and user friendly Braille system. The designed system serves as Braille writing and reading tutor, so visually impaired people can enhance their Braille writing and reading skills without the assistance of a Braille teacher. The designed system takes the input through Braille keyboard and produces the speech output and it also has the capability to read documents. It is believed that by implementing the designed Braille system in schools and homes, Braille literacy rate can be increased and visually impaired people can be employed and can fully participate in society (Khidri<sup>1</sup>, Memon, & Jameel, 2014).

Braille Tutor-A Gift for the Blind developed to teach the basic alphabets and numbers to students with visual impairment. Further the product has data connectivity through Bluetooth link so that the teachers can use it to monitor what the

students are learning. The result is the complete working device Braille tutor with the speakjet IC output through speaker and Bluetooth connectivity for monitoring each device (Anjana Joshi and Ajit,2015).

Braille cell actuator based teaching system for visually impaired students stated that there are significant improvement in technology that proved important and beneficial to physically disabled people. The technological advancements such as smart cane and smart phones for the blind have assisted in their daily life activities. There are screen readers as well as an iPhone application for typing in braille on the touch screen and even today, teaching aids like Wooden Boards with Embossed Dots or indentations are used for teaching Braille alphabet to visually impaired students in their School. Currently, with this technique, a single tutor can teach only a single student at a time and requires considerable amount of time in teaching the alphabet individually to every visually impaired (Gandhi, Thakker, & Jha, 2016).

The paper on “A portable piezoelectric tactile terminal for Braille readersby (Velázquez, Hernández, & Preza, 2012) introduces a novel concept on reading assistive technologies for the blind: the Tacto Book, a system that is able to translate entire electronic books (eBooks) to Braille code and to reproduce them in portable electronic Braille terminals. The Tacto Book consists of a computer-based translator that converts fast and automatically any eBook into Braille. The Braille version of the eBook is then encrypted as a file and stored in a USB memory drive which is later inserted and reproduced in a compact, lightweight, and highly-portable tactile terminal. In particular, this paper presents a piezoelectric ultrasonic actuation approach to design and implement such portable Braille terminal. Actuating mechanism, design concept, first prototype, and performance results are presented and discussed.

Assistive technology for people with visual disability is growing rapidly over the past few years around the world. Such technology enhances the functioning and performance of daily living skills, thereby improves the independent living. These technologies range from low cost to high end and expensive which include mobility, reading, writing, daily living, and communication technologies. Children primarily need technology for education whereas adults for routine living tasks. Over

time the need as well as demand of such technologies will continue to grow due to expected increase in proportion of population with visual disability particularly in low middle-income countries like India. Therefore, the first and forefront strategy to improve assistive technology service for visual disability in India is to create awareness, sensitize among eye care professionals, potential beneficiaries, caregivers, and their families. The present paper by (Senjam, 2020) on Assistive Technology for People with Visual Loss. highlights various type assistive technologies in which few of them incorporate with illustrations so the readers understand easily.

Audio-assisted standalone microcontroller-based Braille System Tutor for Grade 1 Braille symbols by (Garcillanosa, Apuyan, Arro, & Ascan, 2016) presents a design of an audio-assisted stand-alone microcontroller-based Braille System Tutor that aims in improving the literacy of visually impaired people especially in the developing countries such as the Philippines. The proposed Braille System Tutor is composed of two single cell, one for reading and the other is for writing of the Grade 1 Braille alphanumeric characters. It was implemented with the use of a Raspberry Pi 2 B+ microcontroller and programmed using the Python language. The program enables to activate the push-pull solenoid to display the Braille pattern for the read mode, and it also activate the tactile switches to be pressed by the user during the write mode. Through hit and miss collection of data, the prototype gives a 100% correct results for read mode - by giving correct Braille pattern. The prototype also gives a 100% correct results for the write mode by identifying if the correct Braille combination entered by the user is correct or incorrect through an audio message.

The Computerized Braille Tutor: A Computer-Based Braille Learning Program by (Kapperman, Heinze, Hawkins, & Ruconich, 1996) Conveyed that the Computerized Braille Tutor is an interactive software tutorial, accompanied by a manual, that sighted persons can use to learn the literary braille code or to refresh their braille skills, either independently or under the supervision of an instructor in a braille course. The software presents 15 lessons that address different aspects of the literary braille code and include braille-translation and proofreading exercises and graded self-evaluation proficiency tests.

The study on the comparative analysis of computer software and Braille literacy to educate students having visual impairment focussed on compare the feasibility and usage of Braille literacy and computer software to educate children with visual impairment. Main objectives of the study were to identify the importance of Braille and Computer literacy by the perceptions of male and female students with visual impairment, to identify the importance of the Braille and Computer literacy in different classes of students with visual impairment and to identify the difference of Braille and Computer literacy importance in different schools of students with visual impairment. Five special education institutions were selected where students with visual impairment were studying. A convenient sample of 100 students was taken from these schools. A three point rating scale was used as research instrument. Researchers personally collected data from the respondents. Data was analyzed through SPSS. Major findings showed that students were more interested in Braille system than computer software. Braille system and required material was resent in all the schools while computer teachers with required experience were not available in these institutions. Teachers were found expert in Braille literacy as compare to the computer software- It was recommended that proper awareness about most recent technologies were necessary for teachers in special education institutions. Students as well as teachers should be provided chances of hands on practice to create interest in computer software use in special education (Bano et al., 2011).

