International Journal of Research in Special Education

E-ISSN: 2710-3870
P-ISSN: 2710-3862
Impact Factor (RJIF): 6.69
IJRSE 2026; 6(2): 12-15

Journal's Website
Received: 18-11-2025
Accepted: 22-12-2025

R Adaikalam
Ph.D. Research Scholar, Department of Special Education and Rehabilitation Science Alagappa University, Tamil Nadu, India

Dr. J Sujathamalini
Head and Professor, Department of Special Education and Rehabilitation Science Alagappa University, Tamil Nadu, India

Corresponding Author:
Dr. J Sujathamalini
Head and Professor, Department of Special Education and Rehabilitation Science Alagappa University, Tamil Nadu, India

Educational Approaches in Tamil Nadu: Implications for Technology-Based Nemeth and Scientific Notation Training among Secondary-Level Students with Visual Impairment

R Adaikalam and J Sujathamalini

DOI: https://www.doi.org/10.22271/27103862.2026.v6.i2a.146

Abstract
Students with visual impairment are still facing struggle in Mathematics & Science, where symbolic and abstract concepts played a vital role in secondary level curriculum. Nemeth Code and scientific notation are important to facilitate equal opportunities to these students in learning STEM. This research used qualitative methods to discuss the educational strategies embraced to train Nemeth and scientific notation to students with visual impairment at secondary level. Data collections were done using semi-structured interviews and classroom observation and Thematic analysis among 28 students. The results indicated lack of accessibility and its efficient employability. The paper highlights the importance of technology based instructional strategies to access and conceptualization of mathematics and science learning among students with visual impairment. Implications are mentioned in connection with the development of the curriculum and policy efforts that can be used to support STEM education.

Keywords: Visual impairment, Nemeth Code, scientific notation, assistive technology, qualitative study

1. Introduction
Education is very critical in enhancing independence, social involvement, and economic integration of persons with disabilities. The students with visual impairment require not only to be included in curricula but also to have access to quality education, which means everyone should have the means of appropriate instructional materials and learning resources. In secondary school level, academic complexity is even higher especially with mathematics and science subjects which involve heavy dependency on symbolic representations, equations and graphical information. Nemeth code and scientific notation can be regarded as the starting point of mathematical and scientific education of learners with visual impairment who can now access such information using their sense of touch and hearing.

Nemeth Code is a globally known system of Braille that was created and developed with the intention of symbolizing mathematical and scientific symbols. Mastery of Nemeth Code allows students with visual impairment to engage meaningfully with algebra, geometry, physics, chemistry, and higher-level mathematics. Nevertheless, teaching Nemeth Code has its own peculiarities, particularly in situations where the traditional Braille techniques are the main approach to teaching, which is not accompanied by proper technological assistance. Assistive technologies have shown great promise to improve Nemeth teaching in recent years: screen readers, refreshable Braille displays and computer-assisted instructional programs in digital mathematics have the potential to offer multi-sensory access and immediate feedback.

The blind schools have remained in the center of educating students with visual impairment in the Indian context and especially in the state of Tamil Nadu. Although inclusive and technology-based education are focused on the national and state-level policies, there is no certainty of how much training on technology-based Nemeth and scientific notation is implemented in the classroom environment. The current culture tends to favor the traditional mode of teaching Braille with little focus on the technology mediated learning experiences in the student perspective.

This paper aims to fill this gap by discussing the lived experiences of secondary-level

students who experienced visual impairment in a blind school in Tamil Nadu. Foregrounding the voices of the students, the research seeks to learn how the existing instructional methods affect their learning of Nemeth Code and scientific notation, and what consequences such learning will have on the technology-based teaching methods.

2. Review of Literature

This part presents the review of the most significant national and foreign works concerning the education of the visual impairment students, the learning of the Nemeth Code and the scientific notation, and the application of the assistive technology to the secondary-level STEM education. The review is thematic and there are references to authors and study titles to place the current research in context with the current scholarship.

2.1 Visually impaired students, education in the Secondary level.

In the article by Ferrell, Mason, Young and Cooney (2006) [4], Evidence-Based Practices to students with visual impairments, the authors presented an overall picture of instructional strategies to learners with visual impairment. Critical commentary: Although the need to implement specialized practices at the secondary level was boldly confirmed in the study, it primarily brought an overview of all educational strategies in general, but not specific subject-related issues in mathematics and science notation. Additionally, the student-centred qualitative evidence was largely lacking as the opinions of students were also weakly represented.

