Inclusive Science Education in Elementary and Secondary Schools With a Focus on Strategies for Teaching Science to Children With Visual Impairments

Synopsis of Ph.D. Thesis

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Publications relevant to the thesis

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Sharma, A., & Chunawala, S. (2016). Science learning and visualization: A case of students with and without vision, learning the atomic structure. In G. J. Vitus and C. Praveen (Eds.). *Proceedings annual-cum-international conference of All India Association for Educational Research INTCONF 2015: Standards and benchmarks for excellence in learning and teaching research:* University of Kerala, Kerala, 12-22.

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Abstract

Science education has been described as 'elitist' by some science educators (Fensham, 1986), as it tends to exclude and discourage marginalized and low-achieving students from opting for science in higher studies. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), though such exclusion is experienced by all marginalized groups based on factors such as remote location, poverty, gender discrimination, disability, language and traditional or cultural deprivation (UNESCO, 2010), it is the most acute in the case of persons with disabilities (PWD). The latter is also among the most marginalized groups in the world according to the World Health Organization (WHO, 2017). In Indian classrooms, students with disabilities (SWD) are almost invisible, especially in science classrooms. This puts a serious question mark on the present model of science education followed in the country. Such exclusion is completely undesirable and against the constitutional values as Article 51A (h) of the Indian constitution makes it a fundamental duty of every citizen “to develop the scientific temper, humanism and the spirit of inquiry and reform”.

To combat discriminatory attitudes, the United Nations Educational, Scientific and Cultural Organization (UNESCO) suggests the building up of an inclusive society through regular schools with an inclusive orientation (UNESCO, 1993 and 2003). Inclusion differs both philosophically and institutionally from ‘special schooling’ that focuses on special treatment for special groups. Though well-intentioned, such special schools often, actually lead to social segregation of students.

A broad vision of a society that aims to include all, suggests that it is pertinent to make efforts towards the development of an education system that endeavors towards the inclusion of all the marginalized/deprived groups, not just those with disabilities. But since the scope of such a study would be extremely large, the present work has focused on the inclusion in education of the largest group of marginalized people that is, PWD. The study has made efforts to understand the status of inclusion of students with disabilities (SWD) in general and science education in particular, in the Indian context. The work has scrutinized the need for inclusive science education for SWD through literature and has surveyed to ascertain the views of teachers, parents and the peers of SWD regarding the inclusion of SWD in classrooms. The next phase of the work further narrowed down its focus, to developing and testing some strategies for teaching science to students with visual impairments (SVI). The mixed research methodology has used both qualitative and quantitative methods of analysis.

Chapter 1: Introduction

1.1 Background and motivation

The nature of science education has been described as 'elitist' by some science educators (Fensham, 1986), as it tends to exclude students. As described by Aikenhead (2009, p.1), 'Science and technology education in schools has traditionally served an elite group of students' and the elitist nature of science discourages marginalized and low achieving students to opt science for their higher studies.’ According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), though such exclusion is experienced by all marginalized groups based on factors such as, remote location, poverty, gender discrimination, disability, language and traditional or cultural deprivation (UNESCO, 2010), it is the most acute in the case of persons with disabilities (PWD) which is also the most marginalized group in the world (World Health Organization, 2017).

In India, a general survey would suggest the invisibility of persons with disabilities in classrooms. This puts a serious question mark on the present model of science education followed in the country. If one were to take the case of persons with visual impairments, India has a population of around 50 lakh persons with visual impairments. Around 4 lakh SVI are enrolled in grades I to VIII of schools. Of these, about 15000 students are getting education in 250 schools and 150 institutions and associations for persons with visual impairments under various programs of education, (Mehta, 2010). But, when one scrutinizes the data more deeply, it may be noticed that most of these special schools are located in large towns and cities (Natsume & Thamburaj, 2001) thereby excluding rural persons with impairments. The Ministry of Statistics and Programme Implementation (2016) provides information that around 20% of SVI in the age group of 5-19 years have never attended a school. Also, the news reports (Sharma, 2015) have highlighted the inefficacy of educational institutions in providing quality education. According to this news, only 8449 students with disabilities (around 0.56% of the total enrolled students) were found enrolled in 150 colleges, universities and educational institutes that were covered under the study.

1.2 Education status of students with disabilities (SWD)

The problem faced by SVI is the tip of the iceberg of the larger social problems faced by marginalized groups. In the case of PWD, there exists a two-way link between disability and poverty; poor people are more at risk of acquiring a disability because of lack of access to good nutrition, health care, sanitation, as well as safe living and working conditions. Once individuals develop a disability, they face barriers to education, employment, and public services that push the large group of marginalized populations further into poverty.

Table 1. Distribution of persons by the type of disability in India (Social Statistics Division, Ministry of Statistics and Programme Implementation, 2016)

Total population—121 crore			
Total disabled population- 2 crore (2.21% of the total population)			
Vision 18.8% (50 lakh)	Hearing 18.9% (50 lakh)	Speech 7.4% (20 lakh)	Movement 20.3% (54 lakh)
Mental Retardation 5.6% (15 lakh)	Mental Illness 2.7% (7 lakh)	Other 18.4% (49 lakh)	Multiple Disability 7.9% (21 lakh)

A deeper probe indicates that not just science education but also the overall perspective of education is in a pathetic condition for SWD. Table 2 depicts a large number of out-of-school children with impairments at the elementary level of schooling and extreme exclusion at the university level.

Table 2. Status of education of children with disabilities

Source: Social & Rural Research Institute, IMRB. (2014), Social Statistics Division, Ministry of Statistics and Programme Implementation (2016) and Sharma, N.C, (2015)

Category of disabled children	**Number**
In 6-13 years age range	21 lakh
In above age range and enrolled in Elementary school	15 lakh (71.9% of above)
Out of school children in the above age range	6 lakh (28.07% of total)
Disabled youth in 150 colleges, Universities and institutes	8449 (0.56% of total enrolled students)

As compared to the national literacy figure of around 74.04 percent, the literacy level of PWD is only 54.5 percent. The literacy rate for the female disabled population is even lower (around 44.6 percent) as compared to the national average of over 65 percent for the female population (MHA, 2011). The reasons for such a sorry state of education of students with disabilities (SWD) have been discussed in section 1.7.

1.3 Efforts for the education of students with disabilities (SWD)

Five major legislations that have some bearing on disability that have been enacted by the Government of India and implemented at both the Central and State level are: The Rehabilitation Council of India Act, 1992, The Persons with Disability Act, 1995, The National Trust Act, 1999, The Right of Children to Free and Compulsory Education (Amendment) Act, 2012 and the Rights of Persons with Disabilities Act, 2016. The education of children with disability has been part of the National Policy on Education and the Program of Action since 1998.

Currently, India has adopted the inclusive model of education as a consequence of the National Curriculum Framework, 2005, and the National Curriculum Framework for Teacher Education (National Council for Teacher Education, 2010). Despite the movement towards inclusive education, a large number of SVI still get an education in special schools due to various reasons, one of which is the lack of research on implementation aspects of inclusion (Jones, Minogue, Oppewal, Cook & Broadwell, 2006). In the Indian scenario, an issue with special schools is that SWD can opt for less rigorous courses in their secondary schooling and omit science topics which are considered to be 'difficult'. Lack of science teachers and science learning materials is a regular feature in special schools due to low expectations of curriculum planners, teachers, parents and society from SWD (Sacks, Kekelis & Robert, 1992).

The concerted and institutionalized efforts for uplifting the education status of SWD began in India with the National Policy on Education (1968), which along with an emphasis on the education of girls and backward groups of children envisaged the expansion of educational facilities for students with disabilities (SWD) through integration in regular schools. This policy was followed by a series of programs, policies, and acts that first led towards integrated education and then towards the inclusion of SWD in education. Internationally such efforts could be seen from the year 1975 onward after the Declaration of Rights of Persons with Disabilities by the United Nations general assembly.