The study on the Efficacy of A Computer-Based Program To Teach Visual Braille Reading created an efficient computerized program and taught 4 sighted college students to select text letters when presented with visual depictions of braille alphabetic characters and resulted in the emergence of some braille reading. The current study extended these results to a larger sample ( $n=81$ ) and compared the efficacy and efficiency of the instructional program using 2 different response modalities. One variation of the program required a response in a multiple-choice format, and the other variation required a keyed response. Both instructional programs resulted in increased braille letter identification and braille reading. These skills were maintained at a follow-up session 7 to 14 days later. The mean time needed to complete the program was 22.8 min across participants. Implications of these results for future

research, as well as practical implications for teaching the braille alphabet, are discussed (Scheithauer & Tiger, 2012)

In the Evaluation study on Computer-Based Instruction for Young Braille Readers in mainstream education, Seventeen schools who took part in a three-year project where computers were introduced as a reading and writing tool for young braille readers. The purpose of the project was to evaluate the significance of computers for both the development of the pupils' reading and writing skills and the pupils' opportunities for socializing in the teaching situation through interaction with the teacher and classmates. The results of the project showed that the computer was most important as a reading and writing tool for the pupil, opening up new possibilities for text editing in braille. The pupils also became more motivated and could, to a greater extent, do the same work as their peers sometimes even in co-operation in the classroom. There was a clear relation between the general computer readiness in the class and how often the pupil with visual impairment used his/her computer. Instant technical and pedagogical support for the teacher was fundamental as was continual in-service training. According to the teachers, the great advantages for the pupils' learning and inclusion overshadowed possible technical computer troubles (Fellenius, 1999)

A novel Braille pad with dual text-to-Braille and Braille-to-text capabilities with an integrated LCD display that Braille is the writing system that visually impaired people use to write or read or to communicate. This novel design is a low-cost, low-power, portable and user-friendly Braille system. The advantage of the system is that the designed system serves as both Braille writing and reading system, so visually impaired people can enhance their Braille writing and reading skills without the assistance of a Braille teacher. The designed system takes the input through Braille keyboard and produces the Braille output in Braille display; the corresponding English characters are also displayed on the LCD and also in the laptop if it is connected. It also has the capability of reading documents as text. By implementing the designed Braille system in schools and homes, Braille literacy rate can be increased and visually impaired people can be employed and can fully participate in the society (Sultana, Rahman, Chowdhury, & Zaman, 2017).

## **2.20 Mobile Based Braille Technology**

Design of a Braille Learning Application for Visually Impaired Students in Bangladesh discussed the overall situation of VIS in Bangladesh and identifies major challenges that they are facing in getting education. The Braille system is followed to educate blind students in Bangladesh. However, lack of Braille based educational resources and technological solutions have made the learning process lengthy and complicated for visually impaired students. As a developing country, Bangladesh cannot afford for the costly Braille related technological tools for students with visual impairment. Therefore, a mobile phone based Braille application, “mBRAILLE”, for Android platform is designed to provide an easy Braille learning technology for visually impaired students in Bangladesh. The proposed design was evaluated by experts in assistive technology for students with disabilities, and advanced learners of Braille. The application aims to provide a Bangla and English Braille learning platform for Visually Impaired students. The results showed that the design scored an overall satisfaction level of 4.53 out of 5 by all respondents, indicating that our design is ready for the next step of development (Nahar, Jaafar, Ahamed, & Kaish, 2015).

Slate Master: A Tangible Braille Slate Tutor for Mobile Devices is a mobile device didactic tool for the visually impaired designed to ease learning how to use the Braille slate. The Braille slate is a tool used by the visually impaired to manually write Braille encoded text on paper. Slate Master is composed by a Braille tutor mobile application and a custom input interface that mimics the use of the Braille slate. They also present the insights obtained from a preliminary study performed with six Braille education experts that led to the design and development of Slate Master (G. Lee et al., 2017).

Android Based Braille Tutor System for Visually Impaired People was designed to provide an easy Braille learning technology for students with visual impairment. The main objective of the project is to create a low cost, economical presentation device and Braille tutor system based on Android for the blind. This Android Application acts as a tutor at sender side and server side system which receives the data and converts to text to speech and even displays it in graphical manner at the Receiver Side. The Text can also covert into speech at the Receiver Side. Tutor App for visually impaired is a device

that can be used by blind for two major purposes i.e. Note Taker, Electronic Braille Tutor System (Kulkarni & Sannakki, 2018).

