CHAPTER - II

REVIEW OF RELATED LITERATURE

2.0 Introduction

In the first chapter, Rationale along with objectives has been given. The present chapter is devoted to reviewing researches elated to different aspects of Expanded Core Curricular Skills of children with visual impairment. For better understanding, the research has been classified under the captions as follows:

2.1 Expanded Core Curriculum for Visually Impaired Children
2.2 Academic Skills
- 2.2.1 Braille Reading Skills & Fluency
- 2.2.2 Use of Slate & Stylus and Braille Writing
- 2.2.3 Application of Nemeth Code
- 2.2.4 Abacus Usage
- 2.2.5 Study & Reference Skills
- 2.2.6 Use of Tactual or Printed Charts, Graphs & Maps

2.3 Career Education
- 2.3.1 Resources Available for Blind and Low Vision
- 2.3.2 Career Decision

2.4 Independent Living Skills
2.5 Knowledge of Orientation & Mobility
2.6 Application of Technology
2.7 Academic Achievement of Visually Impaired Students
2.8 Academic Skills of Low Vision

2.1 Expanded Core Curriculum (ECC)

Lohmeier (2005) viewed historically; specialized schools for the blind were the only options for educational programming available to students with visual impairments. Throughout the 19th century and into the mid-20th

century, the instruction in specialized schools consisted primarily of the core curriculum or academic areas (Zebehazy & Whitten, 1998). Current research suggested that specialized schools should provide instruction in both academic and specialized skill areas. The eight specialized skill areas identified within the expanded core curriculum are compensatory academics, social development, recreation and leisure, independent living skills, orientation and mobility, technology, career development, and visual efficiency (Hatlen, 1996). Sighted individuals learn these life skills incidentally and through modeling, but students who are blind or visually impaired have little or no opportunity to acquire them through that kind of learning. This study examined whether specialized schools for students who are blind or visually impaired in the United States are including the eight areas of the expanded core curriculum in their instructional programs and whether they are doing it before, during, or after school hours.

Recent research has supported the importance of the ECC and has investigated the current state of ECC instruction in the United States. The Council for Exceptional Children (2009) included all nine areas of the ECC in its list of the knowledge and skills that beginning teachers of students with visual impairments need. It included only the skills and knowledge that have been validated by research as valuable for the education of children with disabilities, thus indicating that the larger educational community recognizes that all areas of the ECC are important for students with visual impairments.

Lewis, Savaiano, Blankenship, & Greeley-Bennett (2014) conducted an extensive review of existing literature to identify intervention research in three areas of the expanded core curriculum (ECC) for students with visual impairments: independent living skills, self-determination skills, and social interaction skills. Students with visual impairments often struggle to develop competence in these three areas without direct instruction, yet it is thought that they are critical for successful adult functioning. Results were summarized by the ECC area, with seven (30%) studies on independent living skills, six (26%) studies on self-determination, and ten (43%) studies on social

skills. Single-subject multiple baseline designs were most commonly used, though many of the researchers failed to demonstrate experimental control through sufficient replications of their interventions to support causality. Based on the paucity of intervention studies, the authors concluded that there are few research-based strategies to facilitate the development of skills in these three areas.

Wolffe & Kelly (2011) reported that the National Longitudinal Transition Study 2 (NLTS2) is a nationally representative, longitudinal database of high school and post-high school transition-aged youths with disabilities. The tools used in the data collection process included interviews with parents or guardians and with the youths; surveys of teachers, school programs, and school characteristics; students' assessment histories; and transcripts detailing which courses the students had taken, the grades the students received, and the students' attendance records. The descriptive data pertaining specifically to measures of the ECC fell into two categories: youths with low vision and youths who are completely blind. The analyses indicated that there are numerous significant relationships between the receipt of instruction in ECC-like content areas and meaningful outcomes, such as employment, postsecondary training, and engagement in social activities.

Ringwalt (2013) investigated how the Expanded Core Curriculum (ECC) was taught to high school students who are blind or visually impaired at the Indiana School for the Blind and Visually Impaired (ISBVI). The study focused on three students pursing different academic tracks with varying degrees of vision. The students were observed throughout their school day and during residential time. Following the students through the day brought to light the instructional strategies that the teachers used to assist them in mastering the components of the ECC. Differences were apparent between the components of the ECC taught in the classes where students were working towards a certificate of completion and classes where students were working towards a diploma. Students who were working on a certificate of completion focused on independent living skills, recreation and leisure skills

and social skills. Students working towards a diploma received more instruction in compensatory skills, visual efficiency skills and assistive technology skills; the one ECC component that was consistently instructed to all students was instruction in orientation and mobility. Four themes emerged from analyses of the observations and interview data: 1.the time needed to provide the instruction, 2.to whom does the responsibility fall for instructing students in the Expanded Core Curriculum (ECC), 3.the level of preparedness of students who attend ISBVI; and, 4.differences in opportunities for students in academic vs. life skills classrooms in ECC instruction.

Sapp & Hatlen (2007) surveyed the views of teachers of students with visual impairments and O&M specialists of the ECC, all the participants responded to open-ended questions with positive comments about the importance of the ECC in the lives of their students. Most of them discussed how the skills in the ECC prepare students for real life. Some went further, stating that when students master ECC skills, it is the "difference between life and a successful life," and students who received high-quality instruction in the ECC have a "richer quality of life" than do those who do not. Some participants were even more passionate about the importance of the ECC, stating, "It [the ECC] is everything...almost more important than academics" and "What point is there in reading/writing/math if you have no friends and can't get a job?"

Lohmeier, Blankenship & Hatlen (2009) findings were supported by those of other studies that reported teachers of students with visual impairments and O&M specialists do not have enough time to teach self-determination skills, one of the areas of the ECC (Agran, Hong, & Blankenship, 2007). A direct evaluation of how teachers of students with visual impairments spend their time also showed that the teachers spent most of their time on academic and compensatory skills and only a limited time on other areas of the ECC (Wolffe, Sacks, Corn, Erin, Huebner, & Lewis 2002). Much of the time that the teachers spent on areas of the ECC that are not

closely tied to academics occurred in an unplanned and unstructured manner that limited their instructional effectiveness.

Lohmeier, Blankenship, & Hatlen (2009) completed a survey of professionals' views about the National Agenda for the Education of Children and Youths with Visual Impairments, Including Those with Multiple Disabilities and the ECC. They found that most respondents believed that teachers of students with visual impairments and O&M specialists were knowledgeable about the ECC and that most were committed to the need for assessment and instruction in all areas of the ECC. Unfortunately, they also found that most respondents did not believe that these professionals had the time to teach all areas of the ECC.

Sapp & Hatlen (2007) national surveyed 50 professionals who attended 16 university training programs found that more instruction for preservice teachers in the ECC is provided now than in the past. Students who graduated in the past 10 years, compared to students who graduated earlier, rated their training higher in all areas of the ECC, with differences in scores on career skills, self-determination, social skills, and technology skills reaching significance ($p<.05$). Despite this improvement, all but two respondents listed suggestions for skills in the ECC for which they wished they had received more training: skills in specific areas of the ECC, ways to incorporate the ECC into the typical school day, applying the ECC to students with a range of visual and intellectual abilities, and incorporating the ECC into students' IEPs and lesson plans. The differences in responses indicated that some personnel preparation programs are strong in preparing teachers for providing instruction in the ECC, but that all can improve in some areas.

2.2 Academic Skills

2.2.1 Braille Reading Skills & Fluency

1. Braille Training

Ryles (2004) reported on a research study that has revealed that literacy rates of blind high school students who began their Braille education at an early age are consistent with those of their sighted peers. The study further disclosed those legally blind children who received infrequent or no Braille training, or who began their Braille education later in life, exhibited noticeably lower literacy rates.

Hooper, Ivy & Hatton (2014) identified constant time delay as an evidence-based practice to teach print sight words and picture recognition. The authors tested the effectiveness of constant time delay to teach new braille words. A single-subject multiple baseline across behaviors design was used to investigate the use of constant time delay to teach recognition of highly motivating braille words to four students with visual impairments and intellectual disabilities. Results showed that each participant learned all words taught (9-12 words each). A functional relation was demonstrated for all four participants by immediate changes in trend from baseline to intervention. This was the first published report of the successful use of constant time delay to teach braille word recognition to students with visual impairments and intellectual disabilities. An attending cue was introduced into the procedures for students with a low number of unprompted correct responses, and results were positive. Possible sources of variability in word retention were discussed.

2. Phonological Awareness of Braille Readers

Greaney & Reason (1999) measured the phonological performance of a sample of 22 braille readers aged 7:10-12:1 years. They found that the scores achieved for each test of phonological awareness/memory were higher than those expected from the norms of sighted children. However, in spite of this phonological superiority, the braillists did not read as well as sighted

children, and authors concluded that progression from phonological to orthographic awareness was hard to achieve for children who were blind.

Gillon & Young (2002) compared the phonological-awareness skills of nineteen New Zealand children aged 7-15 years who were using braille as their reading medium, with those of a control group of sighted children who were chronologically three years younger but of the same reading age. They 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.

A study by **Dodd & Conn (2000)** in the UK, asked children (average age 10:1) with and without visual impairments to segment words phonemically with and without braille contractions. They too found that braillists performed below the level of sighted children on reading measures, but also found that they performed relatively poorly on phonological awareness skills in comparison with a matched group of sighted children. In particular, they found that the participants who were blind scored lower on segmenting words that contained braille contractions, concluding that the logographic nature of braille (e.g. the fact that contracted braille symbols such as ‘the’ in the word ‘further’ can cut across phonological boundaries) affects a reader’s ability to segment words phonemically and that some phonological difficulties might be related to ‘the nature of contractions in braille orthography’.

Barlow-Brown & Connelly (2002) noted that in relation to young pre-school children, congenitally-blind children do not receive exposure to environmental print and do not generally learn to recognise written letters of the alphabet prior to schooling in braille. In comparison, **Treiman & Rodriguez (1999)** found that most fully sighted children begin school able to recognise approximately 15 print letters. Barlow-Brown and Connelly found that blind children ‘with no knowledge of written letters or written words showed no ability at measures of phonological awareness’ whereas ‘Blind children with knowledge of written letters and no written words showed much

increased phonological awareness'. The authors noted that letter learning is a major contributor to the development of phonological awareness in children who are blind, and phonological awareness skills develop only after children who are blind experience a written form of language, arguing that 'learning to recognise braille letters provides the impetus for improvements in phonological awareness' . They concluded that, whereas for sighted children knowledge of letter names goes hand-in-hand with knowing what the letter name refers to (the orthographic symbol), 'until blind children learn braille letters they can't make this connection and the development of phonic awareness is stifled as a consequence'.

Murphy, Hatton & Erickson (2008) investigated strategies in a survey of the early literacy practices of 192 specialist visiting teachers of pupils with visual impairment who work with preschool children in the USA, for promoting phonological awareness used by teachers. These included: singing and listening to songs, nursery rhymes and chants; reading stories with interesting sounds/rhythms; building knowledge of sound-symbol associations in meaningful contexts; inventing words that rhyme with child's name; playing with sounds in words (e.g. tongue twisters, nonsense rhymes); playing word games with children to identify beginning sounds in words; pointing out particular sounds in words when reading a storybook; emphasising the number of syllables or phonemes in spoken words . The study found that most teachers did not use direct structured instruction to promote phonological awareness, such as pointing out particular sounds in words or emphasising the number of syllables or phonemes in spoken words, nor were they implementing recommended practices in early literacy such as promoting phonological awareness and the function of writing. The authors suggested that this may be for want of an access to current resources on teaching literacy, and concluded that there was a need for the development of resources that address phonological awareness skills.

Crawford & Elliott (2007) focused research into phonological methods for learning to read braille involved 6 Australian braille readers in primary

schools. Crawford found that teaching braille letters as phonemes resulted in more efficient performance than teaching braille letters as graphemes, and they reported that their work confirmed results from an earlier study with preschool blind children (Crawford, Elliott and Hoekman, 2006) which found that introducing braille words as onset- rimes 'produced statistically significant better performance in comparison to instruction in braille words as whole words'. This in turn mirrored the findings of Vik and Fellenius (2007) with six primary school braille readers in Norway. This finding implies that some contractions may interfere with a style of teaching which emphasises phonic analysis, for example, simple upper word signs (such as 'p' for people), or where contractions do not align with phonic boundaries (such 'the' in 'other' and 'of' in 'roof').

Studies of blind children in the early stages of schooling generally support the view that they match children who are fully sighted in most aspects of phonological awareness. However **Emerson, Holbrook & D'Andrea (2009)**, reporting on the findings of the ABC Braille study, suggested that while young beginning braille readers in kindergarten and first grade (ages 4-6) did not have great difficulty acquiring basic reading skills, they began to show 'deficiencies in acquiring higher level decoding skills' in second grade and above (age 6+ years). The tests that focused specifically on phonemic awareness showed most children in kindergarten (75%) had acquired 5-7 of the 7 basic skills for this age range including blending word parts, blending phonemes, detecting initial sounds, and linking letters to sounds. By first grade the children had developed 7 or 8 of the 8 basic reading skills, including substituting initial/final consonants, and blends in the final position. However, when it came to applying these phonological skills to acquire higher level skills such as recognising CVC words (e.g. mat), or CVC words with a 'Magic E' (e.g. mate), children's results were much less consistent. Indeed **Erickson & Hatton (2007)** identified specific strategies such as repeated readings, direct instruction in phonics, and big word

decoding that emphasizes morphemes, as being of great benefit to school-aged children with visual impairments and blindness.