Table 3. Efforts made for the education of SWD

Towards integration	Towards inclusion
International efforts	
1975, Declaration on Rights of Persons with Disabilities, United Nations, General Assembly 1981, International Year of Disabled Persons (IYDP)	1994, The Salamanca statement, UNESCO 2000, Education For All movement, UNESCO 2006, The Convention on the Rights of Persons with Disabilities, United Nations General Assembly
Efforts made by the Government of India	
1968, National policy on Education, MHRD 1974, Integrated Education for Disabled Children program, MHRD 1987, Project Integrated Education for the Disabled (PIED), MHRD 1986, National Policy of Education, MHRD 1992, Program of Action on National Policy of Education of 1986 1992, Rehabilitation Council of India Act, 1994, District Primary Education Program, MHRD 1995, Persons With Disability Act	2004, Sarva Shiksha Abhiyan, MHRD 2005, National Curriculum Framework, NCERT 2005. The National Action Plan for Inclusion in Education of Children and Youth with Disabilities (IECYD), MHRD 2006, National Policy for Persons with Disabilities 2009, National Curriculum Framework for Teacher Education 2009, The Right of Children to Free and Compulsory Education (RTE) Act 2012, The Amendment in RTE Act 2016, Rights of Persons With Disability Act

A review of the literature in the field suggests that presently in India there is support for inclusive education from various educational programs, policies and laws. However, there is a need for research to be undertaken to locate the barriers to inclusion and to find educational strategies to overcome these barriers, which is the purpose of this research.

1.4 Need for inclusion in education

According to UNESCO (1994), regular schools with an inclusive orientation are most effective in combating discriminatory attitudes, building an inclusive society and achieving education for all. As a broad social model, inclusion in education endeavors to incorporate the diversity of the population into the schooling system. UNESCO (2003) describes inclusive education as an approach that transforms the education system to respond to diverse learners and dispels discrimination. As an ideology, no student is to be excluded from any key educational processes because of gender, class, race or ability but should be provided an optimal environment for learning. In this regard, inclusion differs both philosophically and institutionally from 'special schooling' that focuses on special treatment for special groups. Though often well-intentioned, such special schooling leads to the social segregation of students. Such a nature of schooling is also against the social model of disability which understands disability to be arising not due to the embodied differences, rather arising from processes of interaction and inaccessible educational institutions (Powell, 2016).

Research studies all over the world have supported inclusion in education through reports of its positive effects on students' academic achievement, basic communication and motor skills (Katz & Mirenda, 2002). Studies have also reported the social benefits of inclusive education for all students, with or without disabilities (Rule, Stefanich, Boody & Peiffer, 2011). These benefits include; increased communication and social interaction opportunities for students, active participation in the school community and individualized education goals for students (Prakash, 2012). There is also a comparative study between students with disabilities (SWD) in inclusive and special settings in the USA that reported no significant differences in the development of language and social behavior of SWD at elementary levels (Lal, 2005). Such studies as the latter can relieve educationists from the anxiety of any disadvantage that SWDs may face in inclusive settings.

The foreword of the United Nations International Children's Emergency Fund (UNICEF, 2003), focused on inclusive education in India, estimates that "70% of children with disabilities, including those with mild mental retardation, can attend regular schools provided the environment is designed to be accessible and the institution is willing to accommodate them".

1.5 Need for inclusion in science education

The constitution of India has acknowledged the significance of promoting science education for all to develop a rational and egalitarian society. Reflection of this acknowledgment is seen in Article 51A (h) of the Indian constitution, which makes it a fundamental duty of every citizen "to develop the scientific temper, humanism and the spirit of inquiry and reform". Education for all and equal opportunity in employment is guaranteed by the Constitution of India. Article 21A: Right to Education (RTE) places responsibility on the State to provide, "free and compulsory education to all children of the age of 6 to 14" (Ministry of Law and Justice, 2009), thus, making education a fundamental right in India. The constitution also gives all its citizens a fundamental Right to Equality through Articles 15 (i) and 25 (ii.b) for social equality and equal access to public areas which includes all schools and colleges maintained by public funds and through Article 16 (i) for equality in matters of public employment.

1.5.1 Possible effects of inclusion

It can be envisaged that putting a thrust on inclusive science education would not only be beneficial to the career of students with diverse cultures and learning needs but also to science education, science and thereby to human society. Inclusion is not merely a philosophy of education; rather it is a philosophy for life Moreover, by bringing new dimensions of cultural and sensory perceptions into science more holistic and lively progress may get boosted in science. To implement inclusion in science education there is a need for research from the initial stage of planning education be it curriculum, infrastructure, training or the social aspects of education. To summarize, it may be stated that inclusion in education can ensure an enlightened citizenry capable of making rational decisions.

1.6 Status of science education for students with visual impairments

In today's world of information explosion, a lack of knowledge of science and technology can prevent active participation in society. Regarding students with visual impairments (SVI), literature indicates that the academic difficulties faced by SVI like, difficulty in skill of tabulation (Kumar et, al., 2000), delayed and egocentric conceptual understanding and a delayed de-contextualization (Biskup, 2011) are a consequence of the in-built structure of science teaching-learning process that has too much reliance on visual mode. While SVI have the same range of cognitive abilities as other students, the excessive dependence on the visual mode for teaching science causes academic problems for them. The vision-based procedures of experimentation and observation followed in science labs and the visual teaching-learning aids used in general schools discourage science learning among SVI. This practice often puts undue pressure on SVIs to opt the subjects other than science despite their high aspirations in science. Also, the provision of the choice of less rigorous subjects for SVI instead of science (like music, painting, home science) by the examination boards (Central Board of Secondary Examination, 2019) gives an excuse to the school authorities for encouraging or even forcing SVI for not opting science. In this way, the system that is intended for the benefit of SVI debars them from a very important area of learning.

Some of the problems faced by SVI have been identified by Kumar, Ramasamy, & Stefanich (2000), and Fraser & Maguvhe (2008) as: lack of confidence; lack of motivation; low expectations; offering of less rigorous subjects instead of science; pessimistic attitude of educators; inflexible curriculum; inflexible assessment standards; excessive use of visual stimuli for conceptual development in science; difficulty in the skill of tabulation; limited access to computers, encyclopedias, sources of reference and relevant publications and lack of special educators in special schools with a science background. Other contributing factors are inaccessibility of equipment and aids for doing and learning science appropriate to the needs of SVI, teachers' lack of awareness of effective pedagogy for teaching science to SVI, general low expectations from SVI and negative attitudes of teachers and other educating agencies towards SVI.

It is therefore quite reasonable to explore a variety of experiences that are useful to SVI as-well-as others for learning and doing science that are not dependent only on visual modes. Experiences that have been found effective for science learning for SVI involve the use of audio and tactile perceptions. When these modes are supplemented to visual modes an effective multi-sensory science teaching-learning and doing for inclusive science classrooms is possible. Also, to increase the accessibility of science for SVI we need to raise expectations from SVI, identify their learning needs/ styles and make adaptations in the education process accordingly.

A live example of the sad state of the science for SVI is the real story of Mr. Kartik Sawhney (SVI) who had to struggle to opt for science in class XI after a denial by the concerned secondary education board. He later secured 95% marks in science in class XII and then studied computer science in a reputed university abroad (Chowdhury, 2013). To emphasize that persons with visual impairments can pursue and do science, Jones & Broadwell (2008) gave examples of scientists with like, William Skawinski (a chemist who had low vision in childhood and lost vision completely after graduation), Larry Hjelmeland (a biochemist who lost vision at age of 35) and Geerat Vermeij (researcher in evolutionary biology who lost vision in early childhood).

1.6.1 Services required for the education of SVI

The services required for the education of SVI under any model of education can be categorized under five main headings namely administrative, curriculum, support services, communication, and external support agencies: All the required services may be further subdivided as:

Administrative: Funding (allowances to SVI and development of inclusive infrastructure/facilities); admission policy (easy admission to SVI in schools); location (regular class, activity class or special section).

Curriculum: Inclusive courses; adapted teaching-learning material (TLM) (with braille/ tactile markings); examination (decision regarding adaptation/ relaxation or common exam); adapted curriculum transaction through the individualized educational program (IEP).

Support services: Transport, braille books, magazines and talking books in libraries; special educators; teacher training and workshops; specialized services for the assessment of educational institution; medical support services; community and parental support; reader and recording services; training to SVI for use of assistive devices like talking computers and optical aids.

Communication: Mass awareness regarding legal provisions and policies for education of SWD; interaction and exchange of educational expertise between institutions; agencies to coordinate, help and monitor the implementation of an inclusive process.