In their book on Foundations of Education of Blind and Visually Impaired Children and Youth, Holbrook, Kamei-Hannan, and McCarthy (2016) [5] emphasized the role of organized teaching of Braille and alignment of curriculum. Critical analysis: Despite the fact that the authors admitted the growing complexity of the curricula of secondary levels, the work was more practitioner focused. Little emphasis was put on the experience that students are having regarding such methods of teaching, especially regarding the integration of technology in the classroom.

In the report, Global Education Monitoring Report: Inclusion and Education (UNESCO, 2019), there are systemic obstacles that are reported to impede the accessibility of students with disabilities to quality secondary education. Critical reflection: The report had important insights and policy recommendations at a macro-level, but it did not provide micro-level qualitative information on classroom practices and student experience, particularly with regard to specialised skills such as learning Nemeth Code.

2.2 Learning Scientific Notation and Nemeth Code

In one article, Kapperman and Sticken (2003) [6] in A Case for Increased Training in the Nemeth Code of Braille Mathematics, it was argued that lack of sufficient time in instruction and insufficiency in training are the cause of poor Nemeth proficiency. Critical analysis: The research has been successful in bringing out structural constraints in Nemeth teaching, but the findings were mostly instructional issues as opposed to actual student learning. Lack of qualitative student stories restricts knowledge on how these issues can be applied at the learner level.

In the article, Reading Math: How Students with Visual Impairments Access Mathematics, Bouck and Weng (2014) [2] focused on strategies used by students to gain access to mathematical information. Critical analysis: Even though the study recognised the fact that students depend on memorisation a lot, it failed to address the emotional and cognitive impact of memorisation strategies. Moreover, the impact of technology in advancing the scientific notation learning was not studied thoroughly.

In their article titled Assistive Technology Use by Students with Visual Impairments: A National Perspective, Mason, McCall, Arter, McDermott, and Coleman (2014) [8] presented empirical data concerning the trends in technology usage. Critical analysis: Although the study has shown the unequal access to assistive technology, it was conducted on a national level and not on the learning of Nemeth and scientific notation at the secondary level. The results therefore provide little information as to the subject specific reform of instruction.

2.3 Assistive Technology and STEM Education of students with Visual impairment

In their article, Kelly and Smith (2011) [7], The Impact of Assistive Technology on Academic Achievement of Students with Visual Impairments, the authors had positive results with regard to academic performance following the application of technology-based instruction. Critical reflection: The study found that assistive technology was effective however it was based largely on achievement and it has failed to fully investigate the subjective learning experiences and situational limitations of students in special schools.

In their article, Implementation of Assistive Technology with Students who are Visually Impaired: Teachers Readiness, Abner and Lahm (2002) [1] identified the institutional barriers to the use of technology. Critical analysis: The teacher-centred nature of this research restricts the research to get direct insight on the issue of student learning. The lack of voices in students poses the necessity of learner-centred qualitative studies.

In the World Bank report titled Bridging the Disability Divide through Digital Technologies, Raja (2016) [9] highlighted the potential of digital tools to change things. Critical review: Although the report was a strong proponent of technology adoption, it was still quite hypothetical and policy-based, and provided few empirical data concerning the implementation on the classroom level or learner performance.

2.4 Student perceptions and Ethnographic Analysis

In The Impact of Braille Reading Skills on Employment Outcomes, Ryles (1996) [10] associated the outcomes in the long term with the literacy skills. Critical commentary: Despite reaffirming the significance of solid Braille foundations, the study did not touch on modern issues like technology-based learning of Nemeth that needs to be considered in order to make it pertinent to the contemporary STEM education environment in secondary learning.

The recent qualitative disability education literature has placed emphasis on student voice but not many have been specifically based on Nemeth Code or learning of scientific notation in special schools in India. This weakness further supports the need of current student-based qualitative research.

2.5 Critical Analysis

The analysis of articles shows that the available literature has significantly facilitated the study of Braille literacy, instruction of the Nemeth Code, and the use of assistive technologies in students with visual impairment. Most of these studies are, however, fragmented in nature in that most of them focus on policy level views, teacher readiness or overall instructional strategies. Limited researches have conducted an overall study of the interplay between educational practices and technology integration and student experiences at the secondary level, especially in scientific notation and the content-heavy and content-rich STEM-related material. In addition, the student voices are often not represented enough giving limited understanding of the cognitive and emotional aspects of the learning of Nemeth Code in the real classroom settings. This synthesis illustrates the necessity of a special, learner-oriented qualitative research study that reflects on the experiences and realities of students, particularly their lived experiences as well as their situational realities to give empirically informed recommendations on better technology-based teaching and learning of Nemeth and scientific notation in blind schools.