More recently, **Hatton, Erickson & Lee (2010)** examined the phonological awareness of 22 young children with visual impairments and no additional disabilities aged 4-7 (average age 5.4). The study tested for syllable-segmentation, 'sound-isolation' (the ability to recognise onset and produce isolated sounds at the beginning of words), and sound-segmentation skills (the ability to segment individual words into sounds and phonemes) and 'letter sound knowledge' (the ability to identify letters and digraphs when they are written down). The study found that the phonological awareness skill of the children in the sample was commensurate with those of children who were fully sighted. It also found that within the sample of visually impaired children, potential braille readers scored better on the first three tests than potential print readers. Among the possible explanations they put forward for this finding was that potential braille readers are more attuned to the sounds in oral language than potential print readers (who may be more attuned to visual stimuli). The authors concluded with earlier findings of Millar (1997) who found that 'the phonological skills and preferences of young blind children should make it easier for them to learn the phonemic detection and segmentation skills that are needed for learning braille'.

3. Reading Media

Ryles (1996) compared a number of outcomes for congenitally legally blind adults who learned to read braille or print as their original reading medium. It was found that those who learned to read using braille had higher employment rates and educational levels, were more financially self-sufficient, and spent more time reading than did those who learned to read using print.

Rogers (2007) found only 107 children who used both print and Braille for reading or writing. This constituted approximately 17% of the population of children aged between five and sixteen who used Braille. Rogers suggested that, because visual processing is faster and more efficient than tactile

processing, print initially may be the preferred format, particularly in reception classes, where children are not required to process large amounts of information. Almost all the children (86%) had begun by learning print in reception class, but by the age of seven 54% had also been introduced to Braille.

Lusk & Corn (2006) noted that a single-medium policy was common in the United States in the 1980s but that dual use was now seen as a positive advantage for some children. They studied dual-media learners in the United States and explored the instructional methods and curricular decisions of teaching dual media to students with low vision and reported the students' present literacy levels and reading rates and their teachers' expectations for future levels of literacy. They found a generally positive attitude towards both print and Braille among the students. Only half the students who used dual media had progressively deteriorating eye conditions. Only 15% used standard print with optical devices as their primary reading medium. In addition, 49% used large print, 19% used Braille, and 18% used standard print without optical devices as their primary reading medium. All the students used at least one method of accessing print and were learning or using Braille.

Goudiras et al. (2009) examined reading media (braille, cassettes, screen-reader, screen-magnifier, large print, low vision aids, CCTV) used by visually impaired adults. This article reported the results of a research project involving 100 people with visual impairment. The participants were interviewed and asked to fill in a questionnaire to gather data on use of different reading media and the training in use of reading media, as well as age, gender, age of onset of visual impairment, education, and place of residence. The authors also explored participant perceived advantages and disadvantages of the various reading media, and the perceived suitability of each reading medium for daily, educational, and professional tasks.

Klingenberg, Fosse & Augestad (2012) estimated the occurrence of braille-reading students in Norway who were educated according to their grade-level progression in mathematics from 1967 to 2007. It also analyzed the association among these students' progression in mathematics and the causes of visual impairment, the age at which the diagnosis was established, the students' gender, and the students' use of reading media (braille as the sole, primary, or secondary literacy medium). A retrospective, population-based study design was used. All the students who had received braille education in the past four decades prior to the study were included. The following data were abstracted from each student's records: birth year, country of birth, gender, year diagnosed, diagnosis, type of reading media, and whether the student's education had followed their grade-level progression. The results showed that in total, 248 braille-reading students were identified. Of these students, 141 (57%) had been taught mathematics at grade level. In 19 of the 45 principal eye diagnoses that were registered, all the students were educated according to the normative grade progress in mathematics. There were no statistically significant associations between gender and the abstracted variables or between mathematics education and reading media. During the four decades under study, there was some variation in the distribution of different diagnoses. Students with diagnoses related to the central nervous system had a comparatively higher risk of not attaining their normal grade level in mathematics.

Njue, Aura & Komen (2014) reviewed that Braille remains the main medium of reading and writing among persons with blindness world over. This study aimed at establishing factors that have continued affecting Braille competency among young beginners in Kenya. The study was carried out at Thika School (Thika County) and St. Lucy School (Meru County), both being among the largest schools for learners with visual impairments in Kenya. The study adopted a descriptive survey design. A random sample of thirty girls and thirty boys was selected for the study. Five out of the eight teachers teaching reading and writing of Braille participated in the study.

Two English lessons were observed in progress in each of the schools under study. The study revealed that there were no arrangements put in place to train children in reading readiness skills before introducing them to reading and use of Braille. There lacked uniformity in the way teachers approached the teaching of Braille.

Zebehazy & Wilton (2014) investigated the perceptions and practices of teachers of students with visual impairments in Canada and the United States regarding graphics (both tactile and print) that are used by students with visual impairments. Questions focused on quality, importance, and instruction in the use of graphics. An electronic survey was disseminated. Results were summarized by percentage, based on the number of respondents who answered each question. Parallel questions that compared responses for tactile versus print graphics were statistically compared using the Wilcoxon signed-rank test, and effect sizes were computed. Results showed that in general, teachers valued the use of graphics and the need to provide instruction. Significant differences were found in how teachers answered tactile and print graphic questions. Fewer than 50% of the respondents felt that graphics were appropriately adapted on large-scale assessments, that there was sufficient instruction in the use of graphics in mainstream classrooms, or that there was an adequate amount of instructional time to teach the use of graphics. Findings highlighted a need to gain insight into effective teaching strategies that help students gather information from both tactile and print graphics.

Al-Said (2010) explored the notion of what constitutes literacy, particularly as pertaining to people who are blind or visually impaired, specifically those that do not use Braille as their primary way to access and produce text. A mixed design was used including a biographical presentation of what it means to be blind and "literate" or "illiterate". Additionally, a qualitative study was conducted exploring the understanding of what literacy, as applied to a population of blind and visually impaired individuals, means. Four groups of stakeholders (a) University students, (b) teachers, and

(c) professionals, each of whom worked with or were themselves blind or visually impaired, and (d) literacy specialists were interviewed. An experimental study was conducted to determine if differences existed among three groups of individuals in their ability to process and recall information through their preferred way of processing text as opposed through audition alone. The three groups were individuals who were blind or visually impaired and either used Braille or did not and individuals with sight who read the visual print. The results of this experiment were that there were no differences found across and within groups in terms of amount of information retained when allowed to access text in their preferred way or by listening to it alone, with the exception of sighted individuals who retained more information when reading rather than listening to text. These results were presented as feedback to the original interviewees to determine whether these results would change the views of any of the original interviewees with respect to their notions of literacy and the role of auditory-based access to text. The results of the study revealed a very complex understanding of what constitutes literacy but a general consensus as to what literacy means across those who were interviewed and suggested that Braille was not the only viable approach to accessing text, but because of technological advances, audition is also viable.

4. Braille Assessment

Sacks, Hannan & Erin (2011) viewed children's perceptions of learning to read and write braille was measured using an open-ended 10-item questionnaire. The data were evaluated by amount of time, level of contractedness, and level of achievement. No differences were found with respect to time or the introduction of contractions. Differences were apparent between the high- and low-achievement groups.

Bell, Ewell & Minov (2013) documented the need for, pilot testing, and validation of the National Reading Media Assessment (NRMA). The NRMA is an assessment of the visual reading efficiency of youth ages Pre-K through

12th grade who are visually impaired. The tool was designed to measure the extent to which large print materials are sufficient to complete academic tasks, whether Braille should be introduced, or whether the youth should be given primary instruction in Braille. Findings supported the efficacy of this tool in making the decision to recommend print, Braille, or dual media for pre reading youth and those in kindergarten through 12th grade.

Greaney, Tobin & Hill (1998) tested the reading of 317 UK Braille readers using a Braille version of the NARA (Neale Analysis of Reading Ability)-a popular reading test developed for sighted children that tests reading speed, accuracy, and comprehension. The data showed that the average reading ages for accuracy, comprehension and speed for the sample generally fall below their chronological age, and lag behind both fully sighted and low-vision readers. The size of the "lag" increases with age. In the case of Braille, however, the area of greatest lag was found in reading speed. The disadvantages of the reduced speed of information processing increased as children move through the education system.

5. Hand Movements while Reading Braille

Myers (1976) has shown that children acquainted with Braille can usually read better with their left than with their right hand. It is also known that, at least in right-handed people, the right cerebral hemisphere is dominant for counting dots. The study compares, in right-handed subjects unacquainted with Braille, the comparative skill of right and left middle (M) and index (I) fingers in counting Braille dots. In one experiment with 30 subjects no significant difference was found between LI and RI fingers. Another experiment failed to reveal any R/L differences although it detected a superiority of I over M fingers at P less than 0.025. When the task was split between the two I fingers working simultaneously they performed significantly (P less than 0.001) better than when working alone.

Wilkinson & Carr (1987) reviewed four reading-related, information-processing tasks administered to right-handed blind readers of braille who

differed in level of reading skill and in preference for using the right hand or the left hand when required to read text with just one hand. The tasks were letter identification, same-different matching of letters that differed in tactual similarity, short-term memory for lists of words that varied in tactual and phonological similarity, and paragraph reading with and without a concurrent memory load of digits. The results showed interactions between hand preference and the hand that was actually used to read the stimulus materials, such that left preferrers were significantly faster and more accurate with their left hands than with their right hands whereas right preferrers were slightly but usually not significantly faster with their right hands than with their left hands. In all cases, the absolute magnitude of the left-hand advantage among left preferrers was substantially larger than the right-hand advantage among right preferrers. The results suggested that encoding strategies for dealing with braille are reflected in hand preference and that such strategy operated to modify an underlying but somewhat plastic superiority of the right hemisphere for dealing with the perceptual requirements of tactual reading. These requirements were not the same as those of visual reading, leading to some differences in patterns of hemispheric specialization between readers of braille and readers of print.

Wright, Wormsley & Kamei-Hannan (2009) reviewed that using a subset of data from the Alphabetic Braille and Grade 2 Braille study, researchers analyzed the patterns and characteristics of hand movements as predictors of reading performance. Statistically significant differences were found between one- and two-handed readers and between patterns of hand movements and reading rates.

Scheithauer & Tiger (2014) viewed line tracking is a prerequisite skill for braille literacy that involved moving one's finger horizontally across a line of braille text and identifying when a line ends so the reader may reset his or her finger on the subsequent line. Current procedures for teaching line tracking are incomplete, because they focused on tracking lines with only small gaps between characters. The current study extended previous line-

tracking instruction using stimulus fading to teach tracking across larger gaps. After instruction, all participants showed improvement in line tracking, and 2 of 3 participants met mastery criteria for tracking across extended spaces.

6. Use of Grade 1 and Grade 2 Braille

Clunies-Ross (2005) summarised the debates in the United States over the use of grade 1Braille, noting its increasing use with particular groups, including beginners of all ages, children with learning difficulties, mainstream teachers, and parents. Study reported that grade 1 Braille is seen as an additional option rather than a replacement for grade 2 Braille, with learners making the transition from grade 1 to grade 2 at some stage in their learning.

Herzberg, Stough & Clark (2004) reported that during the past 50 years, teachers have used grade 2 braille as the preferred method of teaching reading to children and adults. Grade 2 braille involved the use of the traditional alphabet, along with 189 different characters and contractions that represent a group of letters or whole words. Ponchillia and Durant noted that braille research has focused on the proficiency of braille readers, but few studies have been conducted on the instructional methods used by braille teachers. This pilot study interviewed four certified teachers of students with visual impairments (that is, those who are blind or have low vision) to examine the assessment and instructional strategies that they used with their students. Interviews, the primary method used to collect data for this study, were conducted by the first author over a four-week period and ranged in duration from 30 minutes to 75 minutes. Findings included: (1) four common factors affected the assessment process; (2) teaching grade 1 braille requires different strategies and materials than does teaching grade 2 braille; and (3) for students to be successful in learning grade 1 braille, teachers thought that their students must understand how the knowledge of braille would be of benefit to them.

Emerson, Holbrook & D'Andrea (2009) investigated that the Alphabetic Braille and Grade 2 Braille Study found no difference between high

and low achievers in the development of literacy skills on such measures as age, etiology of visual impairment, family attitudes and behaviors regarding literacy activities, class size, and time spent with a teacher of students with visual impairments. Some differences between the groups were seen on measures of social interactions, the introduction of contractions, and time spent with paraeducators, but the most demonstrated difference was the provision of consistent structured reading instruction.

7. Spelling Skills of Braille Readers

Monson & Bowen (2008), in a review of research on the development of phonological awareness by Braille readers, found that relationship between phonological awareness and Braille is uncertain, because of the lack of commonality among the studies, the extent of contradictory findings, and the small number of studies involved Braille readers. Evidence regarding the written spelling skills of Braille readers is less clear-cut, although recent studies suggested there is no significant difference in spelling performance between Braille and print readers. For example, Clark and Stoner (2008) compared the spelling skills of students who are Braille readers with a normative sample. The Test of Written Spelling was administered to twenty-three students who were blind at various grade levels to ascertain their spelling ability. A one-sample *t*-test indicated no significant difference in spelling ability.

Clark-Bischke & Stoner (2009) examined the spelling skills in the written compositions of 20 students who read braille and offered further evidence that the skills of these students are similar to those of sighted students. The assessment of writing samples focused on the number of words spelled correctly and used an error analysis to describe patterns of spelling errors.

Hong & Erin (2004) compared 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. They found no

significant differences in performance over a range of skills, such as reading speed, reading accuracy, comprehension, and spelling ability, between initial instructions in the two types of Braille.

Emerson, Holbrook & D'Andrea (2009) 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. While the findings supported the view that contractions do not hinder the development of good spelling skills, the confounding difficulties of the sampling discussed above do not allow for conclusions to be drawn about the relative effects of learning through contracted and uncontracted braille on spelling performance. For example, 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.