External support agencies: Braille presses and publications; specialized organizations for the development of affordable technologies and teaching-learning material to facilitate learning to SVI; research for identification of areas where visual impairments pose severe learning difficulties and devising suitable strategies and pedagogy for resolving these; job training and placement services. (Natsume & Thamburaj, 2001; Sood, Nada & Nagpal, 2006 and Mukhopadhyay, 2015).

1.6.2 Learning mediation aids/ Assistive devices for SVI

Some of the available learning mediation aids for SVI are:

Informative and representational aids: Braille textbooks; auditory analogs of visualization; tactile diagrams; 3-D models; specimens; audio recordings.

Data recording aids Audio recorders; Braille slate; brailler; stylus; audio labeling device; tactile graph paper.

Laboratory tools: Talking thermometers; talking calculators; talking pH meter; Braille N device for reading outputs of balances; rulers with Braille markings of numbers at specified distances; syringes with tactile marking for measuring out accurate amounts of liquids (as substitute of pipette); light sensor probe; talking BP machines; talking glucometer.

Reading tools: Hand-held magnifier lens; text magnifiers; reading machines; talking machines.

Multimedia aids Smart mobile phones; computers with speech software, interface speech synthesizers, screen readers, screen magnifiers.

Drawing tools: Smooth rubber mat; metallic foil; Sewell line drawing kit; spur wheel; Braille paper; an empty ball pen refill to draw raised (feel-able) lines and diagrams; wiki stick; tactile markers; *techtile drawing board*. (Fraser & Maguvhe, 2008; Hill, 2005 and Taraporevala, Trivedi, Kaul & Sawhney 2013).

1.7 Barriers to inclusion in science education

From the above discussion it is clear that despite legal provisions and policies, inclusive education is not yet a reality. It is important to note that all the barriers to the inclusion of PWD cannot be addressed through the policies alone. Rather what is needed is sensitization towards the loss that the country and society incurs by preventing individuals from harnessing their potential and from contributing their resources. Some of the barriers that have led to the slow implementation of the inclusive process in education have been identified through a literature survey. These are as follows:

1.7.1 Attitudinal barrier

UNESCO (2010), identifies public attitudes as a barrier to equal education of people in India. A common attitude among educators, parents, and peers that ‘they’ cannot study science is the foremost barrier to inclusion in science education. Due to such an attitude among the stakeholders, students from various disability groups suffer from low expectations. The low expectation leads to the creation of a poor self-concept in PWD and prevents them from acquiring science education (Fraser & Maguvhe, 2008).

1.7.2 Lack of accessibility

Policies regarding inclusive education remain ineffective if a student with a disability does not have access to classrooms. The first barrier is posed to a student while getting enrolled in schools. Sometimes, the distant location of the school, lack of transport facilities to reach the school and even the economic condition of the family render the school inaccessible to students. Alack of inclusive infrastructure poses a serious barrier to the process of inclusion in education (Ahmed, 2018). Similarly, many schools do not have proper sign-ages put at the different places of school that are important for SVIs and students with other disabilities. Such inaccessibility is not limited only to classrooms, but also to other school facilities like playgrounds, drinking water area, toilets, library, canteen, office, etc.

Apart from the physical accessibility, school activities like assembly, annual functions, sports day, intra/inter-school competitions, exhibitions, etc. that have been designed without considering the diversity of needs and abilities of students also render the social life of school inaccessible to the SWDs.

1.7.3 Lack of trained teachers

Julka (2012) and Ahmed (2018) mention the often-cited problem of general educators, which is the lack of in-service or pre-service training to address the diverse and specific learning needs of children with disabilities in inclusive classrooms. Due to this lack of training, a teacher, despite a positive attitude and good intentions feels unprepared to educate SWD in his/her classroom.

1.7.4 Curricular barrier

Christine (2008) states that almost no attempts are made to address the exclusive nature of the curriculum, especially the evaluation procedures, which have kept the process of inclusion ineffective for a very long time. In some states of India, the medium of instruction of science at the senior secondary level has formally been declared to be English, which may create a strong cognitive barrier for students from marginalized groups. The need to learn a foreign language to learn science creates an extra cognitive load on students.

1.7.5 Classroom barriers

The World Bank (Peters, 2004) has stated that in India the quality of public secondary education is "alarmingly low". Some factors for this state of affairs are the high teacher-pupil ratio in science and other classrooms, lack of pedagogical research for effective teaching in inclusive settings, lack of inclusive culture and inclusive practices in schools, lack of "knowledge base about various impairments... and how it affects the learning process" (Auluck, 2012) and lack of special co-educators in schools. Gillies & Carrington (2004) point to a dire need to review the attitude, organizational structures, curriculum and pedagogical practices of science education to guide a transformation regarding the inclusion of all children.

1.7.6 Lack of adaptive technology

Students with disabilities generally have a different kind of learning needs, modes of perceptions and preferences, so a modified "access to content materials that are consistent with their learning preferences and needs" (Broderick, Mehta-Parekh, and Reid, 2005) is needed to be used in science classrooms and laboratories. Such modifications may include use of adapted laboratory equipment with tactile markings, providing hearing or speech aids to students, provision of a facilitator to support a student's access, use of audio-recorded texts; Braille, large print materials, tactile marked graphs, models or diagram, peer support, additional time in tests or fewer items or questions to address, multi-modal presentations, etc. But a general survey of Indian classrooms shows a marked shortage of such resources (Taraporevala, et. al., 2013).

1.7.7 Lack of communication among stakeholders

Effective communication among stakeholders regarding the roles they need to play is a must for effective implementation of any endeavor. This is true even for the implementation of inclusive education as per the legal provisions and policies. Many a time a science teacher neither has complete information about needs of SWDs nor has information about whom to approach in case of any help in imparting inclusive services. Due to this, the activities offered by him/her may not be a good match for SWD (Heyne, 2003). Some communication problems like, absence of a single agency or point of contact that addresses the issues of inclusion; lack of accurate information to the implementers regarding their roles and about how the other stakeholders may be helpful to them also deteriorates the inclusive process.

In India, different ministries administer or are in charge of varying services for persons with disabilities. Thus, while inclusive education is the responsibility of the Ministry of Human Resource Development, education in special schools is the responsibility of the Ministry of Social Justice and Empowerment (Sharma & Deppeler, 2005). Finding a balance or co-ordination between the different ministries with the final aim of helping the individual may be difficult, thus becoming a barrier to inclusion.

1.8 Learning strategies in science classrooms for inclusion

1.8.1 Cooperative learning

In any class, one may always find differences in skills, interests and abilities among students and in the senses, they use primarily for learning. Therefore, to make learning effective a teacher must acknowledge such differences when planning pedagogic strategies or learning aids. One such pedagogic strategy is cooperative learning that caters to diversity. It adopts heterogeneity as a principle and incorporates all students including those who were earlier excluded from the regular education scenario. The students through this strategy work together by helping each other and participating in the learning process according to their abilities. No student can sit without participating because each group member has the responsibility for the learning of all material and students must help each other to learn (Sapon-Shevin, 2005).

A vast body of research has demonstrated that cooperative learning strategies in classrooms maximize the learning of students even with regards to those topics that are complex and otherwise difficult to learn. In addition to the academic benefits, there are social educational outcomes of interpersonal relationship skills developed through cooperative learning. A cooperative learning situation develops a feeling of positive interdependence among the learners to reach common goals and the achievement of these common goals involves the promotion of efforts of the fellow group learners (Johnson, Johnson & Smith, 2007).

Deutsch (2006) describes the psychological processes that are involved during the positive interdependence through cooperation as:

- *Substitutability*: The acceptance of the activities of the other group mates to fulfill one’s own needs.
- *Positive attitudes:* The evaluation of responses of self and others as favorable, with a belief that “we are for each other, we benefit one another” (Deutsch, 2006).
- *Inducibility*: The readiness for getting influenced by others or for influencing the other group members.

Sharma & Chunawala (2015 and 2016) report on contexts of cooperative learning through diagrams and models which were successful in evoking higher-order questions from students and were effective for SVIs to draw and learn through diagrams.

1.8.2 Visualization

Visualization involves a series of mental processes that occur in the visual cortex and parietal lobe of the brain through inputs from the environment and memory (Trojano, Grossi, Linden, Formisano, Hacker, Zanella, Goebel & Di Salle, 2000). According to Vavra, Watrich, Loerke, Phillips, Norris & Macnab (2011) visualization can be differentiated into -

- *Visualization objects:* physical objects of representation like models, pictures, diagrams, geometrical illustrations, animations, videos.