2.6 Research Gap

The research article, A Case for Increased Training in the Nemeth Code of Braille Mathematics, Kapperman and Sticken (2003) [6] claimed that insufficient instructional time and teacher expertise are among the factors that cause students to have difficulties with learning the Nemeth Code. The analysis showed that the students of secondary level are especially susceptible to the gaps in the proficiency of Nemeth because of a higher symbol density.

In an article by Bouck and Weng (2014) [2], Reading Math: How Students with Visual Impairments Access Mathematics, the authors discussed the use of mathematics by students with visual impairment. Their research came up to conclude that a high percentage of students employ memorisation techniques when they have complex notation and this restricts their conceptual knowledge and problem solving.

Another research study titled Assistive Technology Use by Students with Visual Impairments: A National Perspective, Mason, McCall, Arter, McDermott, and Coleman (2014) [8] established that although Nemeth Code is a prerequisite of mathematical accessibility, students are usually deprived of an opportunity to practice Nemeth in the form of technology-based environments. Assistive Technology in STEM Education for Students with Visual Impairment

In their article Implementation of Assistive Technology with Students Who Are Visually Impaired Teachers Readiness (Abner and Lahm, 2002) [1], they have found that there are institutional and pedagogical barriers which restrict effective use of technology. Despite it being research on teachers, it gave valuable information on the impact of limited implementation on the student learning outcomes.

The report by Raja (2016) [9] published by the World Bank, "Bridging the Disability Divide through Digital Technologies" noted the potential transformations of digital tools to reduce educational inequalities of persons with disabilities. The report however warned that in the absence of proper instructional models, adoption of technology alone may not be associated with significant learning.

In The Impact of Braille Reading Skills on Employment Outcomes, Ryles (1996) [10] also indirectly pointed to the long-run implications of a poor performance in Braille and Nemeth by pointing to the post-school outcomes of literacy skills. The paper highlighted the significance of good underpinning skills in secondary school.

Even more recent qualitative research in disability education has emphasized the need to capture the voices of students to learn more about barriers to and enablers of learning. The studies indicate that the visual impaired students do find technology-based learning as empowering, but they are always frustrated when the instructional practices do not change anytime they are text-based.

Even with the increased amount of international research, it is evident that no qualitative research has been conducted to specifically investigate secondary level students with visual impairment in the Indian blind school contexts especially on learning Nemeth Code and scientific notation.

3. Methodology

3.1 Research Design

The research design was descriptive qualitative research to have the lived experiences and perceptions of the students with visual impairment on teaching Nemeth and scientific notation.

3.2 Samples and Locality

The sample was comprised of 28 students of secondary level with visual impairment who were attending a blind school in Tamil Nadu. The students were a mixed grade group between 9 and 12. Participants were selected according to purposive sampling technique because they had that exposure to mathematics and science courses which included Nemeth Code.

3.3 Data Collection Methods

There were two main ways of data collection:

Semi-structured interviews: One-on-one interviews were carried out to understand the experiences of students, issues and attitudes they had in the learning of Nemeth and scientific notation.

Classroom observation: Non-participant observations were conducted to learn the instructional practices and learning environments.

3.4 Ethical Considerations

All the participants gave informed consent. The research was conducted anonymously and it was ensured that it was confidential, and the participants were informed of their ability to withdraw at any point.

3.5 Data Analysis

The data analysis was done by means of thematic analysis. The data were familiarized, coded, and themes were developed and refined. Manual coding was used to make sure that close interaction was made with narratives of the participants.

4. Findings

There were five significant themes of the thematic analysis of interviews and classroom observations. To add credibility and authenticity, verbatim statements of students are added as representatives.

Theme 1: Low exposure to technology-based Nemeth Instruction.

Many participants stated that they were taught Nemeth Code by using the traditional methods of teaching Braille with little exposure to assistive technology.

The only books that we learn from the Nemeth symbols are the Braille books. We do not use computer or mobile tools in our class quite often. (Student 7, Class 10)

Theme 2: Problems in Learning Scientific Notation with the Traditional Braille

Students reported difficulties with understanding complex symbols applied in physics and chemistry in cases where the instruction was based on the sense of touch.