8. Braille Writing Skill

Swarup & Bhan (2009) examined the difference in the rate of the acquisition of braille writing skills in students using a slate and stylus in comparison to a brailler. The study focused on 5 students in a Montessori School in Mumbia, India. The teachers in the study "concluded that the use of a brailler significantly improved the speed of Braille writing acquisition and felt that it would improve the efficiency of the learning process and the acquisition of braille literacy."

Southern, Clawson, Abowd & Romero (2012) presented the evaluation of BrailleTouch, an accessible keyboard for blind users on

touchscreen smartphones. Based on the standard Perkins Brailler, BrailleTouch implements a six-key chorded braille soft keyboard. Eleven blind participants typed for 165 twenty-minute sessions on three mobile devices: 1) Braille Touch on a smart phone; 2) a soft braille keyboard on a touchscreen tablet; and 3) a commercial braille keyboard with physical keys. Expert blind users averaged 23.2 words per minute (wpm) on the BrailleTouch smartphone. The fastest participant, a touchscreen novice, achieved 32.1 wpm during his first session. Overall, participants were able to transfer their existing braille typing skills to a touchscreen device within an hour of practice. The authors reported the speed for braille text entry on three mobile devices, an in depth error analysis, and the lessons learned for the design and evaluation of accessible and eyes-free soft keyboards.

9. Braille Reading Performance and Fluency

The decline in the number of braille readers since 1963 (American Printing House for the Blind, 1991) has been widely discussed by professionals and censured by consumer groups (Rex, 1989; Schroeder, 1989; Stephens, 1989). Although there is no consensus on the causes of this decline, a number of factors have been cited. Among them are the rise in the number of visually impaired children with additional disabilities who are nonreaders (Rex, 1989), disputes on the utility of the braille code (Thurlow, 1988), the decline in teachers' knowledge of braille and methods for teaching it (Schroeder, 1989; Stephens, 1989), negative attitudes toward Braille (Holbrook & Koenig, 1992; Rex, 1989), and the greater reliance on speech output and print magnification technology (Paul, 1993).

Savaiano & Hatton (2013) evaluated whether children with visual impairments who receive repeated reading instruction exhibit an increase in their oral reading rate and comprehension and a decrease in oral reading error rates. A single-subject, changing-criterion design replicated across three participants was used to demonstrate the association between a repeated reading intervention and the oral reading rate, comprehension, and error rate.

Results showed that in visual analysis of the data there was a functional relation between repeated reading and oral reading rate for two participants and a functional relation between repeated reading and comprehension for all participants. There was not a functional relation between repeated oral reading and error rate. Based on the results of this study, repeated reading appears to be an effective practice for some students with visual impairments.

Oshima (2014) focused on the associations of braille reading fluency and individual factors, such as the age at onset of blindness and number of years reading braille, and the tactile sensitivity of people with early and late blindness. The relationship between reading speed and these other factors was examined to identify factors that influence reading speed. Nine people with early blindness and 10 people with late blindness participated in this study, which included the measurement of accuracy of word recognition, braille reading speed, and tactile sensitivity. Results showed a significant partial correlation between reading speed and the age at onset of blindness, controlling for number of years reading braille ($r = -0.68$, $p < .005$), and no significant partial correlation between tactile sensitivity and reading speed after controlling for the age at onset of blindness ($r = -0.08$, ns). A direct relationship between reading speed and tactile sensitivity was not confirmed, and the age at onset of blindness appears not only to mediate the relationship between reading speed and tactile sensitivity but also may be a crucial factor influencing braille reading fluency.

Radojichikj (2015) compared reading performance between 8 students who are using Braille and 14 students who are using enlarged print to read. Reading performance was determined using reading rate (words per minute, wpm). Reading rate results showed no significant difference ($p>0.05$) between those using the Braille (16.62±11.61 wpm) and those using the enlarged print (27.21±24.89 wpm). Results showed that Braille reader students read at lower reading rate compared to print reader students with visual impairment.

Mohammed & Omar (2011) compared reading performance between visually impaired and normally sighted school children. Participants (n = 299) were divided into three groups: normal vision (NV, n = 193), visually impaired print reader (PR, n = 52), and Braille reader (BR, n = 54). Reading performance was determined by measuring reading rate and comprehension. ANOVA was used to compare the results. A statistically significant difference was found in reading rate between the three groups (p less than 0.0001). The BR had the lowest reading rate compared to other groups. Only a small percentage of the visually impaired children were able to achieve a reading rate within the normal values of normally sighted children. Results of the comprehension test showed no significant difference in the scores of the three groups (p = 0.232). The findings of this study suggested that visually impaired students required a longer time to read and understand a text and this has implications on the time given to them, especially during examinations.

Veispak, Boets & Ghesquière (2013) investigated the relation between reading, auditory, speech, phonological and tactile spatial processing in a Dutch speaking sample of blind braille readers as compared to sighted print readers. Performance is assessed in blind and sighted children and adults. Regarding phonological ability, braille readers performed equally well compared to print readers on phonological awareness, better on verbal short-term memory and significantly worse on lexical retrieval. The groups did not differ on speech perception or auditory processing. Braille readers, however, have more sensitive fingers than print readers. Investigation of the relations between these cognitive and perceptual skills and reading performance indicated that in the group of braille readers, auditory temporal processing has a longer lasting and stronger impact not only on phonological abilities, which have to satisfy the high processing demands of the strictly serial language input, but also directly on the reading ability itself. Print readers switch between grapho-phonological and lexical reading modes depending on the familiarity of the items. Furthermore, the auditory temporal processing and

speech perception, which were substantially interrelated with phonological processing, had no direct associations with print reading measures.

Argyropoulos & Papadimitriou (2015) in the present study assessed the performance of students who are visually impaired (that is, those who are blind or have low vision) in braille reading accuracy and examined potential correlations among the error categories on the basis of gender, age at loss of vision, and level of education. Twenty-one visually impaired Greek school-aged children participated in the present study. The students who participated were enrolled in different educational settings; that is, special schools and mainstream educational settings. The research tool was a subset (three subscales) of a standardized instrument (Test A, Padeliadu & Antoniou, 2008) that evaluates reading accuracy in Greek. All interactions between researchers and students were videotaped, and the analysis of the obtained data was focused on phonological and non phonological-type errors. Results showed significant differences in performance were found between male and female participants-$t(19) = 2.12$, $p < .05$-as well as between students who attained primary and secondary education: $t(19) = 1.96$, $p \cong .05$. The average number of errors in the three subscales correlated very highly, signifying that performance was very similar. Positive correlation was found between replacement and subtraction types of error ($p < .05$), and replacement and recognition ($p < .001$), and the total number of errors was positively correlated with replacement ($p < .001$), subtraction ($p = .001$), and recognition errors ($p < .001$). Male participants made more replacement errors: $t(19) = 2.09$, $p \cong .05$; participants in secondary education made significantly fewer errors of recognition: $t(19) = 2.49$, $p < .05$; and students who were congenitally blind made significantly more errors of addition: $t(19) = 1.96$, $p \cong .05$. Regarding the recognition type of error, there was a significant interaction effect between grade and age at loss of vision: $F(3/17) = 3.09$, $p = .05$. Participants did not benefit exceptionally from semantic information, and it is unclear whether a higher school level leads to the improvement of braille reading accuracy. “Reading the entire word” seemed to be the most effective decoding strategy.

2.2.2 Use of Slate & Stylus and Braille Writing

Kwaya, Sallehb & Majidc (2010) compared the effectiveness of Braille writing with slate and stylus the conventional method and the A-J+3+6 method. An experimental study was conducted on ten blind students and eight low vision students using mix-method design. Results showed i) method A-J+3+6 is more effective in Braille writing than the conventional method, ii) students who used the conventional method tend to do more mirror errors than students who used the A-J+3+6 method, iii) there is no statistically significant in Braille writing using conventional method when level of vision problem and age were controlled.

Allman (1998) compared which braille-related communication skills 233 teachers of students with visual impairments taught and which 531 adults with visual impairments actually used. Teachers taught use of braillewriters, computers, audiocassette recorders, and typewriters, but rarely taught use of slates and styli and sighted readers' services, which were often used by visually impaired adults. (DB)

Knowlton & Berger (1999) in a survey of 51 teachers licensed to teach children with visual disabilities in Minnesota found they had high abilities for using references when transcribing Braille, producing Braille with Braillewriters, interlining Braille, and using software for Braille transcription, low abilities for writing with slate and stylus and that few had Braille transcriber certification.

Kalra, Lauwers, Dewey, Stephelton & Dias (2007) reported less than 3% of the 145 million blind people living in developing countries are literate. This low literacy rate is partly due to the lack of trained teachers and the challenges associated with learning to write Braille on a traditional slate and stylus. These challenges included writing from right to left, writing mirrored images of letters, and receiving significantly delayed feedback. Extensive conversations with the Mathru School for the Blind near Bangalore, India, revealed the need for a robust, low-power, low-cost Braille writing tutor. The

authors presented an iterative and participatory design process resulting in the creation and refinement of a prototype Braille writing tutor system. This system used 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. The study reported on lessons learned from the implementation of this project and from a six-week pilot study at the Mathru school, and outlined future directions for improvement.

2.2.3 Application of Nemeth Code

1. Literary Braille Data and Nemeth Code

Wetzel & Knowlton (2006) collected reading rate data from both print and braille readers in the areas of mathematics and literary braille. Literary braille data was collected for grade 2 and grade 1 braille text with dropped whole-word contractions and part-word contractions as they would appear in the Unified English Braille Code. No significant differences were found between grade 2 and grade 1 braille reading rates or between print and Nemeth oral reading rates. Reading rates in cells per second for mathematics were slower than for literary material in both print and braille.

Ivy & Hooper (2015) reported many students with adventitious vision loss or progressive vision loss need transition from print to braille as a primary literacy medium. It was important that this transition is handled efficiently so that the student can have continued access to a literacy medium and made progress in the core curriculum. For this study, the authors used constant time delay to teach literary braille contractions and Nemeth Code for Mathematics and Science Notation (hereafter, Nemeth Code) braille symbols to learners with visual impairments who were making the transition from print to braille. A single-subject, multiple-probe research design were used to test the effectiveness and efficiency of constant time delay to teach literary braille or Nemeth Code. Three female students, aged 13 to 15 years, participated at a specialized school for students with visual impairments. The students' braille and math instructor delivered interventions in the

classroom. Procedural fidelity and interobserver agreement data were collected. Results showed that two students learned 40 short-form literary braille contractions, and one student learned 28 Nemeth Code symbols throughout the study. Students appeared to generalize learning after instruction with the first word set to identify similar contractions. Students maintained learning throughout the study at high levels. Visual analysis of the data suggested a functional relationship between constant time delay and contraction identification. This study replicated previous work (**Hooper, Ivy, & Hatton, 2014**) to expand understanding of the scope of the usefulness of time delay in braille education. For students making the transition from print to braille, constant time delay may be an efficient method to help students acquire braille. The efficiency itself may increase students' confidence and motivation to learn braille.

2. Training for Teachers in Nemeth Code

Rosenblum & Smith (2012) gathered data on methods and materials that were used to teach the Nemeth braille code, computer braille, foreign-language braille, and music braille in 26 university programs in the United States and Canada that prepare teachers of students with visual impairments. Information about instruction in the abacus and the preparation of tactile graphics was also gathered. A faculty representative from each university completed a 39-question online demographic survey during fall 2011. Frequency counts for each item were tabulated, and comments were reviewed and categorized. Results showed that all 26 university programs provided instruction in the Nemeth braille code. The authors also provided introductory information on foreign-language braille, computer braille, and music braille. There was a high rate of consistency across the programs in what constituted a braille error. The university programs required students to prepare tactile graphics and learn computation on the abacus. The delivery of courses through a hybrid model was most common. University programs were providing instruction in the Nemeth braille code, though there is variability in the topics that were covered, the books that were used, and the assignments

that were required. Most university programs were also exposing their pre service students to specialized braille codes and were teaching them to produce tactile graphics and to perform computations on the abacus.

Kapperman & Sticken (2002) discussed the lack of preparation teachers of students with visual impairments have in the Nemeth Code (the Braille code for mathematics). It then described a Windows-based tutorial for sighted persons to learn the Nemeth Code, a tutorial for teachers with blindness, and how to access the tutorials.

Rosenblum & Amato (2004) examined the preparation in and use of the Nemeth braille code by 135 teachers of students with visual impairments. Almost all the teachers had taken at least one course in the Nemeth code as part of their university preparation. In their current jobs, they prepared a variety of materials, primarily basic operations, word problems, tactile graphics, and fractions.

3. Competence of Teachers in Nemeth Code

DeMario & Lian (2000) in a survey asked 205 teachers of students with visual impairments to rate their perceived competency in transcribing math materials into the Nemeth code (the Braille code for math) and their need to do so. Results indicated a significant difference between mean rating on competency and need for 23 of the 55 listed math skills.

Smith & Rosenblum (2013) presented the initial validation of a comprehensive set of competencies focused solely on the Nemeth code. Using the Delphi method, 20 expert panelists were recruited to participate in the study on the basis of their past experience in teaching a university-level course in the Nemeth code. The Delphi method used multiple iterations or "rounds" to develop a consensus. The panelists were given the list of competencies developed by a focus group and were asked to rank their importance and the level of resources they would expect a beginning teacher of students with visual impairments to use. With each round, the panelists

were provided with the statistical results and comments on the previous round, so they could make an informed decision on their next rating. Results showed only three rounds were necessary for the panelists to reach a consensus. For writing, the panelists reached a consensus on 12 (41%) statements for importance and 17 (59%) for reference. For reading, they reached a consensus on 19 statements (66%) for importance and 23 (79%) for references. Comments from the panelists focused primarily on the fact that teachers of students with visual impairments need to use resources more often for writing to ensure the quality of their transcriptions, but that they should be able to read without resources.