- *Introspective visualizations:* mental pictures other terms are: mental representation, mental imagery, mental construction, mental scheme.
- *Interpretive visualizations:* cognitive processes involving the interpretation of both the above, mental manipulation and transformation of objects or representations and transfer from concrete mode to an abstract mode of thinking.

Several studies have considered science as a special subject that requires a great deal of visualization (Gilbert, 2005; Jones & Brodwell, 2008; Ramadas, 2009) for enhanced learning and understanding. Emphasizing visualizing experiences in science, the dual coding theory (Clark & Paivio, 1991) prefers an 'additive effect of imagery and verbal codes' over 'verbal codes alone' for the promotion of better learning experiences. Tversky (2001) promotes the use of visualization objects in science for easy access, integration, and operation of information. Vavra et al. (2011) report that the imagination of extremely abstract concepts, like that of subatomic particles, can be successfully facilitated by scientific visualizations.

1.8.2.1 Visualization and visual impairment

It has been contested whether visualization is done by persons with visual impairments. Research has indicated that parts of visual cortex in persons with congenital visual impairments get activated while doing activities that involve inputs through tactile form of perception (Sadato, Pascal-Leon, Grafman, Ibanez, Deiber, Dold & Hallet, 1996) and even during braille reading by persons with no vision (Zangaladze, Epstein, Grafton & Sathian, 1999). More recent research has acknowledged that it is possible to have visual imagery in the absence of visual experience (B’ertolo, 2005).

On the contrary, some studies suggest that vision impairment harms the visualization abilities of persons with visual impairments. For example, Cornoldi, Bertuccelli, Rocchi, & Sbrana (1993) report that limitations arise for persons with no vision due to higher cognitive load in complex tasks such as, matrices of 3-D objects which could be due to the spatial experiences being limited in range. Two studies by Papadopoulos & Koustriava (2011, 2011a) report an adverse influence of loss of vision on tasks that require visualization for spatial coding and spatial representation. Such studies may have contributed to low expectations from students with visual impairments (SVI) which is reflected in the less rigorous mathematics and science curriculum that is offered to SVI at the secondary level (XRCVC, 2013).

1.8.2.2 Disadvantages faced by SVI due to emphasis on the visual mode of teaching science

However, SVI are often at a disadvantage while learning science and technology as the visual mode is given a lot of importance during teaching (Kumar, Ramaswami & Stefanich, 2001; Fraser & Maguvhe, 2008; Jones, Minogue, Oppewal, Cook & Broadwell, 2006). Often diagrams that can be a useful resource in teaching-learning become problematic as their use lacks any reference to the considerations of cognition, history and philosophy (Ramadas, 2009, p. 302). Also, such excessive reliance on a single mode of perception is despite the fact that to communicate science, the visualization experiences are available through more than one mode (vision) of perception. (Figueiras & Arcavi, 2012). The process of visualization is cognitive and can be aided by explanatory verbal descriptions, tactile and other representations (Heller, 2002).

The situation is complicated as optional subjects/topics are offered to SVI to reduce the so-called 'cognitive load' on them. Thus, SVI find it difficult to pursue subjects of their interest and their aspirations to get into careers of science are restrained (Sharma & Chunawala, 2013a). This situation deprives the science of gaining insights and expertise from a diverse group of people with different abilities and forms of perceptions.

1.8.3 Multimodal communication

Kress, Jewitt, Ogborn & Tsatsarelis (2001) propose to look at science learning as a dynamic process that involves transformative sign-making. This view prioritizes multimodal communication through different combinations of speech, writing, gestures, actions, visual images, spatial arrangements and concrete materials. The idea is that the complete meaning of an event is not communicated through a single-mode alone. On the other hand, different meanings are conveyed through different modes. Therefore a 'combined effect of the orchestration of the modes' is essential and hence a need for multimodal communication.

Kress et al. (2001) give a detailed analysis of the learning procedure that takes place in a multimodal science class where a teacher uses different modes to develop the concept of 'blood circulation'. In this class, the teacher uses verbal narratives and gestures to shift from action on the body to a model and then to a diagram for creating a 'visual continuum of the different depths' of information. The final level of abstraction of the class reached a level of representation of human blood circulation as an image in the textbook.

Jewitt, Bezemer, & O'Halloran (2016) advocate multimodal communication for recognizing the differences between different semiotic resources and the use of their combinations for making effective meaning-making. In an inclusive class, such a process of meaning-making becomes much more useful because of its inherent scope of the multi-sensory engagement. Through the use of multiple modes, students get more chances of making meaningful learning through their preferred senses.

1.8.4 Multiple representations

A closely linked, sometimes integrated and yet different concept to multimodal communication is the concept of multiple representations. Multimodal communication involves meaning-making by learners by integrating the different components of the representation (Tang, Delgado & Moje, 2014) whereas, multiple representations refer to multiple ways to symbolize or refer to some entity. Representations whether verbal or non-verbal; are manipulably leading to the transformation of experience. They help us understand, reason with and communicate science concepts. The use of multiple representations in teaching and assessing has been strongly recommended by various researchers. External representation through verbal explanations, drawings, specimens, photographs, diagrams and physical models is common in teaching and learning of science.

1.8.5 Students' drawings

According to Mathai & Ramadas (2009), textbooks require a larger variety of visuals ranging from depictive pictures to sketches and schematic drawings. However, what is equally important is to get students themselves to draw diagrams to represent their learning, but such engagement is often limited in schools (Ramadas, 2009). For Anning (1997) and Tversky (2002), sketch drawings are thinking tools that not only serve to communicate an idea to self but also to initiate new ideas and discoveries. Ainsworth, Prain, & Tytler, (2011) suggest that students should be asked to draw when learning complex science concepts as drawing is both motivating and help to make students' understanding explicit. Besides, drawings as external representations can help in assessing learning (Pittman, 1999 and Rapp & Kurby, 2008).

Drawing is one of the strategies that have been used in this study to provide an opportunity for students to represent their conceptual understanding. Drawings in science education tend to be an underutilized resource not only for SVI but also for students with vision. However, in education, one must also focus on the limitations of using drawings when children differ in their drawing abilities. How do students with visual impairments (SVI) depict their ideas through drawings? In the absence of visual cues, drawing is challenging, and tactile/haptic cues are dependent upon. This particular study explores the challenges that are encountered by SVI when dealing with a situation that requires them to draw or to deal with diagrams.

1.8.5.1 Drawings and students with visual impairments (SVI)

The National Curriculum Framework (National Council of Educational Research and Training (NCERT), 2005) has emphasized the importance of visuals and visualization for students' learning. But the excessive reliance on the visual mode in teaching science and science demonstrations leaves limited scope to use other kinds of learning experiences such as the haptic mode and other senses (Figueiras & Arcavi, 2012), putting SVI at a disadvantage in learning science (Kumar, Ramasamy & Stefanich, 2001; Fraser & Maguvhe 2008).

Another problem that plagues SVI is the lack of drawings and diagrams in the Braille textbooks (Vibhute, 2014), which have '*nothing but pages and pages of boring Braille dots'* (United Nations International Children's Emergency Fund, 2000). Thus the experience of SVI with drawings and diagrams in the context of science tends to be limited. Studies on the use of diagrams for SVI in the learning of science have reported their effectiveness (Stoffers, 2011). Hill (1995) reports on the use of raised line diagrams with SVI to give nearly full access to diagrammatic aspects of science and raise the quality of science education. The haptic perception through raised lines and the visual perception through the use of colors give full opportunity for visualization to students with and without vision. Jubran (2012) reports the use of adapted diagrams for learners with sensory disabilities. These studies suggest that science learning of SVI can be facilitated through the use of diagrams.

Chapter 2: Research Design

2.1 About the ideology and study

Looking towards the broad vision of a society that aims to include all, it is pertinent that efforts must be made towards the development of such a system of education that endeavors towards the inclusion of all the marginalized/deprived groups. But since the scope of an all-inclusive education is extremely large to be addressed through one single research, this study has focused on the inclusion of the largest group of marginalized people, that is, the group of PWD, in education. The study makes efforts to understand the status of inclusion of SWD regarding education in general and science education in particular, in the Indian context. It scrutinizes the need for inclusive science education for SWD through literature and field surveys and tries to ascertain the views of teachers, parents, and peers regarding inclusion in education.