Hardware Based Braille Pad on Mobile Phone is used read Braille notations. These Braille editions are available for each language. This is new independent electronic device which enables a visually impaired person to read messages. A prototype of the communication and kit used by the blind has been designed using Arduino Uno (Vadivu, Deepak, Kumar, Sabeek, & Krishnan, 2019)

## **2.21 Braille Writing Tutor**

Automated Braille Writing Tutor designed to teach braille writing skills to visually impaired children using voice feedback. The methodology of Intelligent Tutoring Systems correlates to an automated tutor for teaching braille writing skills. This automated Braille Writing Tutor consists three dimensions: (1) Initial field testing in three different countries;(2) Exploring customization needs for improving relevance indifferent cultures; and (3) Adding relevant games for increasing motivation. The outcome of this work is an enhanced low-cost tool that can help to increase braille literacy in blind communities around the world (Kalra, Lauwers, Dewey, Stepleton, & Dias, 2009)

Design of a braille writing tutor to combat illiteracy is an iterative and participatory process resulting in the creation and refinement of a prototype braille writing tutor system. This system uses a novel input device to capture a student's activity on a slate using a stylus and uses a range of techniques to teach braille writing skills to both beginner and advanced students. We report on lessons learned from the implementation of this project and from a 6-week pilot study at Mathru, and outline future directions for improvement (Kalra et al., 2009).

## **2.22 Computer Based Braille Tutoring System**

A computer-based program to teach braille reading to sighted individual conducted a preliminary evaluation of a computer-based program intended to teach the relation between braille characters and English letters using a matching-to-sample format with 4 sighted college students. Each participant mastered matching visual depictions of the braille alphabet to their printed-word counterparts. Further, each

participant increased the number of words they read in a braille passage following this training. These gains were maintained at variable levels on a maintenance probe conducted 2 to 4 weeks after training (Scheithauer & Tiger, 2012).

Evaluating Training and Implementation of the Individualized Meaning-Centered Approach to Teaching Braille Literacy investigated the effectiveness of training workshops in braille literacy for teachers of students who are visually impaired and have additional disabilities. Participants in the training workshops in the Individualized Meaning-Centered Approach indicated general satisfaction with the training. Most reported using the approach with students in their caseloads and overwhelmingly reported positive outcomes for students (Durando & Wormsley, 2009).

A web-based braille code instruction course with instructor intervention for pre-service teachers, and concluded that online instruction offered a high quality, rigorous approach to delivering instruction, with appropriate technological support (Koenig & Robinson, 2001). However, this required human instructor support, which would not solve the problem of severe shortage of braille instructors. Instead, this research proposed an automated, self-accessed e-learning tutorial system as a more sustainable and viable solution for training special educators who learn braille by sight. An automated course has the added advantage of expanding ad infinitum (Cook & Dupras, 2004), therefore, additional resources are unnecessary with increase in users.

Reading through touch discussed the importance and look at the difficulties that face visually impaired learners and those with visual impairment and multiple difficulties to learn Braille as an alternative and essential method of reading and writing. It will also show the importance of developing strategies that help those learners, wherever possible, to interact with letters through touch in the course of education. It will start by giving a general background to Braille and its role. The paper will then look at different problems that may arise from the use of Braille as the only method of reading and writing for people with vision impairment, and then it will conclude by introducing alternative and additional interventions which can be used to overcome the associated problems (Khochen, 2011).

Effectiveness of a Braille Training Program for teachers in Jordan aimed to know the effectiveness of a braille training program for the teachers in Jordan. Achieve the study aims; the questionnaire of effectiveness braille training program used to collect data from (15) teachers before and after implementation of the program. The findings indicated that the program was effective, and it contributed to increasing teachers' knowledge about reading and writing Braille (AlTarawneh & Majali, 2021).

### **2.23 Conclusion**

This purpose of research review is to help the reader understand different aspects of education of students with visual impairment particularly on Braille literacy. There has been much research and discussion conducted on teaching Braille to students with visual impairment including braille as a literacy medium for visually impaired, Importance of Braille literacy for Academic Achievement, Impact of Braille literacy, Status of braille reading ,Methods of Teaching Braille ,Perceptions of Uncontracted and Contracted Braille, Hand movements and braille reading, Spelling and Braille, Braille Reading Accuracy Vs Reading fluency, Challenges in Braille Literacy, Role of teachers in Braille literacy and Teacher attitude towards braille. Currently more researches have focused on Braille writing technology ,computer based Braille Reading instruction, Technology based Braille reading and writing, Braille to speech technology, Assistive technology for literacy of students with visual impairment, Technology aided Braille tutoring system, Mobile based Braille technology ,Braille writing tutor and computer based tutoring system. Effectiveness of such technology based interventions related to Braille literacy specifically for Grade2 Braille(contracting braille) for students with visual impairment needs to be established. More research is required to gain better understanding of how technology is useful and why the students with visual impairment are struggling to identify themselves with their peer groups. Research on literature review revealed that in countries like the United States, technology based instructions for Braille education have been modified to meet the needs of students with visual impairment .But in Indian context modification/adaptation or development of new devices for Braille literacy is rarely noted. Hence the present research was planned to develop a tech aided grade2 braille tutoring system and study its effectiveness by introducing it to students with visual impairment.