2.2.4 Abacus Usage

1. Application of Abacus

Nester (1974) described is the use by blind persons of the Cranmer abacus, a computational device adapted from the Japanese abacus. Noted is the lack of carefully controlled research on its use. A comparison of calculation by abacus and by paper and pencil was said to indicate that the use of such mechanical devices does not give the blind competitor an undue advantage over sighted competitors.

Behr (1976) investigated variables which affect how well children learn from manipulative aids and how to use such aids in teaching mathematics. Five small groups from one second-grade classroom were stratified by achievement and taught using (1) counting sticks; (2) Dienes blocks; (3) abacus; (4) all three materials; or (5) counting sticks and unifix cubes, Dienes blocks and graph paper, and the abacus and colored chips. Two- and three-digit numeration and addition and subtraction with and without regrouping were presented in 22 lessons involving manipulative, picture, and symbolic phases. Lesson plans and reactions of pupils were included, in addition to data from evaluation interviews recorded on videotape and scored later. The abacus appeared to be less effective for teaching two-digit numeration than were blocks or sticks, but the three single embodiments

appeared equally effective for teaching the other topics. Multiple embodiments were "superior" for developing two-digit numeration, but "not superior" for the other topics. Use of materials was more effective than non-use of materials (by a control group).

2. Abacus Instruction by Teachers

Steinbrenner & Becker (1982) examined that by the applicability to blind and visually impaired students, the study surveyed 25 teacher training institutions about the kinds of abacus programs available to trainees and the effectiveness of these programs. On the basis of respondents' statements, the authors concluded that majority of programs were both incomplete and ineffective.

Amato, Hong & Rosenblum (2013) in the study to 196 teachers of students with visual impairments, reported on the experiences with and opinions related to their decisions about instructing their students who are blind or have low vision in the abacus. The participants completed an online survey on how they decided which students should be taught abacus computation skills and which skills they teach. Data were also gathered on those who reported that they did not teach computation with the abacus. Results showed that the participants resided in the United States and Canada had various numbers of years of teaching experience. More than two-thirds reported that abacus computation skills instruction began when their students were between preschool and the secondary grade. When students were provided with instruction in abacus computation, the most frequently taught skills were the operations of addition and subtraction. More than two-thirds of the participants reported that students were allowed to use an abacus on high-stakes tests in their state or province. Teachers of students with visual impairments are teaching students to compute using the Cranmer abacus. A small number of participants reported they did not teach computation with an abacus to their students because of their own lack of knowledge.

3. Comparison of Finger Math and Abacus

Maddux, Cates & Sowell (1983) reported that the use of finger math, a form of arithmetic computation with the fingers, were compared to use of the abacus in helping visually impaired and blind students develop mathematic concepts. Finger math is explained to be more concrete, simple, and accessible.

Maddux, Cates & Sowell (1984) reported three severely impaired elementary-level students who were proficient in use of the abacus for addition and subtraction (through three-digit numbers) displayed no confusion in the transition from abacus to fingermath, quickly learned fingermath, and improved in use of the abacus.

2.2.5 Study & Reference Skills

Tuttle (1974) studied three reading media for the blind: Braille, normal recording, and compressed speech. The subjects were 100 students between the ages of 14 and 21 attending school in California. All subjects were Braille readers. The Reading Versatility Test was given to the subjects in all three forms: Braille, normal recording, and compressed speech. No difference in comprehension was found between Braille, normal recording and compressed speech. Braille took almost twice as long as listening to normal recording and three times as long as listening to compressed speech. Tuttle (1974) concluded compressed speech was more efficient than either Braille or normal recording.

Hughes (1979) compared Braille and compressed speech as learning modes for legally blind adults. The primary purpose of the study was to determine whether significant differences occurred in the amount of knowledge achieved as a result of using Braille or compressed speech. Thirty legally blind adults from Oregon comprised the study population. All subjects were Braille readers. Hughes (1979) found no significant differences in achievement scores when using Braille or compressed speech as learning modes.

Lindecker (1981) compared Braille and optacon reading comprehension in seven blind public school students. The author concluded that Braille and optacon reading comprehension were equal when subjects were given equal instruction. The study further recommended that curricula for blind students should include new media such as the Optacon on an equal basis with Braille.

D'Andrea (2012) viewed students who read braille use assistive technology to engage in literacy tasks and to access the general curriculum. There are only few research on the ways in which technology has changed the reading and writing practices and preferences of students who use braille, nor is there much research on how assistive technology is learned by students with visual impairments. This article described the first phase of a mixed-methods study that was conducted to investigate the current use of paper braille and assistive technology among students aged 16-22, and the students' attitudes toward braille and technology as tools for classroom learning in high school and college. The first phase of the study consisted of 12 structured interviews of students from across the United States, which were transcribed, analyzed qualitatively, and coded for themes. Results showed that the practices used by students fell into three broad themes, (1) the wide variety of devices used for reading and writing, (2) the types of tasks they performed using specific devices, and (3) the ways students learned practices for using braille and technology. Their attitudes fell into three themes as well: (1) preferences about braille and of technology tools, (2) how students chose to use those tools for specific tasks, and (3) the role teachers played in learning to use technology. Results of the study indicated the changing nature of how students use various tools and how they selected approaches to complete their class work, and the importance for students of being able to make choices regarding tools and strategies.

2.2.6 Use of Tactual or Printed Charts, Graphs & Maps

1. Tactile and Haptic Skill Perception of Visually Impaired

Withagen, Vervloed, Janssen, Knorrs & Verhoeven (2010) viewed in a study of 48 children with congenital blindness who attended mainstream schools focused on the tactile and haptic skills they needed in typical academic and everyday tasks. The results showed that, in general, the children mastered such tactile tasks, but some items posed special problems.

Picard, Albaret & Mazella (2014) researched on haptic picture perception with adult participants, and little is known about haptic picture perception in visually impaired and sighted children. In the present study, the authors compared 13 visually impaired children (early blind and low vision) aged 9-10 years and 13 agematched blindfolded sighted children on their ability to identify raised-line pictures of common objects when information about object category was provided prior to picture presentation (semantic cueing). The visually impaired children had moderate practice with tactile pictures, whereas the sighted controls had no prior practice with tactile pictures. The authors sought to determine whether the benefits of semantic cueing would add to those of practice, resulting in higher performance in the visually impaired children compared to the sighted controls, or whether semantic cueing would compensate for the lack of practice with tactile pictures in the sighted children, leading to a possible disappearance of the advantage of the visually impaired children over the sighted controls. The results showed that the visually impaired children outperformed the sighted controls on both identification accuracy and response time to correct naming. The study concluded that the visually impaired children outperformed the sighted controls because they benefited from both semantic cueing and superior exploration skills. By contrast, in the sighted children, semantic cueing was not sufficient to compensate for their encoding difficulties.

Theurel, Witt, Claudet, Hatwell & Gentaz (2013) investigated factors that influenced haptic recognition of tactile pictures by early blind children.

Such a research is motivated by the difficulty to identify tactile pictures, that is, two-dimensional representations of objects, while it is the most common way to depict the surrounding world to blind people. Thus, it is of great interest to better understand whether an appropriate representative technique can make objects' identification more effective and to what extent a technique is uniformly suitable for all blind individuals. The objective was to examine the effects of three techniques used to illustrate pictures (raised lines, thermoforming, and textures), and to find out if their effect depended on participants' level of use of tactile pictures. Twenty-three early blind children (half with a regular or moderate level of use of tactile pictures, and half with either no use or infrequent use) were asked to identify 24 pictures of eight objects designed as the pictures currently used in the tactile books and illustrated using these three techniques. Results showed better recognition of textured pictures than of thermoformed and raised line pictures. Participants with regular or moderate use performed better than participants with no or infrequent use. Finally, the effect of illustration technique on picture recognition did not depend on prior use of tactile pictures. To conclude, early and frequent use of tactile material develops haptic proficiency and textures have a facilitating effect on picture recognition whatever the user level.

2. Use of Visual Diagrams

Rastogi & Pawluk (2013) viewed the increasing use of visual diagrams in educational and work environments, and even our daily lives, has created obstacles for individuals who are blind or visually impaired to "independently" access the information they represent. Although physical tactile pictures can be created to convey the visual information, it is typically a slow, cumbersome, and costly process. Refreshable haptic displays, which interact with computers, promise to make this access quicker, easier, and cheaper. One important aspect in converting visual to tactile diagrams is to simplify the diagram as otherwise it can be too difficult to interpret with touch. Enabling this to be under user control in an interactive environment, such as with refreshable displays, could allow users to avoid being overwhelmed by

the diagrams at any instant in time while still retaining access to all information in "storage". Through this article the authors investigated whether two types of diagram simplification--boundary simplification and contextual simplification--showed potential utility in an interactive environment. Boundary simplification was found to be significantly helpful in answering general questions about borders on a geographic map, and contextual simplification was helpful in answering relational questions, as compared to using the original map unchanged.

3. Resizing Images of Objects

Szubielska & Marek (2015) investigated the question of whether or not subjects who are congenitally blind experience greater difficulties mentally in resizing images of objects than those who have low vision or are adventitiously blind. Two experiments were conducted: one in which subjects were asked to mentally enlarge objects they previously explored manually, and one in which subjects were tested for the ability to demonstrate the change in the size of an object imagined to be moving away. Three groups of high school students with visual impairments took part in the experiment: congenitally blind, “late blind,” and those with low vision. Results showed the linear size of an object enlarged in their imagination; congenitally blind participants overestimated its size more frequently than those who were late blind. The degree of mental reduction of the size of an object imagined to be moving away was comparable for all groups. The results suggested that the difficulties experienced by congenitally blind participants with the mental resizing of objects may be related to problems with performing mental scaling transformations. In the low vision group, the etiology of the subjects' visual impairment was not taken into consideration. The group turned out to be heterogeneous with respect to imagery processes.

4. Importance of Tactile Map

Simonnet, Vieilledent, Jacobson & Tisseau (2011) examined a map exploration and representation exercise was conducted with participants who

were totally blind. Representations of maritime environments were presented either with a tactile map or with a digital haptic virtual map. The authors assessed the knowledge of spatial configurations using a triangulation technique. The results revealed that both types of map learning were equivalent.

Gual, Puyuelo & Lloveras (2014) determined whether the process of memorizing a tactile map key, or legend, can be improved by including three-dimensional (3D) symbols produced by means of 3D Printing. The method used in this study involved asking a group of 20 volunteers with different profiles to memorize eight tactile symbols from two keys, each of which had different characteristics: Key 2 included 3D tactile symbols and Key 1 had only two-dimensional (2D) tactile symbols. Results showed statistically significant differences between the two keys. Use of Key 2 yielded a 48.72% reduction in the number of errors compared to Key 1 (N = 20, p-value = .014). These data showed that combining 3D with flat relief symbols (2D) improved the process of memorizing a tactile key because the 3D attributes can be distinguished from the 2D features by touch.

Jehoel, Ungar, McCallum & Rowell (2005) evaluated the relative suitability of a range of base materials for producing tactile maps and diagrams via a new ink-jet process. The visually impaired and sighted participants tactilely scanned arrays of symbols that were printed on seven substrate materials, including paper, plastic, and aluminium. In general, the rougher substrates were scanned faster than the smoother substrates, and the majority of participants preferred the rougher substrates over the smoother ones.

5. Use of Tactile Graphics

Azevedo & Santos (2014) focused on the difficulties that visually impaired students have when dealing with graphics and diagrams in their study of geometrical optics. This case study suggested practices that use low cost materials, easy to find and to handle, and that provided a tactile

perception for visually impaired students. The activities employed light and easy to carry magnetic boards and different types of magnets, mainly shaped rubber magnet strips. A student-centered learning method, namely Karplus's learning circles, was adopted. The positive results obtained in this work suggest that the students were able to realize and to understand in detail the figures and graphics presented to them.

Ryles & Bell (2009) viewed Seventy-three children with visual impairments aged 2-10 and their parents participated in a project that examined the children's interest in and exploration of tactile graphics. The parents reported that the children's interest in and conceptual understanding of the project's tactile workbook were high and that the children explored the workbook's raised-line drawings using both hands without a consistent preference.

Smith & Smothers (2012) presented here was to determine how well tactile graphics (specifically data analysis graphs) in secondary mathematics and science braille textbooks correlated with the print graphics. A content analysis was conducted on 598 separate data analysis graphics from 10 mathematics and science textbooks. The authors cross-validated the findings through a comparative analysis of the tactile graphics of five shared textbooks. Results showed that discrepancies were found between the print graphic and the tactile graphic in 12.5% of the sample. The most common discrepancy was differences in how data lines and data points were individualized in the print graphic compared to the tactile graphic. On the basis of the reviews of the graphics, the researchers answered a 5-point Likert-scale question (from 1 = strongly disagree to 5 = strongly agree) asking if the “tactile graphic is a valid representation of the print graphic.” The overall score for the sample was 3.71 (SD = 1.60), with a Krippendorff alpha of 0.6328 (the measure of disagreement and alpha > 0.70 are considered moderate). The findings demonstrated that while the majority of tactile graphics have good correlations to their print counterparts, there is still room for improvement. Some transcribers omitted a tactile graphic without providing

a reason. Forty graphics (6.7%) were omitted from the braille transcription. Two textbooks were missing more than 85% of the tactile graphics of the data graphs.