The next phase of the study narrows its focus to science education for SVI. Based on the learning from literature and field surveys some strategies for science teaching were developed and tested with SVI's and sighted students. These survey reports and experiences from the science teaching strategies form the basis of research findings and contributions of this study.

2.1.1 Ethical considerations

Prior permission was obtained from the heads of institutions where the study/studies were conducted. Clear instructions were given to the participants regarding the requirements of the study and the confidentiality of the participants. Care was taken not to disclose the identity of the participants at any stage.

2.2 Research objectives and questions

Objectives

The study endeavors to study; the status of inclusion in science education through secondary data and classroom observations, aspirations of children with disabilities in science, views of teachers, parents and students regarding the inclusion of SWD in education; and develop strategies for teaching science to SVI.

Research Questions

1. What aspirations do children with disabilities have for science education and careers?

2. What are the views of teachers, students and parents regarding the inclusion of students with disabilities in education?
3. What strategies are effective for teaching science to students with visual impairment at school?

   3a. What role can drawings play in communicating science to students with visual impairments?

2.3 Methodology

The study used the 'Mixed model research design', which mixes qualitative and quantitative approaches 'within or across the stages of the research process' to find answers to research questions. The specific sub-type of the design used is 'within-stage mixed-model' because the quantitative and qualitative approaches were mixed at only one stage of research (Creswell & Clark, 2011). Methods used for each research question have been tabulated in table 4.

Table 4: Methods used for different research questions (RQ)

RQ	Methodology	Nature of sample	Method of analysis
1	Survey through questionnaire and interviews	Purposive sampling of SWD from 6 different schools	Thematic analysis of responses
2	Survey through 5 point Likert scale on attitudes	Convenience sampling of 97 teachers, 166 parents and 521 students from 10 different schools	Mean responses; t-tests for differences in demographic variables
	semi-structured interviews	Snowball sampling of 6 teachers, 5 students and 4 parents	Thematic coding of audio recorded responses
3	Facilitation by the researcher for cooperative learning among students	Purposive sampling of 20 students from 1 inclusive school	Analysis of written responses of students and record of their performances on tasks
	Facilitation by the researcher for cooperative learning among students	Purposive sampling of 18 students from 1 inclusive school	Analysis of written responses and drawings of students and record of their performances on tasks
	Facilitation by the researcher for cooperative learning among students	Purposive sampling of 5 students from inclusive settings and 5 students from a special school for SVI	Analysis of video-recorded activities and drawings made by students

2.4 Overview and structure of the thesis

This thesis reports the development of inclusive education movement and status of inclusion in science education through literature survey; the aspirations of children with disabilities in science through a survey and the level of social acceptance of inclusion in science education among teachers, parents and students through qualitative and quantitative analysis of a survey. It also reports the strategies of teaching science to children with visual impairments that are being used by educators and those developed by the researcher of this study.

The thesis has been presented in 6 chapters. Chapter 1 presents an introduction to the status of education of students with visual impairments (SVI) and the difficulties faced by them in science, and what lead to the initiation of this research. A literature review has been presented to understand the important aspects related to the study such as, the process that has given momentum to inclusive education as well as the status of inclusion in science education.

Chapter 2 presents an overview of the research and specifies the research objectives and research questions that have been sought to be answered in this study. Chapters 3 and 4 present survey studies on aspirations of students with disabilities and that of the attitudes of teachers, students and parents towards inclusive education. These studies present the need for inclusive science education and the social acceptance of inclusive education. Chapter 5 presents three studies aimed at identifying strategies to make science education effective for SVI.

Chapter 6 presents a summary of the answers to research questions as obtained through the various studies and the findings of this research. The limitations of this study, the theoretical as well as methodological contributions of this research are also included here. The chapter makes recommendations for stakeholders and future researchers. This last chapter ends with a personal postscript that presents the growth of the researcher while involved in this research.

Chapter 3: The aspirations of students with disabilities in science

The literature survey reports that only a few students with disabilities are studying in institutions of higher education. So, what can be the reason for this sorry status of higher education for such a large section of the population. Can the reason behind this poor status be the present state of education which does not fit into the aspirations of students with disabilities and thus provides unequal '**conditions for success'?** To explore this question an attempt was made to study the aspirations of SWD with regards to science.

Regarding aspirations for studying science, the India Science Report (Shukla, 2005) reports that 60% of students of classes sixth to eight in India aspire to study science in higher education. In a comparative study, Bevins, Brodie & Brodie (2005) report a contrast between a large number of school students of developing countries who give high value to the careers that involve science and the smaller number of their counterparts from industrialized countries having aspirations to become scientists or technologists. Thus we were eager to know what aspirations do SWD has for studying science.

3.1 Objectives of the survey

The study explores the aspirations of SWD concerning science, their perceptions of science; science education and inclusion in science education. To fulfill this objective a survey was conducted with the help of a questionnaire having the following sub-questions:

How do SWD perceive science?, Do the careers that SWD wish to pursue involve science and within science what careers do SWD prefer to pursue?, What do SWD expect to learn in science?, What difficulties do SWD face in learning science?, What changes would SWD suggest in science education?, What are the attitudes of SWD towards inclusion in science?

3.2 Methodology

3.2.1 Sample

30 students from 6 schools were selected through purposive sampling to participate in the study. Among the participants 3 students were from a government senior secondary school for girls, 11 were from two government senior secondary schools for boys, 12 students were from an inclusive school, and 4 students were from 2 special schools for SVI. The characteristics of the sample have been tabulated in table 5.

Table 5. The sample for aspiration questionnaire

Code of school	Gender	No. of students in class & Age	Types of disabilities
1. Government senior secondary school for girls	3 Girls	(3) Class 6, (11, 12 & 14 yrs)	1 Visual disability 1 Orthopedic disability 1 Learning disability
2. Government senior secondary schools for boys (2 schools)	11 Boys	(9) Class 6 (11 to 15 yrs) (2) Class 10 (18 yrs)	4 Learning disability 1 Cognitive disability 1 Dwarfism 1 Cerebral palsy 3 Orthopedic disability 1 Visual disability
3. Inclusive school	7 Boys	(7) Class 6, 11, 12, 14 to 17 yrs	4 Orthopedic disability 2 Multiple disabilities 1 Visual disability
	5 Girls	(5) Class 6, 13 to 15 yrs	3 Orthopedic disability 1 Hearing disability 1 Hearing & speech disabilities
4. Special schools for SVI (2 schools)	4 Boys	(3) Class 6, 15 to 17 yrs (1) Class 10, 16 yrs	4 Visual disability

3.2.2 Tools used

To explore the aspirations of students with disabilities in science, a questionnaire was developed in dual languages: English and Hindi, based on the 6 questions mentioned in 3.1. A pilot study was also done with 6 SWDs based on which the questionnaire was modified. None of the sample students had responded to the questionnaire during the pilot study. The content validation of the questionnaire was done by three subject experts and one language expert.

3.2.3 Tool administration

The modified final questionnaire was administered to 30 SWD by the researcher in their schools' premises. For the students with disabilities other than visual impairments, the questionnaire was administered in groups. For the SVI the questionnaire was administered in the form of structured interviews. One SVI was interviewed at a time and the responses were written by the researcher and were also audio recorded. A thematic analysis of responses of students on the questionnaire was done. Following are exemplary questions asked in the final questionnaire:

Fig 1. Some questions from the questionnaire on students' aspirations in science

6. Among the following what qualities are required to achieve a good understanding of science? Tick √ at the required qualities.

Good memory	Repeated drill and practice
Categorization	Analysis
Experimentation	Observation
Truthfulness	Discipline
Patience	Good knowledge of English
Good understanding of content	

7. What difficulties do you face while learning science?______________________________

3.3 Results and analysis

What is science?