The symbols are quite perplexing in the field of science. Equations are long, and it does not come easy for me to understand. (Student 14, Class 11)

Theme 3: Reliance on Memorization Strategies

Some students reported that they learned symbols and how to go about the exams instead of gaining conceptual clarity.

On exams, I memorize the formulae since it is too time consuming to comprehend all the symbols.

Theme 4: Emotional Frustration and Academic Pressure

Subjects complained of frustration, anxiety, loss of confidence especially when taking exams with symbol heavy content.

It makes me nervous when I do exams in math's, as I realize that a single error in symbols can change all things.

Theme 5: Favorable Approaches to Technology-aided Learning

Students expressed great interest in the use of technology approaches to learning despite the lack of access.

Math's and science will be easier for us provided we learn using computer or talking software.

5. Discussion

The results point to the lack of connection between the potentiality of assistive technology and its practical implementation in the blind school under the study. The experiences of students are consistent with the literature that highlights the fact that technology-based pedagogy is necessary to facilitate meaningful acquisition of Nemeth Code.

6. Conclusion

This research discussed educational practices in a blind school in Tamil Nadu and included its consequences on the use of technology in the training of Nemeth and scientific notation in students with visual impairment at secondary level. Through foregrounding voices of students, the study was able to show that there were so many gaps in the teaching practice mainly on the low level of integration of assistive technology and the use of old-fashioned Braille. The results highlight the importance of pedagogical changes to support the instructional strategies in line with the academic requirements of the secondary-level STEM education. The incorporation of technology-based Nemeth teaching can help improve conceptual knowledge, decrease the frustration rates of learners, and boost the academic self-confidence of students with visual impairment. The research makes its contribution to the scarce qualitative studies in the Indian setting and provides usable information to educators, curriculum designers, and policymakers, who are determined to ensure inclusive and accessible education.

7. Implications

The study has crucial implications for secondary-level education of the students with visual impairment. To begin with, curriculum planners must give special attention to the systematic incorporation of technology-based teaching of Nemeth and scientific notation in mathematics and science curriculum. Second, assistive technology must be placed as a central teaching tool but not as a secondary resource. Third, instructional methods based on student-centered learning that focus on conceptual learning as a substitute of rote learning should be introduced to minimize academic stress and improve academic outcomes. Lastly, in the quest to ensure equal access to education in STEM, policy programs must be used to facilitate access to accessible digital tools and other resources accessible by learners in the blind schools.

8. Limitations, Future Research.

It was also a restricted study done in one blind school with a very small sample size. Future studies can be conducted on mixed methods studies in various institutions.

References

1. Abner GH, Lahm EA. Implementation of assistive technology with students who are visually impaired: Teachers' readiness. Journal of Visual Impairment & Blindness. 2002;96(2):98–105.
2. Bouck EC, Weng PL. Reading math: How students with visual impairments access mathematics. Education and Training in Autism and Developmental Disabilities. 2014;49(3):360–375.
3. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology. 2006;3(2):77–101.
4. Ferrell KA, Mason LH, Young J, Cooney J. Evidence-based practices for students with visual impairments. Exceptional Children. 2006;73(2):141–160.
5. Holbrook MC, Kamei-Hannan C, McCarthy T. Foundations of education for blind and visually impaired children and youth. New York (NY): AFB Press; 2016.
6. Kapperman G, Sticken J. A case for increased training in the Nemeth Code of Braille mathematics. Journal of Visual Impairment & Blindness. 2003;97(2):110–112.
7. Kelly SM, Smith DW. The impact of assistive technology on academic achievement of students with visual impairments. Journal of Special Education Technology. 2011;26(3):1–14.
8. Mason LH, McCall S, Arter D, McDermott M, Coleman M. Assistive technology use by students with visual impairments: A national perspective. Journal of Visual Impairment & Blindness. 2014;108(2):99–112.
9. Raja DS. Bridging the disability divide through digital technologies. Washington (DC): World Bank; 2016.
10. Ryles R. The impact of Braille reading skills on employment outcomes. Journal of Visual Impairment & Blindness. 1996;90(3):219–226.
11. UNESCO. Global education monitoring report: Inclusion and education. Paris: UNESCO; 2019.
12. World Health Organization. World report on disability. Geneva: WHO; 2011.