Rosenblum & Herzberg (2015) collected data from youths with visual impairment about their experiences with tactile graphics and braille materials used in mathematics and science classes. Youths answered questions and explored four tactile graphics made using different production methods. They located specific information on each graphic and shared their thoughts about the quality of the graphics. Results showed twelve youths in 6th to 12th grades participated. Almost all participants reported typically receiving braille materials and using tactile graphics in their mathematics and science classes. Participants varied in their accuracy in locating specific information in four tactile graphics. They all reported that what made a tactile graphic “good” was clarity of information. The majority of the youths reported that occasionally they do not have access to mathematics and science materials at the same time as their peers. Some seemed concerned by the lack of materials, and others did not. The lack of materials may be problematic, since some of the students reported completing the assignments later or not at all. Youths overwhelmingly reported a need to have tactually distinctive elements in graphics.

2.3 Career Education

2.3.1 Resources Available for Blind and Low Vision

Crudden & Sansing (2011) in a study on state wide assessment of stakeholders' needs was conducted for a state agency providing habilitation, rehabilitation, and independent living services to persons of all ages who are visually impaired (that is, those who are blind or have low vision). This needs assessment was designed to acquire an accurate and thorough picture of the agency's strengths and weaknesses. Five focus groups were conducted as part of this assessment to identify stakeholders' views of the service delivery needs of persons who are visually impaired. The analyses of the data from

the focus groups were clustered into four distinct themes or concerns regarding the variability in services, outreach, transportation, and service delivery.

Afful-Broni & Ankutse (2014) focused on the main factors that are militating against the effective and efficient support services delivery to children with special education needs in the Volta Region of Ghana. The study investigated the various types of support services being rendered, the quality of the human resource and the adequacy of material resources. A total of 60 respondents were involved in the study. The main instrument used was a set of questionnaires designed and validated by the researchers. Data collated and analyzed showed that only three out of the ten services were being delivered and though the Ghana Education Service had experienced and competent personnel, it was plagued with the non-availability of material resources.

Crudden (2012) examined rehabilitation providers' beliefs about services and service delivery strategies that are successful in facilitating the transition from school to competitive employment for youths who are blind or have low vision. Five focus groups were conducted, two with rehabilitation state agency personnel and three with members of professional organizations at their annual conferences. A protocol with four queries about transition services generated data for a content analysis by a team of three researchers. Results showed that the participants identified transition services before age 16, communication among service providers and families, assessment, and the development of specific skills as important factors in facilitating the transition to competitive employment. Parental involvement was also identified as a positive factor in the transition and career planning. Transition services were not routinely provided before age 16, thus hindering the development of skills and careers. Improved communication among service providers and parents promoted advocacy and the successful transition to work. The qualitative research strategies used in the study did not generate results that were generalized to other populations or settings or that were used to

evaluate outcomes. The results were assessed for transferability and to understand the transition process.

2.3.2 Career Decision

Hoyt (1985) in the implications of career education for blind and visually impaired students focussed on providing general employability skills and fusing the career development process and the teaching/learning process into the curriculum.

Wong (2004) investigated two groups of visually impaired (VI) students in Britain confronting post-school transition. One group aspired to enter university, the other group has decided on vocational training. Positive image, employment pragmatics and the notion of "something extra" are contributing factors shaping VI students in their post-school choices. Underlying these influences was a determination to ensure employability is achieved at the completion of their chosen post-school path.

Pavey, Douglas & Corcoran (2008) collected data from a large scale project called "Network 1000". Network 1000 seeks to survey the changing needs and opinions of visually impaired adults. Data have been collected from 1007 visually impaired people across Great Britain. This analysis focussed upon a sub-sample of approximately 250 adults aged between 18 and 42 years. In all cases, the onset of these participants' visual impairment was during childhood (i.e. under 17 years of age). The analysis presented data in relation to their education and employment, and reflected upon the factors that seem to be associated with both. It appeared that earlier onset of visual impairment is associated with higher levels of educational achievement. There was no clear link between the current level of visual impairment (at the time of interview) and educational achievement. In terms of employment, those with higher levels of educational qualification were more likely to be employed. Those with lower levels of qualifications were more likely to describe themselves as "long term sick and disabled" or "unemployed". Employment rates amongst younger visually impaired people appeared higher

for those who had childhood visual impairment than those who did not. This suggested a positive impact of education. Also, employment rates were generally much better amongst younger visually impaired people than those over 50 years old. Nevertheless, the reported employment rate of 40 per cent is still very low. Some time was also spent considering visually impaired adults with severe learning and communication difficulties and their lives following compulsory education, including possible explanations for their likely under-representation in the project sample.

Reed & Curtis (2012) presented a study of the higher education experiences of students with visual impairments in Canada. Students with visual impairments and the staff members of disability programs were surveyed and interviewed regarding the students' experiences in entering higher education and completing their higher education requirements. Results showed that although the reported graduation rates were high, the students took more than four years to complete their studies. They thought that heavy reading requirements, work in groups, and an inability to participate in some activities were barriers to their full participation in higher education. The findings demonstrated that barriers have a negative impact on the higher education experience of students with visual impairments.

Steinman, Kan, Boeltzig-Bron, Haines, Halliday & Foley (2013) hypothesized that consumers who are blind or visually impaired (that is, those who have low vision) who were served by state vocational rehabilitation agencies with decision-making control over administrative functions would experience better vocational rehabilitation outcomes than consumers served by vocational rehabilitation agencies with less control in these areas. The authors merged person-level RSA-911 data with agency-level data collected as part of the National Survey of State Vocational Rehabilitation Agencies, which were conducted in 2011. The authors employed multilevel modeling, controlling for select person-level characteristics, and agency-level indicators of primary decision making control by vocational rehabilitation agencies in six key administrative functions: human resources, infrastructure,

management information systems, policies and procedures, program evaluation, and purchasing. Dependent variables were measures of "any employment" and "competitive employment" outcomes. The authors reported a positive association between agency decision-making control over policies and procedures and competitive employment outcomes by consumers who were blind (odds ratio = 2.64; 95% confidence interval 1.23 minus 5.72). Among consumers who are visually impaired, agency decision-making control over human resources was negatively associated with any employment closures (odds ratio = 0.56; 95% confidence interval = 0.36 minus 0.93) and competitive employment outcomes (odds ratio = 0.56; 95% confidence interval = 0.33 minus 0.97). Results demonstrated the potential for factors related to agencies, in addition to factors related to individuals, to function as mediators of vocational rehabilitation outcomes for consumers who are blind or visually impaired.

Connors, Curtis, Emerson & Dormitorio (2014) examined transition-age youths with visual impairments have higher rates of unemployment than their peers without impairment, and factors associated with success after graduation; however, it is unknown whether these factors remain influential across the first decade after exiting high school. Five waves of the 10-year National Longitudinal Transition Study-2 data were used for this analysis. The following factors-number of years since leaving high school, specific year exiting high school, paid work experience during high school, and high school completion-were examined for their longitudinal relationship with successful outcomes using generalized estimating equations. Results showed that specific year exiting high school, paid work experience during high school, and high school completion were shown to be predictive of successful outcomes (as measured by post-high school employment or enrolment in post-secondary school or both). Youths with visual impairments who left high school in 2000-2002 were 2.2 times more likely to be successful when compared to those who left in 2006-2008 ($p < 0.05$). Youths who worked for pay during high school were 3.6 times more likely to be successful compared

to those who did not work for pay ($p < 0.01$), while those who completed high school were 3.3 times more likely to be successful when compared to those who aged out or dropped out of high school ($p < 0.001$). The amount of time spent away from high school was not significantly associated with post-high school success. Completion of high school and paid work experience during high school are critical to long-term success for up to eight years post-high school. Taking into account specific years can be important in longitudinal studies. In this research, the recession appeared to have significantly lowered success across all post-high school groups.

Bell & Mino (2013) focused that individuals who are legally blind or visually impaired in the United States have long suffered high rates of unemployment. The purpose of this study was to determine the current employment status of these individuals and to analyze its consistency with federal reports. The study also examined demographic factors, education, civic involvement, and rehabilitation experiences of this population in order to determine whether some of the factors could be identified as contributing to the employment outcomes. Results showed that the employment rate for individuals who are legally blind/visually impaired is 37%, which is consistent with previous research. Findings show that a gender gap still exists, with a significant difference in annual earnings between men and women. Education and rehabilitation-related factors seemed to impact employment outcomes; where higher educational attainment is associated with better employment outcomes. In addition, those individuals who were trained under the Structured Discovery approach were more likely to be employed and to have higher earnings than those who did not. Finally, for individuals who read braille on a weekly basis and used a white cane, the likelihood of being employed and receiving higher earnings was higher than those who did not use these tools.

McDonnall, O'Mally & Crudden (2014) investigated employers' knowledge about how persons who are blind or visually impaired performed typical job tasks (that is, use accommodations), how this knowledge relates to

employers' attitudes about these individuals as employees, and where employers seek help with job accommodations. Businesses from four states were contacted by telephone to request participation; surveys were completed by 160 randomly selected businesses and 37 businesses referred by vocational rehabilitation agencies, yielding a total sample of 197. A 5-item instrument measured employers' knowledge about how blind or visually impaired persons complete typical job tasks, and an 11-item instrument measured employers' attitudes toward blind or visually impaired persons as employees. Results showed that a majority of employers (67%) could not identify how blind or visually impaired persons performed any of the typical job tasks. Employers referred by vocational rehabilitation agencies were more likely to identify correct strategies than employers in the randomly identified sample. Knowledge levels were associated with attitudes toward blind or visually impaired persons as employees. Only 8.8% of the randomly identified sample cited an appropriate source of information about accommodations; 49.7% cited a secondary source and 41.5% were not able to identify an appropriate source. Most employers have limited or no knowledge about how blind or visually impaired persons perform routine job tasks. Those employers with greater levels of knowledge also had more positive attitudes toward blind or visually impaired persons as employees. It was encouraging that many employers were aware of an appropriate or secondary source of information about accommodations, and would therefore be likely to find such information if needed.

Hewett, Douglas & Keil (2014) viewed that there is little research into what happens to blind and partially sighted young people as they make the transition from compulsory education into further and higher education, and employment. This article described a longitudinal study which was tracking the progress of 78 young people with visual impairments in England and Wales as they make this transition. Early findings were presented in relation to the experience of 47 of these participants who had recently completed their General Certificate of Secondary Education (GCSE) (age 16 years) and made

the transition to life beyond compulsory education. All of them remained in some form of education. The majority reported having enjoyed their studies, achieved well in their GCSE examinations, and had experienced positive transitions. There are some areas of concern: many did not appear to have engaged with the more formal pre-transitional preparation processes of 'transition review'; there was evidence of the young people being restricted in participating in part-time work; and some were reserved about applying to university in the future due to tuition fees.

2.4 Independent Living Skills

1. Skill Performance of Visually Impaired Children

Sacks, Wolffe & Tierney (1998) examined how adolescents and young adults (15- to 21-year-olds) with visual impairments spent their time engaged in academic, social, daily living, and vocational pursuits in comparison to youth without visual impairments. The authors conducted two studies: (a) a quantitative analysis between matched pairs of visually impaired and sighted adolescents, and (b) a qualitative analysis involving students with visual impairments only. Both studies identified socialization and career development as areas where students with visual impairments may need additional supports to achieve life success.

Lewis (2002) reported that the parents of children with visual impairments and the parents of their same-age sighted peers were interviewed to determine their children's mastery of 101 daily living skills. As a whole, the children with visual impairments performed only 44% of the tasks independently, while the sighted children performed 84% of them independently.

Khadka, Ryan, Margrain, Woodhouse & Davies (2012) identified the educational, social and leisure activities and issued that matter to school children and young people with a visual impairment and to compare their lifestyle with fully sighted counterparts. Thirteen focus groups were conducted and the groups were stratified by age, gender, visual status and school

location (urban and non-urban). The sessions were audio taped, transcribed verbatim, coded using NVivo software and a qualitative data analysis was carried out to identify the main themes. Eighty-one children and young people aged between 5-18 years participated in the focus groups; 34 were visually impaired (22 boys) and 47 were fully sighted (24 boys). In total, 121 different daily living activities important to children and young people were discussed in the focus groups. Results suggested that children and young people with a visual impairment have similar lifestyles to their fully sighted counterparts but are more restricted in some specific activities. The children and young people also reported that sometimes these restrictions were imposed by those supporting them rather than their own abilities. This information provided an in-depth understanding of the impact of visual impairment in school-aged children and young people.

2. Independent Living Training

Mashele & Smit (2011) reported that the World Health Organisation (WHO) recognised visual impairments in children as deserving priority treatment and intervention. All possible attempts should therefore be made to research every area that may influence the development and independence of children with visual impairments to aid in the management of this problem. Previous research indicated that caregivers play an important role in the independent development of children with visual impairments. This study compared the self-care, mobility and social function skills of learners with visual impairments who resided in a school residence designed for learners with visual impairments to those who lived at home. A descriptive study was conducted, comprising both quantitative and qualitative methods of data collection. A saturation sample including caregivers of learners in the school residence and caregivers of learners living at home was used for data collection. Data collection was done using the Paediatric Evaluation of Disability Inventory (PEDI) and semi-structured interviews. Results showed that the PEDI indicated no statistically significant difference on all the measured scales in the living environments of the two groups of learners.

Seven caregivers reported the importance of familiarising and orientating learners with visual impairments to the layout of an environment, objects and people within their living environment to enhance independence. Caregivers indicated that they used different methods of adaptations to the PEDI to enhance independence in learners. The study indicated the influence of the living environment on the development of independence.