To elicit the students' perceptions regarding science the open-ended question; ***According to you what is science?*** was asked. The responses of more than half of the students (17) could be grouped under the category of science as an *accumulated and systematized body of knowledge*. The responses of six students came under the category of *science as a creator of technological products*, whereas the response of 3 students fell in the category, *science as a scientific method of investigation*. For the student with Dwarfism, science was a *transcendental experience*, while a girl with orthopedic disability from a government school for girls felt that science is something *entertaining.* According to a boy with multiple disabilities from the inclusive school, science was *magic*, while for a boy with a learning disability, science is a *very good thing*, while another boy with a learning disability from the same school equated science with a *textbook.*

It is to be noted that none of the students, remarked about indigenous science. This might be an effect of the westernized science education and as suggested by Hodson (1993, p.86), "the implicit curriculum message is that the only science is Western science".

Science as a school subject

Through a closed-ended question, most of the students (28/30) stated that science was "very important" or "important". Thus, students with disabilities, like other students in India have a positive image of science (Chunawala and Ladage, 1998). Only 2 boys from an inclusive school, one who had an orthopedic disability and another with multiple disabilities felt that science is "absolutely unimportant". It is interesting that regarding "what is science?" one of these students had reported that science is a creator of technological products, while the other had perceived science as magic.

The majority of the students (28/30) also felt that science is “very interesting” or “interesting”, while only one student from a government school for boys who had a cognitive disability found science “boring”. Regarding the utility of science too, most students (26/30) reported that science is “very useful” or “useful”. Two students from an inclusive school (a boy with multiple disabilities and a girl with hearing and speech disabilities) reported it to be “somewhat useful”, a student from government school for boys who had cognitive disability said science is “useless”, while another girl student from an inclusive school who had orthopedic disability reported science to be “absolutely useless”. Regarding students’ perception of the difficulty of science, half of the students (16/30) reported that science is “very easy” or “easy”, 5 students found science to be “somewhat easy”, while 9 students (30%) found science as a subject to be “difficult” or “very difficult”.

Effect of science on students' lives

Of the 30 students, 13 (43%) students said that *science makes life easier,* 7 students (23%) felt that science *promotes learning experiences* whereas 2 students felt that it was an *agent of chang*e. According to 2 students, science *takes care of health* while one boy from a special school who had visual impairment felt that it *pollutes the environment*. According to a female student from the inclusive school who had an orthopedic disability, science helps to *develop healthy eating habits*, whereas a girl from the same school with hearing impairment remarked that science does not affect our lives. Another girl from government school for girls who had visual impairment stated that she was unable to answer this question, while a girl from an inclusive school, who had hearing and speech impairment did not respond to the question. Thus, overall a majority of students mentioned positive effects of science on our lives.

Preferred Career/Job/Profession

To the question regarding what course of higher education would the students opt for, half of the students (16/30) stated that they wished to pursue science, 10 wished to pursue arts (which refers to humanities in the Indian context), 2 wished to pursue commerce, 2 wished to pursue computer courses, while 1 wished to pursue a course of designing. Interestingly all the 4 students from the special school for students with visual impairments wished to study languages (2 Hindi and 2 English) and one among them wished to pursue English, Political science, History and Science courses together.

The job most preferred by SWD was that of the teacher (9/30) and interestingly of these 5 were girls. The next preferred jobs were that of a doctor (6 students), engineer (2 students), any government job (2 students), IAS (Indian Administrative Services) officer (2 students and both were from special school) and cricketer (2 students and both had orthopedic disabilities). When asked what career would they undertake if they were good in science, again the most preferred job was that of a teacher (9/30), scientist (7), doctor (6), engineer (4). The other responses were by individuals, army personnel, policeman or doctor, work in a mobile shop, government job and musician. Since the academic performance results are not correlated by the researcher to the choices, one can say that the job preferences and courses of study are similar to that which would be made by any student.

Learning expectations from science

When asked “what would you like to learn in science?”, some of the students' (9 students) learning expectations were directly related to the *knowledge domain.* For example, knowledge of discoveries and discoverers, questions and answers to science, easy knowledge, becoming a doctor, knowledge of solar system & making machines, knowledge about nutrition and technological things, etc. Some expectations were related to the *processes of science* (18 students). These were, making drawings and pictures, doing practicals in the laboratory, doing projects, scientific procedures, doing experiments, activities, inventing and discovering things, learning to become good human beings and assistants of scientists. Some students (3) said that they expected to learn some *general areas of education* from science like spellings; understanding, reading, and writing.

Suggestions for science education

Some suggestions given by students to make science education were quite interesting. Some of these suggestions have been presented in the following figure.

Fig 2. How can science education be made interesting? Some students suggestions

make the study of science like a game *make reading interesting* *make science understandable* *study with concentration* *tell jokes* *read and write correctly* *do activities* *understand and obeying science* *read write and sit silently*	*do understandable tasks* *through enjoyment and concentration* *pay attention to the teacher's words* *supplement theory with practicals* *do experiments* *tell stories along with serious subject matter* *make use of technologies and miracles of science* *understand science and do experiments* *know about changing world and diagrams*

An important expectation/suggestion put forward by three SWD is concerning the learning of drawings and diagrams in science to make learning science more interesting and effective. Raised line diagrams have been suggested by Carney, Engbretson, Scammell and Sheppard (2003) for teaching science to SVI. Conducting experiments, doing activities, practicals and projects were mentioned by 18 (60%) of the students as their expectation or suggestions for science education, suggesting the importance of the same for them.

Attitude towards teaching science to SWD

Most of the students (26/30) had a positive attitude towards the inclusion of SWD in science. Some of the reasons given were as follows:

> *Science has a specialty... science is made for disabled students* (Male student from government school with dwarfness)
>
> *If God has snatched the vision then... we can do so much... even... if not a scientist... we can do something in the future.* (Male student from a special school with a visual disability)

However, four boys from government school (two with a learning disability, one with an orthopedic disability and one with a visual disability) stated that science should not be taught to those with disabilities (the reason being the difficulties in learning science as perceived by these students).

Difficulties faced in science

The students were asked what difficulties they faced in learning science; the difficulties of all students while learning science and those specifically of SWD.

Table 6. Number of SWD reporting difficulties in science on the aspiration questionnaire

	What difficulties do ***you*** face while learning science?	What difficulties do ***all*** students face while learning science?	What specific difficulties are faced by ***SWD*** while learning science?
Understanding science	3	10	6
Sensory and cognitive difficulties	4	7	14
Reading and writing	8	4	4
Memorizing	4	1	
Answering questions of science	3	1	
Lack of concentration	1	1	
Drawing & visualizing diagrams	2		2
Revision	1		
Doing practicals	1		
Lack of laboratory facility	1		
Lack of understanding of English	1		
Difficult words		4	
Irrelevant curriculum & lack of textbooks		1	
Disturbance due to treatment			1
Activities that need locomotion or sitting			4
Responding through speech			3
Do not face any difficulty	10	2	3
Unrelated response	1	2	3

The comparative table 6 shows that SWD have different view on the difficulties faced in learning science when asked about their difficulties, as compared to the difficulties of all students and specific difficulties faced by SWD in learning science. A large number of students from the inclusive school (8/10) responded that they do not face difficulties in learning science indicating a better science delivery program in inclusive settings. It is also clear from the above responses that the spectrum of difficulties faced by SWD is large. As reported by the sample of SWD and the difficulties arising due to lack of understanding science, sensory disabilities and lack of reading writing skills act as hindrances to a large number of SWD.

3.4 Findings

An important finding regarding the question 'How do students with disabilities (SWD) perceive science?' is that a majority of SWD have positive attitudes towards science, perceive it as important, interesting and useful and 8 of the 12 students from the inclusive school responded that they did not face difficulties in learning science indicating possibly better science education facilities for SWD there. The commonly held views by SWD about the nature of science, which were not very different from any other child's views, are that "science is an accumulated and systematized body of knowledge" and "science is a creator of technological products". Also, science was the most preferred subject for SWD for higher education (16/30) which is comparable to the 60% of general students at class six to eight level in the India Science Report (Shukla, 2005), who wanted to pursue some science course at a higher level of education.

Similarly, the responses to the question, about careers that SWD wishes to pursue suggests that science is a valued subject as is demonstrated by SWD through their preference of science-related jobs such as, medical doctors, engineers and scientists. This finding is in accordance with Bevins, Brodie & Brodie (2005). SWD showed interest in a vast spectrum of interesting areas of science that they wished to explore and learn. Interestingly, the number of students who wished to learn the processes of science is almost double to those students wanting to learn different areas of knowledge in science.

3.5 Implications

This study presents a contrasting picture of the low expectations of the stakeholders of education regarding science education for SWD (Sacks, Kekelis & Robert, 1992) and the high aspirations of SWD in science. This also represents the gap between the high aspirations of SWD in science and the meager status of enrolment of SWD in science courses for higher education and in turn in the jobs requiring science backgrounds. The interesting finding that more students from inclusive settings do not face difficulties in science indicates better science education conditions in inclusive settings. It is important to note that the process of inclusion is not only beneficial to students from diverse abilities and disabilities, but it would also be beneficial to science education as a whole. To bring about meaningful progress in science education we need to promote inclusion by incorporating the diverse abilities, backgrounds and experiences of students in classrooms.

Chapter 4: Attitudes of teachers, students and parents towards inclusion of SWD

From the above sections, it is clear that SWD do have high aspirations in science. But an important issue is the response of other stakeholders in education to the inclusion of SWD in schools and classrooms. While one may say that often acceptance is only verbal and not demonstrated in behavior, we were interested in learning what is said by stakeholders. Under the framework of the 'Theory of Planned Behavior' (Ajzen, 1991), the statements of attitude scale lie in the 'affective' dimension of attitude which may be related closely with actual behaviors or the intentions of behavior of the concerned person (Favazza, Phillipsen, & Kumar, 2000 and Eagly & Chaiken, 2007). It has been noted in our literature survey that attitudes of various stakeholders affect the process of inclusion and are an important factor in regulating the success of inclusion in education.

4.1 Objectives of the study

The study explores the attitudes of teachers, peers and parents to find their views on inclusion in education. The following sub-questions were explored:

1) What are the attitudes of teachers, parents and students towards the inclusion of SWD in education?
2) What factors affect these attitudes?
3) What are the differences in attitudes among teachers; parents and students towards inclusion?

4.2 Methodology

4.2.1 Tools used

4.2.1.1 ATIEIS Survey

The 'Attitude Towards Inclusive Education Scale' (ATIES) developed by Wilczenski (1992) was adapted to develop a 22 statements survey tool, named Attitude Towards Inclusive Education in India Scale (ATIEIS). The scale was piloted twice and the modifications were made after each pilot. The modified scale was validated by 3 education experts and one special educator. The final scale was developed in English and translated to Hindi (national language), and validated by 2 language experts. The test-retest reliability calculated through Karl Pearson's coefficient of correlation was 0.70. This test-retest was conducted with 14 students, 10 parents and 6 teachers after a gap of 21 days. A glimpse of the scale may be viewed from some of the questions shared in Fig 3.

Fig 3. Some questions from ATIEIS questionnaire

Attitude Towards Inclusive Education in India Scale
A regular class means a general class that is taught by general teachers. Of the following, who do you think should be in a regular class? Please rank your opinion on the scale of 1 to 5 in each of the following cases **Scale (1: Strongly disagree, 2: Disagree, 3: Somewhat disagree, 4: Agree, 5: Strongly agree)** 15. ___ With appropriate support all students with disabilities should be in regular classes. 16. ___ Students who physically harm other students in school should not be in regular classes. 17. ___ Students with disabilities may make classroom teaching and learning stressful. 18. ___ In a regular class with students with disabilities, the academic achievement of other students may get badly affected.

4.2.1.2 Interview

Semi-structured interviews with 6 teachers, 4 parents and 5 students were conducted to gain a better understanding of our attitudinal data collected through the written mode. The written responses when coupled with the interviews provided an additional dimension on inclusion in classrooms. In the interviews, we requested the interviewees to share their educational backgrounds, knowledge about inclusion, experiences with SWD and asked a few probing questions along with the ATIEIS scale to ensure the discourse was rich with personal stories and reflections. The interview analysis was loosely based on thematic coding done by two interviewers independently.

4.2.2 Sample

4.2.2.1 Sample for ATIEIS

Our sampling attempted to achieve a mix of teachers, students and parents from government schools, private schools, special schools and non-government aided schools from Delhi, India. The ATIEIS was administered to teachers, parents and students from 10 different schools in Delhi. The sample was also categorized in terms of gender, the experience of teaching SWD, and exposure to disability (self, family or acquaintance).

Table 7. Summary of the sample for ATIEIS

Type of school	Number of schools	Category of school	No. of teachers	No. of parents	No. of students
Govt. school	6	General	83	114	396
Aided school for students with visual disabilities	2	Special	5	-	39
Aided school run by trust	1	Inclusive	1	13	50
Private school	1	General	8	39	36
Total	**10**	**7 general, 2 special, 1 inclusive**	**97**	**166**	**521**

Table 8. Particulars of sample for ATIEIS

<table>
<tr><th colspan="4">Teachers</th></tr>
<tr><td>Gender</td><td colspan="2">35 females</td><td>62 males</td></tr>
<tr><td>Experience of teaching SWD</td><td colspan="2">32 with experience</td><td>65 with no experience</td></tr>
<tr><td>Teachers with a disability or having exposure to a disabled person in family or friend circle</td><td colspan="2">30 with disability or exposure</td><td>67 without disability and exposure</td></tr>
<tr><th colspan="4">Parents</th></tr>
<tr><td>Gender (Out of 166 parents 14 did not inform about the gender)</td><td colspan="2">50 females</td><td>102 males</td></tr>
<tr><td>Parents with a disability or having exposure to a disabled person within their family or friend circle or both</td><td colspan="2">29 with disability or exposure</td><td>132 without disability and exposure</td></tr>
<tr><th colspan="4">Students</th></tr>
<tr><td>Gender</td><td colspan="2">206 girls</td><td>315 boys</td></tr>
<tr><td>Type of school</td><td>39 from special schools</td><td>30 from inclusive school</td><td>452 from general schools</td></tr>
<tr><td>Disabilities</td><td colspan="2">67 with disabilities</td><td>454 without disabilities</td></tr>
<tr><td>Students who had disability or exposure to a disabled person within their family or friend circle or both</td><td colspan="2">324 with a disability and/ or exposure</td><td>197 with neither disability nor exposure</td></tr>
</table>

4.2.2.2 Sample for interviews

The interview sample although small was purposeful. Two of the interviewed teachers were from special schools in Mumbai and 4 were from regular schools in Delhi. Though the teachers were from 2 cities in different states/geographical parts of India, these cities are similar in terms of population, living standard and urban cultural context. All the parents and students were from Delhi. In the case of teachers, we partly followed snowball sampling with the participants recommending other participants whereas in the case of parents and students the convenience sampling was done. The exposure of interviewees to the type of disability varied.

Table 9. Summary of sample of students, parents and teachers for interviews

	Codes	Gender	Age/ Teaching experience	Type of school	Exposure to disability
Students	St1	Girl	11	General	Yes
	St2	Boy	13	General	No
	St3	Boy	12	General	Yes
	St4	Boy	15	General	Has cerebral palsy
	St5	Boy	14	General	Yes
Parents	P1	Female	37	General	Yes
	P2	Female	39	General	Yes
	P3	Male	42	General	Yes
	P4	Female	35	General	Yes
Teachers	A1	Female	50/ 4 years	Aided school for SVI (classes I to VII)	Yes
	A2	Female	38/ 13 years	Govt. General	Yes
	S1	Female	60/ 30 years	Inclusive school	Yes
	G	Male	59/ 22 years	Govt. General	Has locomotor disability
	S2	Male	50/ 25 years	Govt. General	No
	H	Male	30/ 8 years	Govt. General	Yes

4.3 Results and analysis

4.3.1 Quantitative results

The questions asked in the interviews and the 22 statements used in the ATIEIS were related to attitudes towards the inclusion of students. The 3 categories and the statements of ATIEIS in each category are listed below.

1. Attitude towards inclusion of students with general non-acceptable behavior: (statements 1, 3, 4, 6, 9, 12, 13, 14, 16).
2. Attitude towards inclusion of SWD in classroom: (statements 2, 5, 7, 8, 10, 11, 15).
3. Perceived effects of inclusion of SWD in classroom: (statements 17, 18, 19, 20, 21, 22).