Eriamiatoe (2011) examined the components of independent living training and services to determine their effectiveness in preparing foster youth in Tennessee for adulthood, and whether the youth's perceived effectiveness of these services affected their educational motivation. Support factors (i.e., family, financial, social and emotional), which may have contributed to the emancipated youths' educational motivation, were also explored. Nine post-custody youth from different regions across Tennessee, who were enrolled in 2-year or 4-year higher education institutions at the time of the study, were interviewed. Among the major findings of the study is that although foster youth receive independent living training prior to turning 18, a majority of their independent living skills develop over time in day-to-day experiences with foster parents and group home staff. Another finding was that independent living training and services were not factors in the youths' educational motivation. The study revealed that foster youth do have opportunities to learn independent living skills in classroom-type settings, but it does not seem to be sufficient. The researcher's attempted to gather the youth's perspectives on their effectiveness in preparing them for adulthood, was not substantiated. The study showed that a significant factor in their overall success as post custody youth is the foster care experience in general. The youth reported that experiences in regard to daily living, work and study habits, money management, and employment readiness effectively prepared them for adulthood. The youth's experiences while in foster care not only impacted their decisions to continue on with higher education, but also influenced what career paths they were going to take. The study revealed that family and social support, while in foster care, influenced the youth's

education decisions; financial support that the youth expected to receive also had an impact.

3. Identification of Coin

Hanney & Tiger (2012) taught 2 children with visual impairments to select a coin from an array using tactile cues after hearing its name and then to select a coin after hearing its value. Following the acquisition of these listener (receptive language) skills, authors observed the emergence of speaker (expressive language) skills without direct instruction.

2.5 Knowledge of Orientation & Mobility

1. Visual Search Training

Kuyk, Liu, Elliott & Fuhr (2010) assessed the effect of visual search training on the avoidance of obstacles by adults with visual impairments. A significant reduction in contacts with obstacles under mesopic conditions was found in individuals who received search training. This finding suggested that search training had a positive effect on mobility performance.

2. Use of Cane Technique

Kim, Emerson & Curtis (2010) examined the interaction effects of the amount of practice and the cane technique used in drop-off detection with a sample of 32 adults who were blind. The advantage of the constant contact technique over the two-point touch technique was significantly greater for the less experienced cane users than for the more experienced ones.

Kim & Emerson (2012) reported that although individuals who are blind have used a stick or a cane for their independent travel since the early years of human history, designs for modern long canes did not appear until World War II, when the systematic long cane techniques were developed by Hoover (1962). Ergonomic factors, such as the length of the cane, may affect how well a cane user can detect the presence of obstacles and changes in surface elevation, including drop-offs. How the length of a cane may affect the

detection of drop-offs is of particular interest because there appear to be different opinions on this matter among cane users. According to the traditional method (called the "sternum method"), a proper cane length is defined as the vertical distance from the ground to 2 inches above the xiphoid process (La Grow & Weessies, 1994). In a study conducted with 10 adult cane users who were visually impaired (that is, those who were blind or had low vision), Rodgers and Wall Emerson (2005) reported that the use of a standard-length cane, measured by the sternum method, allowed the users to detect drop-offs significantly better than with the canes that were either 5%-15% shorter or 10%-20% longer than the standard length. However, some cane travelers have advocated for a cane that is substantially longer than the standard length. In this study, the authors investigated whether the length of the cane affects the detection of drop-offs. They also examined whether there is an interaction between the length of a cane and the depth of a drop-off.

3. Orientation and Mobility Training Device

Lahav, Schloerb & Srinivasan (2012) presented a virtual reality system (the BlindAid) developed for orientation and mobility training of people who are newly blind. The BlindAid allowed users to interact with different virtual structures and objects via auditory and haptic feedback. This case study aimed to examine if and how the BlindAid, in conjunction with a traditional rehabilitation programme, can help people who are newly blind develop new orientation and mobility methods. Follow-up research based on this study, with a large experiment and control group, could contribute to the area of orientation and mobility rehabilitation training for the newly blind. The case study research focused on a woman who is newly blind, for 17 virtual sessions spanning ten weeks, during the 12 weeks of her traditional orientation and mobility rehabilitation programme. The research was implemented by using virtual environment (VE) exploration and orientation tasks in VE and physical spaces. The research methodology used both qualitative and quantitative methods, including interviews, questionnaire,

videotape recording, and user computer logs. The results of this study helped elucidate several issues concerning the contribution of the BlindAid system to the exploration strategies and learning processes experienced by the participant in their encounters with familiar and unfamiliar physical surroundings.

Patel & Vij (2012) investigated the inability to navigate independently and interact with the wider world was one of the most significant handicaps that can be caused by blindness, second only to the inability to communicate through reading and writing. Many difficulties were encountered when visually impaired people (VIP) need to visit new and unknown places. Current speech or haptics technology does not provide a good solution. Our approach is to use treadmill-style locomotion interface, unconstrained walking plane (UWP), to allow a richer and more immersive form of virtual environment (VE) exploration to enable VIP to create cognitive maps efficiently and thereby to enhance their mobility. An experimental study was reported that tests design of UWP for both straight walking and turning motions. Two groups of participants, blind-folded-sighted and blind, learned spatial layout in VE using two exploration modes: guided (training phase) and unguided (testing phase). Spatial layout knowledge was assessed by asking participants to perform object-localization task and target-object task. The results showed a significant decrease in time and helps taken to complete tasks, subjective workload, and errors in a post-training trial as compared to a partial-training trial. UWP has been found to significantly improve interaction with VE with visualizations such as spatial information.

Lahav, Schloerb & Srinivasan (2015) developed the BlindAid, a virtual system for orientation and mobility (O&M) training of people who are blind or have low vision, allows interaction with different virtual components (structures and objects) via auditory and haptic feedback. This research examined if and how the BlindAid that was integrated within an O&M training program could be of help when teaching those who are blind or visually impaired to develop O&M skills. Using qualitative and quantitative methods,

this research focused on 16 participants during their O&M course, and studied virtual environment exploration and orientation tasks in virtual environments. Results showed that the encouraging results of the current study indicated the potential strengths of the BlindAid system as an O&M training device for visually impaired people. Follow-up research evaluating transference of knowledge from virtual environments to real spaces could contribute to O&M training for people who are visually impaired.

4. Transportation Barriers

Douglas, Pavey, Corcoran & Clements (2012) broadly reviewed large-scale social surveys of visually impaired people often explore participants' mobility and travel behaviour. The methodologically more challenging is gathering participant-centred data in relation to their own interpretation of the barriers they face. Findings from a national survey of visually impaired people were presented in this article (N = 960, probability sample drawn from the British registers of blind and partially sighted people). The research made use of the World Health Organisation "International Classification of Functioning, Disability, and Health" (ICF) to develop an interview schedule in relation to visually impaired people's participation in mobility and travel. Results found that participants identified a range of barriers and enablers to greater mobility which included individually-based explanations (e.g. difficulties with their eye sight) and socially-based explanations (e.g. inadequate public transport systems). Logistic regression analysis revealed that participants who particularly focused upon individually-based barriers had more severe visual impairment, worried most about their vision, and had most recently lost their sight.

Crudden, McDonnall & Hierholzer (2015) viewed individuals who are blind or have low vision (hereafter, visually impaired) encounter transportation barriers that impede their full participation in life activities, including transportation. This was the first national survey to focus specifically on the transportation issues of persons with visual disabilities. A transportation

survey was developed and disseminated electronically to people who are visually impaired. The first administration, in the fall and winter of 2013, went to persons in a volunteer registry. For the second administration, in early 2014, participants were recruited through electronic postings and e-mails with assistance from consumer groups and professional organizations. The combined useable sample of 492 included individuals with legal blindness (n = 265), total blindness (n = 188), and low vision (n = 39). Results showed that the participants were likely to have received orientation and mobility (O&M) training, and were confident in their O&M skills. They were also likely to have access to public transportation, to use public transportation to get to work, and to be generally satisfied with how they got to work. Transportation issues were less likely to impact participation in employment than several other life activities. Although most participants had received services from vocational rehabilitation agencies, few said those agencies assisted them in finding transportation to work. Although transportation issues affect the lives of persons with visual disabilities, the extent of their impact on employment remains unclear. Survey respondents appear to be using their O&M skills, to be fairly comfortable traveling, and to be generally satisfied with how they travel to work, thus confirming the importance of receiving quality O&M instruction.

5. Employment Outcomes based on Orientation and Mobility Skills

Cmar (2015) said youths with visual impairments attended post secondary school at high rates, yet these individuals have low rates of employment. In this study, factors associated with post-school employment were investigated in a nationally representative sample of youths with visual impairments. In a secondary analysis of data from the National Longitudinal Transition Study-2, multivariate logistic regression analyses were conducted to investigate employment outcomes for youths with visual impairments based on orientation and mobility skills and outcome expectations. Results showed that youths with high community travel scores were significantly more likely to be employed in Wave 4 (up to six years post-high school; B = .25, p = .003)

and those with high outcome expectations were significantly more likely to be employed in Wave 5 (up to eight years post-high school; B = .33, p = .04). Results suggested that independently traveling to places outside the home, using public transportation, and arranging airplane or train trips predict post-school employment for youths with visual impairments. Positive self-beliefs about work for pay, financial self-support, and independent living were also associated with employment.

2.6 Application of Technology

1. Assessment on Technology

Allman & Lewis (1996) viewed to test the validity of the National Literary Braille Competency Test (NLBCT), 181 Florida teachers of students with visual impairments were asked if they transcribe Braille using a Braillewriter, a slate and stylus, Braille computer programs, or transcriber aides. The majority transcribed using computer software or a Braillewriter.

Niebrugge (2012) viewed that when Braille Institute in Los Angeles conceived The Braille Challenge contest more than a decade ago, the goal was to create an innovative way to promote braille literacy. Now that more than 4,500 students over the last 12 years from across the United States and Canada have chosen to participate in The Challenge, it was safe to say that it has been a success. From a technological standpoint, until last year, the Challenge had been holding back from embracing digital technology. In the past, students were allowed to use manual braillers and cassette tape players. In 2011, the committee responsible for the Challenge (of which the author is director) finally took the first step toward using digital technology by requiring participants to use digital audio players instead of analog tapes. This transition gave a surprising sense of how wide of a gap remains between early adopters of new technology and those who have yet to embrace devices such as accessible MP3 players. It was also learned that in order to successfully bridge this gap, the most important thing to do is to ensure that teachers of visually impaired students are provided with relevant and easily

digestible ways to learn how to use such new technology. In this article, the author described how The Challenge serendipitously accelerated the use of digital audio players.

Ratanasit & Moore (2005) investigated the inability of computer users who are visually impaired to access graphical user interfaces (GUIs) has led researchers to propose approaches for adapting GUIs to auditory interfaces, with the goal of providing access for visually impaired people. This article outlined the issues involved in nonvisual access to graphical user interfaces, reviewed current research in this field, classified methods and approaches, and discussed the extent to which researchers have resolved these issues.

2. Use of Assistive Technology

Kapperman & Sticken (2003) reviewed the use of the “Braille Lite” note-taker in studying foreign languages. Cooper and Nichols (2007) reviewed the use of the “Mountbatten” Brailler (a semi-mechanical electronic writing device) with young users in the development of literacy skills. The Mountbatten was chosen over other, more sophisticated electronic writing devices, such as “Braille Note” and “Braille Lite”, on the grounds that it produced a paper copy of the Braille directly. Teachers reported that children using the Mountbatten were able to do more independent writing, with less fatigue than on conventional mechanical writing machines, such as the Perkins Brailler.

Murphy, Hatton & Erickson (2008) in an investigation of the use of technology in early literacy teaching, carried out a survey of specialist visiting teachers of pupils with visual impairment who worked with preschool children in the USA. They 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.

Kelly & Smith (2008) found that young people with visual impairment used computers and telephones for social purpose 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 (2009) investigated the use of assistive technology by students in the United States who are visually impaired through a secondary analysis of a nationally representative database. It found that the majority of students were not using assistive technology.

Sáenz & Sánchez (2010) designed a mobile technology to identify the position and orientation of people who are blind in closed environments, such as a school, building or home, identifying the necessary infrastructure based on criteria of usability, reliability and accessibility, in order for PocketPC device interface developers to be able to define the technology to be used at an early stage. The technology consisted of using PocketPC devices with a data collecting application and another for the representation of space. The authors evaluated its usability, accessibility, reliability, efficiency, and availability. The results of the usability evaluation assured that the interface designed and developed was usable for users who are blind, which was reaffirmed through the accessibility evaluation. The reliability, efficiency and availability evaluations of the system showed that a user who is blind can use the system confidently, because it provided correct information for more independent navigation.

Soderstrom & Ytterhus (2010) investigated the symbolic values and use of assistive technologies from the world of information and communication technology (ICT) in the daily lives of 11 visually impaired young Norwegians. The article used a qualitative interview study and employed an interactionist approach. While the use of ICT is found to symbolise competence, belonging and independence, the use of ICT assistive

technologies is found to symbolise restriction, difference and dependency. Thus, ICT and ICT assistive technologies have inherently contradictory sets of associations. To fit in as ordinary young people the visually impaired participants rejected ICT assistive technologies whenever possible. The partially sighted participants who are somehow capable of participating in online interactions with their peers without ICT assistive technologies rejected them. The blind participants, however, do not have the option of participating online without ICT assistive technologies and, consequently, they accepted ICT assistive technologies.

Guercio, Stirbens, Williams, & Haiber (2011) stated searching for relevant information on the web is an important aspect of distance learning. This activity is a challenge for visually impaired distance learners. While sighted people have the ability to filter information in a fast and non sequential way, blind persons rely on tools that process the information in a sequential way. Learning is slowed by screen readers which do not interact well with web pages. The author introduced WAVES, a tool for the fast retrieval of information in a web page for blind and visually impaired people. This described the WAVES prototype, a system that performed a page restructuring of webpages. The system analyzed webpages, identified elements of interests from a webpage, evaluated their importance by using semantic information and visual cues, sorted them by importance and used them to restructure the webpage so that data from the original webpage are presented to the reader in a concise format. A preliminary evaluation test of the prototype system has been performed with a sample set of users. The results of the preliminary test showed an increase in speed and accuracy when the WAVES system has been used.

Miura, Matsuzaka, Sakajiri & Ono (2012) focussed that along with the spread of touchscreen computers, the accessibility of the touchscreen interfaces should be secured for visually impaired people. Some of them had interest and own touchscreen computers, usage condition and needs of the computer were not investigated. Specifically, following situations concerning

touchscreen computers remain unknown: what kind of inconvenience they found in their using, what kind of functions they need, why some of them avoid using regardless of their interest, etc. In order to propose and familiarize user-friendly interface for visually impaired people, it is necessary not only to research accessible touchscreen computer but also to investigate current situation regarding touchscreen computers. The authors aimed at demonstrating the needs and usages of touchscreen interfaces such as smartphones and tablet computers in people with visual impairment. These situations were investigated through a questionnaire for Japanese visually impaired people. Part of the results indicated that most of them would like to use touchscreen computer, most of owners used by means of screen readers regardless of their visual conditions, and that dynamic and even stable tactile feedback can be effective.

3. Computer-Based Program

Scheithauer & Tiger (2012) 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 & Miller (2013) created 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) an d compared the efficacy and efficiency of the instructional program using two 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.

4. Outcomes of using Assistive Technology

Siu & Lam (2012) examined that although computer assisted learning (CAL) is becoming increasingly popular, people with visual impairment face greater difficulty in accessing computer-assisted learning facilities. This is primarily because most of the current CAL facilities are not visually impaired friendly. People with visual impairment also do not normally have access to personal CAL facilities due to their high price, thus they may have access to public CAL facilities only, such as those provided by schools, libraries and community centers. A case study was carried out in Hong Kong to review the design of public CAL facilities for people with visual impairment. One of the findings showed that children with visual impairment faced more barriers than others in using public CAL facilities. The design inclusiveness of the CAL facilities is low because children with visual impairment may find it difficult to approach, reach, manipulate and use the facilities.

Bickford & Falco (2012) evaluated whether there was a difference in students' outcomes for braille fluency when instruction was provided with traditional braille media or refreshable braille. Students' and teachers' perceptions of the efficacy of the use of the different instructional media were analyzed. Nine students from public and residential schools, using the Patterns reading series, participated in the study. In an alternating-treatments design, weekly curriculum-based measures that were developed to measure oral reading fluency and word-writing fluency were used to monitor the students' progress with each instructional medium. Semistructured interviews at the conclusion of the study gathered information about the benefits and challenges of each medium. Throughout the 18 weeks of instruction, there were no consistent differences between students' use of the refreshable

braille display and their use of paper and the Perkins Brailler. All students achieved gains in their knowledge of braille letters and contractions, and many achieved an increase in fluency, although the increase was not tied to one instructional medium. The participants identified both the advantages and disadvantages of each medium. The study did not reveal consistent differences among the students between the outcomes of instruction with the traditional Perkins Brailler and paper or the electronic braille notetaker with a refreshable braille display. The teachers were concerned about the inability of students to obtain spatial relationships using refreshable braille.

Zhou, Parker, Smith & Griffen-Shirley (2011) in another American study of the use of assistive technology for students with visual impairments reported that a major barrier hindering the use of technology in school was the lack of skills and knowledge by teachers of pupils with visual impairment. 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 by Smith, Kelley, Maushak, Griffin-Shirley & Lan (2009). The survey revealed a self assessed deficit in 55 of the 74 competencies. They 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. They 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. Given the pace of change in the area however they believed that the development of ‘assistive technology

specialists' as 'new types of professional in the field of visual impairment will ultimately be necessary'.

Li Zhou et al. (2012) explored the relationship between computer and Internet use and the performance on standardized tests by secondary school students with visual impairments. With data retrieved from the first three waves (2001-05) of the National Longitudinal Transition Study-2, the correlational study focused on secondary school students with a primary disability of visual impairment who were capable of taking standardized tests. The unweighted sample sizes ranged from 210 to 280. The relationships between using a computer for homework and for the Internet and students' performance on standardized tests on synonyms and antonyms, comprehension of passages, calculation, applied problems, science, and social studies were investigated using multiple regression analyses, with other variables held constant, including gender, severity of vision loss, household income, multiple disability status, and race or ethnicity. Results showed when gender, the severity of vision loss, household income, multiple disability status, and race or ethnicity were held constant, using a computer for the Internet had a significant positive relationship with students' performances on the passage comprehension test ($p = .034$), calculation test ($p = .027$), and science test ($p = .000$). However, using a computer for homework had no significant relationship with students' performances in any of the six tests that were examined. Students who used a computer for the Internet scored significantly higher than did those who did not on the passage comprehension, calculation, and science tests. But students who used a computer for homework performed at the same level as those who did not on all six tests that were examined.

Sodnik, Jakus & Tomažič (2012) reported on a study that explored the benefits and drawbacks of using spatially positioned synthesized speech in auditory interfaces for computer users who are visually impaired (that is, are blind or have low vision). The study was a practical application of such systems an enhanced word processing application compared to conventional

screen-reading software with a braille display. Two types of user interfaces were compared in two experimental conditions: a JAWS screen reader equipped with an ALVA 544 Satellite braille display and a custom auditory interface based on spatialized speech. Twelve participants were asked to read and process three different text files with each interface and to collect the information about their form and structure. Task-completion times and the correctness of the perceived information on text decorations, text alignment, and table structures were measured. Results showed the spatial auditory interface proved to be significantly faster (3 minutes, 12 seconds) than the JAWS screen reader with ALVA braille display (8 minutes, 38 seconds), $F(1,70) = 391.523$, $p < .001$, and 15% more accurate when gathering information on text alignment, $F(1,70) = 28.220$, $p < .001$. No significant difference between the interfaces could be established when comparing questions on text decorations, $F(1,70) = 0.912$, $p = .343$, or table structures, $F(1,70) = 1.045$, $p = .310$). The findings showed that the auditory interface with spatialized speech is more than 160% faster than the tactile interface while remaining equally accurate and effective for gathering information on various properties of text and tables.

Leff (2012) conducted a study on the non-use of assistive computer technology by some people who are legallyblind/visually-impaired was investigated to determine the reasons for lack of interest (Chiang, Cole, Gupta, Kaiser, & Starren, 2006; Williamson, Wright, Schauder & Bow, 2001). Social and psychological factors implicated in non-interest were determined by profiling five participants who were either residents or outside attendees at a facility for blind/visually-impaired people, located in a major city in the northeast corridor. Two questionnaires were utilized in addition to an examination of the literature. The first questionnaire covered multiple areas which included questions concerning prior and current experiences with computers, concerns about using computers, level of satisfaction with instruction, method of obtaining information, incentives to take a computer course, and sources of obtaining medical information. The second

questionnaire, titled Rand Visual Function Questionnaire 25 (2001), involved questions dealing with general health. Triangulation was used as a validity check and included, but was not limited to, informal interviews, observations of the premises and occupants, discussions with equipment manufacturers, reading in professional journals, newsletters and bulletins, consultations with social workers, staff, present and prior residents, and the use of two questionnaires. Results indicated multiple impediments which included the cost of hardware and software, insecurity concerning economic conditions with little or no possibility for employment, satisfaction with the status quo, and a lack of motivation to change. The social and psychological factors included communal apathy and depression, which may be indicative of broad psychosocial problems of interest to educators, psychologists, and social workers.

Kelly & Wolffe (2012) examined the degree to which transition-aged youths with visual impairments have used the Internet and what outcomes they have achieved following their graduation from high school. The authors conducted a secondary analysis of the National Longitudinal Transition Study-2 (NLTS2) database and assessed a nationally representative sample of youths with visual impairments who were making the transition from high school to further education or work. The descriptive analysis showed estimates of Internet use among these youths during three periods (2005, 2007, and 2009). Multilevel longitudinal modeling was used to analyze the change in the prevalence of Internet use as the youths matured and to assess the impact of postsecondary opportunities on online communication. Results showed that across the three waves of data collection, an average of 43% of the transition-aged youths with visual impairments used the Internet regularly for online communication. There was no significant change in the use of the Internet as these young people matured ($p = .06$). The youths who used the Internet for regular online communication were significantly more likely to be engaged in postsecondary work ($p < .01$), education or training ($p < .01$), or volunteering and engaging in community service ($p < .01$). The study showed

that transition-aged youths with visual impairments are not progressing at rates commensurate with their peers without disabilities in the vital area of Internet use. Their best performance, in Wave 5, was 49%; compared to 93% of youths without disabilities in the same year. The positive impact of participation in postsecondary opportunities on the likelihood of online connectivity is demonstrated.

5. Training in Assistive Technology

Trief & Feeney (2003) identified the components of a precollege curriculum needed by learners who are blind and visually impaired, and investigated the importance of acquiring various competencies in predicting whether students with visual impairments and blindness successfully completed a four-year college degree. The findings suggested that students need to learn keyboarding skills and how to use the computer, read and write, and do math continuously throughout their entire education, and that precollege curriculum must concentrate on assistive technology as well as social, communicational, organizational, and daily living. The precollege curriculum should build on and supplement existing basic skills. The scope of its focus should be narrowed to concentrate on college-specific skills and techniques that student with visual impairments need before entering college. With a proper curriculum in place, students can, in a short time, learn, embellish, and sharpen their skills to ensure successful completion of college.

6. Alternative Format Preferences

Adetoro (2012) investigated alternative format preferences among secondary school visually impaired students, focusing on Southwestern Nigeria. Using total enumeration technique, data were gathered from 123 students from six purposively selected secondary schools through the use of a questionnaire and an interview schedule with reliability scores ([alpha] = 0.77) and ([alpha] = 0.75) respectively. Interviews were carried out with 104 (84.5%) visually impaired students. The study found that talking books/audio recordings were the most preferred format (53%)-51% for blind and 55% for

partially sighted students respectively. Reasons for talking book preference included ease of understanding and playback, time savings, teacher's ineptitude, difficulty and volume of Braille materials. The study recommended collaboration of libraries and other stakeholders in improving talking book collections, provision of digital talking books, Braille literacy and a national strategy for training of Braille teachers and Braillists.

Runyan (2013) described an iOS device, such as an iPhone or iPad, does not appear to be an appropriate tool for the blind. It has only a few physical buttons, and it seemed to make sense only for someone with full sight. However, features such as Zoom and VoiceOver and compatibility with braille displays have made iDevices accessible right out of the box to people who are blind or visually impaired. This technology has quickly made its way into classrooms as a highly motivating, sleek, and portable learning tool. As a teacher of students with visual impairments (TVI), Marla Runyan believed iOS technology has potential for students beyond the learning of core academics. An iOS device can provide timely access to curriculum, enable productivity in a portable manner, facilitate social networking and daily living skills, support orientation and mobility skills, and even bridge the gap between braille and print.

Beal & Rosenblum (2015) in the present study evaluated the feasibility of using an iPad application or “app” for algebra-readiness mathematics, with accompanying braille materials and accessible graphics, when used in authentic educational settings. Twenty-nine students with visual impairments in grades 4-11 used the materials under the direction of their teachers of students with visual impairments (N = 19). Twenty percent of the mathematics problems included graphics such as maps, line graphs, and bar graphs. Students and teachers of students with visual impairments provided feedback about the feasibility of using the app with supplemental materials, and made suggestions for additional features to improve the instructional package. Results showed that students completed 984 word problems and solved 80% of them correctly within three attempts. The use of some features

such as hints and “worked-example” videos was low. Participants provided suggestions for improvement of the app features and accessible graphics. Students and teachers of students with visual impairments were able to use the materials successfully, and comments were generally positive. Participants' comments and suggestions were used to revise the app and materials.

Diana & Brent (2000) compared students who used primarily oral media for reading and writing with those who use braille. The author found that "The sequenced, ordered characters of Braille provide a medium laid out in space very much like print. Indexes, lists, outlines, indentation, are meaningful in Braille. One can read them quickly or slowly, stop and back up, and follow a developed argument in ways that are difficult when listening to words flow by on a tape."

2.7 Academic Achievement of Visually Impaired Students

1. Impact on Academic Achievement

Scott (2009) explored how fifteen students with blindness and visual impairments experienced their engagement in undergraduate studies at four 4-year universities and perceived their success. They also provided their understandings of the impact of institutions, faculty, staff, and others on their academic success. Previous literature suggested that students with blindness and visual impairments as well as students with other disabilities were academically successful in college because of institutional support and the positive attitude of faculty and peers (Baggett, 1994; Branker, 1997; Enberg, 1999; Fichten, 2005; and Roy, 2000). Findings from this study demonstrated that participants' understandings and experiences with blindness varied and their subsequent adjustment and transition also differed. Participants described several factors that facilitated the creation of positive educational experiences during their undergraduate programs: positive exposure to a new region of the country, positive peers, supportive departments and professors, financial opportunities, and welcoming and diverse campus environments.

As these students transitioned to the university, they utilized accommodations and services provided by Disability Students Services (DSS) to facilitate their access to the academic environment. The undergraduate students also described challenging experiences, including feeling academic discrimination, a sense of isolation, limited campus accessibility, and peer interaction issues. There were other support systems that facilitated participant academic success, such as mentors, family, administrators, and staff. This study concluded that blind and visually impaired undergraduate students were more likely to succeed academically when they felt a sense of connectedness with the university academic system. DSS is most responsible for facilitating that connectedness. Quality contact and collaboration with faculty were also important, as well as the attitudes of faculty, administration, and staff. The disconnectedness between study participants and the university system was fostered through inflexible bureaucratic procedures; the attitudes of faculty, staff, and administrators; and isolation from peers.

Richardson (2015) studied attainment in visually impaired students taking modules by distance learning with the Open University in 2012. Students with visual impairment alone were less likely to complete their modules and less likely to pass the modules that they had completed than non-disabled students, but they were just as likely to obtain good grades on the modules that they had passed. Students with visual impairment plus additional disabilities were less likely to complete their modules, less likely to pass the modules that they had completed, and less likely to obtain good grades on the modules that they had passed than non-disabled students. These findings were in contrast to those of earlier studies, which suggested that visual impairment had little or no impact upon attainment in higher education. The disparity is attributed to a student population which are nowadays much more diverse both in its abilities and in its disabilities.

Klinkosz, Sekowski & Brambring (2006) compared academic achievement by sighted versus visually impaired students at Polish universities and analyzed potential between-group differences on various

personality traits and their impact on academic grades. Although there was no main effect of visual status on academic achievement, there were some significant differences between the personality traits of the visually impaired and sighted groups.

Giesen, Cavenaugh & McDonnall (2012) investigated elementary and middle school students who are blind or visually impaired (VI) lag up to three years behind non-disabled peers in mathematics achievement. The authors investigated the impact of academic supports in the school on mathematics achievement, controlling grade, gender, cognitive disability, and family SES. Data were from SEELS (Special Education Elementary Longitudinal Study) that followed a national sample of students over six years. Analyses employed multilevel modeling. They found the extent of academic supports in the school was positively related to mathematics achievement for visually impaired (VI) students without cognitive disability but not for those with cognitive disability. Gender and socio-economic status (SES) had no effects. Achievement growth was not hampered by cognitive disability. Schools with more academic supports may enhance mathematics learning for VI students without a cognitive disability, and VI students with a cognitive disability may need both a high level of supports and specialized supports to facilitate mathematics achievement.

Chanfreau & Cebulla (2009) focussed that RNIB commissioned the National Centre for Social Research (NatCen) to carry out detailed analysis of government statistics relating to the educational performance of blind and partially sighted pupils in the UK. According to published government statistics, pupils with visual impairment as their primary special educational need (SEN), do better at GCSE in comparison with other groups of pupils with SEN, but considerably less well than pupils with no SEN.

Verdier & Ek (2014) examined reading development, academic achievement and support in school for six students with blindness or severe visual impairments in inclusive educational settings. School grades and

results from reading observations and decoding skills tests were collected, and interviews were conducted with students, parents, and teachers. Results showed that the outcome of these students' schooling varied a great deal regarding both levels of academic achievement and reading development, as well as in the support needed and received. Students with additional disabilities had less positive experiences in school, and the parents of these students were more critical of the support provided by the schools. Important aspects of the outcomes concerned the attitudes held by school management and teachers and the competence of teachers. In some cases, teachers lacked sufficient knowledge about braille and teaching methods for students with visual impairments.

Ekeh & Oladayo (2013) designed in an ex post facto research to determine the extent to which regular (normal) pupils and special needs pupils (visual and hearing impaired) in inclusive and non inclusive classrooms differ in their academic achievement. It was carried out in Port Harcourt, Rivers State of Nigeria. The population of the study consisted of 206 primary 5 pupils (63 special needs pupils and 95 regular pupils from two privately owned inclusive schools, one government owned special school and one public (regular) primary school. A sample of 158 pupils made up of 63 special needs pupils (27 from inclusive schools and 36 from special school); and 95 regular (Normal) pupils (39 from the inclusive schools and 56 from the regular (non-inclusive) public primary school was used for the study. Purposive and simple random sampling techniques via balloting were used to draw the sample. Three research questions and three null hypotheses guided the study. Data of the study were obtained from the 2010/2011 promotion examination scores records of students, as maintained in the schools under study. Mean (x), Standard deviation (SD) and t-test were used to answer the research questions and test the null hypotheses respectively. Results of data analysis indicated that significant difference existed in the academic achievement of regular and special needs students in inclusive classroom setting, in favor of the regular pupils; significant difference existed in the

academic achievement of special needs pupils in inclusive and non-inclusive classrooms, in favor of those raised in inclusive classrooms; regular pupils raised in inclusive and non-inclusive classrooms differed significantly in their academic achievement, in favor of those in inclusive classrooms.

2. Assessment on Academic Achievement

Wilson (2010) described the Iowa Test of Basic Skills (ITBS) was used in the Cahokia Unit School District No. 187 to give insight on student academic skill level in terms of years and months. Teacher strategies and expertise in the area of education are an integral part of the educational process. Tenure status, or the years of teaching experience, was plagued with the idea that it promotes or has an impact on student achievement. The purpose of this study was to examine if students receiving instruction from non-tenured special education teachers demonstrate the same gains in the areas of reading and math as students receiving instruction from tenured special education teachers in the areas of reading and math. Pre and post-ITBS reading and math scores were used as a basis to examine academic achievement. The hypothesis stated there will be a significant relationship between the tenure status of special education teachers and academic achievement. Scatter plots for each data set were constructed to visually indicate a relationship between the independent and dependent variables. The correlation coefficient was also calculated using the independent and dependent variables, and for some data sets resulted with a negative correlation, meaning there was not a positive correlation, and no further testing was necessary. The correlation coefficient test of significance was the last factor in determining if there was a positive correlation between the independent and dependent variables. The result of the analysis concluded that there was a significant relationship between the independent and dependent variables for some of the data sets. In other words, tenure status had a positive effect on academic achievement. This collaborative research project was conducted by Sheryl Wilson, Trenese Dancy, and Rochelle Harris-Clark. Each researcher studied tenured versus non-tenured teachers;

however, each had a different focus group. Sheryl Wilson focused on instructional special education teachers, Trenese Dancy focused on general education teachers, and Rochelle Harris-Clark focused on all teachers.

2.8 Academic Skills of Low vision

1. Assessment of Low Vision Children

Douglas, Grimley, Hill, Long & Tobin (2002) tested the reading of 476 children with low vision using an unmodified print version of the NARA. The data showed that the average reading ages (based upon sighted norms) for accuracy, comprehension and speed for children with low vision fall below their chronological age. For a fuller analysis of the results also see Hill, Long, Douglas, Tobin & Grimley (2005).

2. Reading Performance and Fluency

Leat & Woodhouse (1993) examined the reading performance and contrast sensitivity measured in 30 subjects with low vision due to a variety of pathologies. The Pepper test was used to quantify reading rate and accuracy with the subject's own prescribed optical reading low vision aid. It was found that both reading rate and accuracy were repeatable measures. Reading rates were found to be correlated with contrast sensitivity at 0.5c/deg (r= 0.62). Multiple regression analysis also showed that the best predictor of reading rate was contrast sensitivity at 0.5c/dcg and that no other components of the contrast sensitivity function helped to explain more of the variance. This indicated that primarily low spatial frequencies are necessary for reading with optical low vision aids, as has been found previously for reading with a close circuit TV system.

Gompel, Bon & Schreuder (2004) viewed in the reading of text found that despite their lower reading speed on a reading-comprehension task; the children with low vision comprehended texts at least as well as did the sighted children. Children with low vision need more time to read and comprehend a

text, but they seem to use this time with enough efficiency to process the semantic, as well as the syntactic, information.

Goodrich, Kirby, Wagstaff, Oros & McDevitt (2004) compared the reading performance of subjects using a prototype, head-mounted laser display, a closed-circuit television (CCTV), and a prescribed optical reading device. The prototype yielded reading speeds that are comparable to optical devices but slower than a CCTV. The brightness and clarity of the laser display have potential for the development of future low vision devices.

Gompel, Bon, Schreuder & Adriaansen (2002) focused in the comparison of the reading comprehension, decoding, and spelling skills of 404 children with low vision and a norm sample of same-age fully sighted children found that the children with low vision with no additional disabilities performed less well than the sighted children only on decoding, whereas those with additional disabilities performed less well on all the tests.

Layton & Koenig (1998) explored a user-friendly method to increase the reading fluency of four elementary students with low vision. An analysis of the effects of repeated readings on the students' reading rates, error rates, and comprehension found that the intervention was successful in improving all four students' reading fluency and did not adversely affect their error rates or comprehension. The results from generalized readings indicated that the students' improved reading rates were generalized to classroom reading.

3. Low Vision Training

Yalo, Indoshi & Agak (2012) viewed that the learners with low vision can be trained to increase their visual functioning through a planned programme of visual experiences. Such a low vision training programme was introduced in Kenya in 1994. However, despite its implementation over the last 15 years, challenges still persist among teachers who work with such learners. The purpose of this study was to document challenges that learners with low vision have on teachers' performance when teaching learners with

low vision in special primary schools for the visually impaired in Kenya. The study was carried out in 6 schools for the visually impaired respondents in the study including 78 teachers survey through questionnaire and observation. The study established challenges faced by teachers as lack of appropriate devices for learners, lack of adequate training of teachers and lack of regular teacher auditing. Strategies suggested to address the challenges were supply of low vision devices, low vision teams based at each school reconstituted to provide co-ordinated learning support and regular case conferencing was mounted to provide teacher support.

4. Learning Medium

Lusk and Corn (2006a) noted that a single-medium policy was common in the United States in the 1970s but that dual use was now seen as a positive advantage for some children. They studied dual-media learners explored the instructional methods and curricular decisions of teaching dual media to students with low vision reporting the students' present literacy levels and reading rates and their teachers' expectations for future levels of literacy. The study found a generally positive attitude towards both print and braille among the students.

Half the students who used dual media in Lusk and Corn's study had progressively deteriorating eye conditions and only 15% used standard print with optical devices as their primary reading medium. In addition, 49% used large print, 19% used braille, and 18% used standard print without optical devices as their primary reading medium.

The instructional approaches to braille reading adopted by teachers using dual media use of reading were almost evenly split between introduction through grade 2 braille and grade 1 braille, with a slight preference for contracted braille (Lusk and Corn 2006b). While most children used enlarged print, just over half of the students used CCTV (closed circuit television) magnifiers and just under a third used optical low vision devices to access standard print. With regard to print reading, 26 of the 76 students were

reading below their grade level and 14 were two or more years below their grade level. With regard to braille, 36 of the 63 students for whom data was available were reading below their grade level, with 25 more than 2 years below their grade level. However, only 15 students were found to be reading below their grade level in both print and braille. The instructional time available for print reading was reported as far exceeding the instructional time available for Braille.

Gadagbui & Ocloo (2008) reported in a qualitative study to investigate the attitude leading to the acceptance of Braille as a mode of instruction. The study used 80 pupils with varying degrees of visual impairment (low vision). The instruments used were questionnaires, interview schedules, observation and work sample analysis. Results indicated that most of the children in the sample had the potential to read bold print. Efforts were made to advise and put in place strategies to improve reading abilities of borderline cases of children who read Braille slowly.

Ndung'U (2011) investigated the literacy medium used by secondary school learners with low vision. The study further aimed at investigating the factors that influence the learner's choice of literacy medium. In this study a survey design is used with questionnaire as data collection tool. A stratified random sample consisting of ninety three (93) male and female learners with low vision drawn from a special residential school for the learners with visual impairments participated in the study. Data was analyzed using descriptive statistics; frequencies and percentages. Findings of the study indicated that majority of learners with low vision use Braille as their primary medium of reading and writing, although a relatively significant percentage also use print with and without aid of low vision devices. The learners' choice of the literacy medium was influenced by mechanical and social factor. Mechanical factors included quantity and quality of assignments, ability to take notes in a chosen medium, reading rate, comprehension and accuracy, fatigue, physical dexterity and working distance from the page. Social factors included

portability, availability and the family's or teacher's perception of the learners needs.

5. Rehabilitation Program

Lamoureux, Pallant, Pesudovs, Rees, Hassell & Keeffe (2007) evaluated the effectiveness of a multidisciplinary low-vision rehabilitation program on quality of life evaluated by the Impact of Vision Impairment (IVI) instrument. First-time referrals to low-vision clinics were assessed before and after rehabilitation (3-6 months). Rasch analysis was used to estimate the three IVI subscale and overall values on an interval scale. A mixed between-within subjects ANOVA was used to identify whether presenting visual acuity had an interaction effect with rehabilitation change. Cohen d values were used to estimate the magnitude of the change and the standardized response mean (SRM) procedure was selected to determine the clinical significance of the rehabilitation-induced changes. The results showed one hundred twenty-four women and 68 men (mean age, 80.3 years) completed the rehabilitation. Most had age-related macular degeneration (62%, 119) and were moderately to severely vision impaired (<6/18; 78%, 149). After rehabilitation, significant improvements were recorded for the overall IVI score (P=0.006) and two subscales: reading and accessing information and emotional well-being (P=0.007 and 0.009, respectively). No significant improvement was found on the mobility and independence subscale (P=0.07). The magnitude of the post-intervention improvement was found to be relatively moderate (Cohen d=0.17-0.30) and clinically modest (SRM=0.22-0.42). The study concluded significant improvements in overall quality of life and two specific areas of daily living in people with low vision were found, although the magnitude and clinical significance of the rehabilitation-induced gains were modest.

Kroksmark & Nordell (2001) explored how four adolescents with low vision and two sighted adolescents spent their leisure time and whether their everyday activities were bound to places or people. According to the diaries kept, the adolescents with low vision performed fewer activities than the

sighted adolescents, did not regularly spend much time with friends, and seemed to be dependent on their parents for transportation.

2.9 Conclusion

Most of the above studies are evident to ascertain the Expanded Core Curricular Skills in enhancing the academic performance of Visually Impaired Students. The study highlighted the Literacy medium, Assessment, Training to Students and Teachers, Techniques and Skill Performance in Expanded Core Curricular Skills of Visually Impaired Students. This review helped the investigator to apply appropriate methodological processes and statistical analysis.