We calculated the mean scores for each ATIEIS statement. Mean scores between 1 and 3 on ATIEIS were considered to indicate a negative attitude while those above 3 indicated a positive attitude to inclusion. While calculating the mean score, responses to negative statements were converted to positive (disagreeing to a negative sentence is positive). T-tests were conducted to find the significance of differences in mean scores (at 95% confidence level) among teachers, parents and students also across their demographic variables. The critical t-values (2 tail) against which the t-test scores were compared are: Parents- Parents: 1.977; Teachers- Teachers: 1.985; Parents-Teachers: 1.969; Parents- Students: 1.963; Students- Students: 1.964; Students (from inclusive school)- Students (from special school): 1.996. The null hypothesis was rejected in case the test static exceeded the critical t value. The mean scores have been appended in tables 12, 13, 14 and 15 in Appendix 1.

4.3.2 Qualitative results

Semi-structured interviews of teachers, students and parents gave a closer view of their perceptions and attitudes about inclusion by engaging with their lived stories. Also, the triangulation provided a lens for the exploration of attitudes that led to the emergence of broad themes.

Themes from teachers' interviews

<u>Variation with the type of disability</u>: As compared to an orthopaedic disability, teachers with no experience with SWD had more negative attitudes towards the inclusion of visual and hearing disability students. A common remark was about “chaos” in the class when there are students with visual and/or hearing impairments. A teacher commented,

> *... such children who are unable to hear or speak can learn only through behavioral techniques. I do not feel that he/she will be able to learn more than this.* (Teacher D)

<u>Technology in the inclusive classroom</u>: Teachers who had the experience of teaching SWD felt that they could teach the same curricula to all students, including all types of SWD students, by simple instructional alterations achieved through technological support. According to these teachers, the curricula could be homogeneous, but the instructional mode should involve flexibility in inclusive classrooms. One teacher expressed,

> *...sometimes I used audiotapes, sometimes I used Braille* (Teacher B)

Another teacher with experience of teaching SWD insisted on making the aid devices readily available to all students in the classroom.

> *Whenever I had students with hearing disabilities in my class, I made sure to provide the information about hearing aids to SWD as well as to other students. I have also suggested other children to experience the tool so that they are mentally prepared about what kind of help they can offer to SWD, so it naturally takes away the stigma associated with such aids/devices.* (Teacher C)

<u>Concerns about the adequacy of inclusive education training</u>: In our interviews, we heard a common concern from the experienced participants about the inadequacy of training programs for novice teachers. Some expressed their worry about superficial coverage for inclusion related topics in the present teacher training courses; others expressed uncertainty regarding the effectiveness of short training courses.

> *All teachers are interested (in inclusion), it is just that getting sufficient knowledge about it is very important. In B.Ed. (Bachelor of Education) or D.Ed. (Diploma in Education) programs, there is no course of inclusion kind and so there is no possibility of knowledge about inclusion.* (Teacher B)

Themes from students' interviews

Inclusion is beneficial for all: Students perceived inclusion of SWD in their classes as beneficial to all students, although the reasons differed from student-to-student. According to Student 4 who is a SWD, he gets regular support from his peers which is always helpful.

> *Sir, they (peers) support us in our tasks, help us in doing our studies and also inform about the school activities.* (Student 4)

The reasons stated by other students regarding why they supported inclusion ranged from happiness gained by helping someone; the possibility of learning new scripts and languages used by SWD and getting benefits of being a close friend of a SWD.

> *It would be beneficial as we will be able to help him (SWD). We will get the benefit as when he will tell us his feelings then we too will feel good. We shall feel even better if he becomes our friend… I would like to know the sign language of those whose talks cannot be understood by me. I would enjoy that a lot.* (Student 1)

Varying attitude due to type of disability: Similar to teachers, students were also negative towards the inclusion of students with sensory and speech disabilities despite being positive for inclusion in general. The response of students on the interview revealed that the reasons behind such conditional attitude were their lack of knowledge of the abilities of SWD.

> *I would not like to sit with a student with a hearing disability because we would not be able to talk to them. Even if we talk to them, they would not be able to reply... They (teachers) would not be able to explain to them and if a teacher asks questions, then they (SWD) will not be able to explain the answer. Also, they would not be able to note the work written on the blackboard.* (Student 2)

Delinquency: The interviews of students revealed the reasons for their negative attitude towards those students who show delinquent behavior. According to them, delinquents were themselves not good in studies and then they bothered others through physical or verbal means.

> *I avoid those students who physically harm other children, are also not good in studies and always keep bothering others.* (Student 2)

Themes from parents' interviews

Delinquency: Although the quantitative data results indicate an overall positive attitude of parents towards the inclusion of delinquent students, but the interviews suggested that parents were also concerned about the well being of their children from the presence of delinquent students in classrooms.

> *Some children are disobedient... some bully type children who show off a lot, also there are some others who do not speak the good language, are in habit of abusing, we do not like them… When*

kids inform that some children misbehave like that, then we tell them to avoid such students. (Parent 1)

Varying attitude due to type of disability: Parents supported inclusion, but they also had concerns regarding the problems that may arise due to the inclusion of students with severe or sensory disabilities. Their main concerns were regarding the support system that needs to be developed for the proper inclusion of students with severe or sensory disabilities. The other reason for a negative attitude towards students with severe disabilities were the feeling that such students may develop a kind of inferiority complex due to comparison with other students of the class in terms of academic achievement. They also felt that class proceedings may be disturbed due to the presence of a child with a difference in abilities.

> *If the disability is mild, then that child can study, but if it is severe then difficulties may arise. Like, in a class of normal children if a child with complete blindness is present and if there is no special teacher to teach him in class then, some difficulties may arise in this matter.… I mean the school must do something in this matter so that other children also do not get disturbed.* (Parent 1)

The success of inclusion depends upon the abilities of teachers: Parents expressed their belief that the success of the process of inclusion depends upon the abilities of teachers to manage the class.

> *Look, everything depends on how the teacher manages the class. If all the arrangements are fine then children can learn nicely… whether a child with a disability is sitting with them or a normal child.* (Parent 1)

Parents suggest ways to make inclusion successful: A parent of a SWD, who is a strong supporter of inclusion has suggested ways to include SWD.

> *Those children should also be educated with the other children because according to me all children are equal, whether they are handicapped, rich or poor. We must not differentiate among children. Children develop inferiority complexes due to it. They should be taught with all other students… Those who are disabled due to loss of vision can be taught through braille script, other disabled children can be helped by class friends, those who cannot hear can be taught by making them read the written texts.* (Parent 4)

4.4 DISCUSSION OF RESULTS

Teachers:

Combining the analysis of attitudes performed using the "type of disability" lens on the ATIEIS survey with the interviews, we unearthed positive and negative attitudes of teachers towards inclusion. A difference was found in the attitudes among teachers experienced in teaching SWD and those who lacked such experience. The experienced teachers were more positive towards the inclusion of all SWDs (including students with severe sensory and speech disabilities) in regular classes as compared to their counterparts. It can be said that the attitudes of teachers are affected by their experience of teaching in classes that have SWDs. The interviews with teachers who have already taught SWDs brought out the importance of specialized technological devices in an inclusive classroom, some used by disabled students while others by teachers to cater to diverse learning needs of students through instruction.

Another factor that came up in the teacher's interviews is their under-preparedness to deal with inclusive classrooms, and this was a major concern raised even by teachers having experiences with teaching SWDs. They were worried that despite a general readiness of novice teachers to make inclusive education successful, lack of specialized training and lack of information regarding specific pedagogy for inclusive settings could impede its practical implementation. For more effective teacher training, we recommend that teachers with prior experience of inclusive settings be involved in pre-service or in-service teacher training programs so that their positivity towards all types of disabilities and rich experiences in teaching SWDs in inclusive settings can be shared with novices. Opportunities must also be provided to pre-service and in-service teachers to witness actual classrooms where inclusion is working successfully, thus giving scope to highlight best practices in inclusion and case studies of successful implementation in teachers' training curricula.

Students:

The students in this study were negative towards the inclusion of those who show delinquent behavior, uncontrolled behavior, are irregular and inattentive in class and those with vision and hearing-related disabilities. The result shows differences among attitudes of students from inclusive, general and special schools. The students from the inclusive school were more positive in attitude towards inclusion as compared to students from special as well as general schools. This is an important finding reflecting that the type of school in which a student is enrolled affects the attitude of students. As evident from the responses of SWD during the interview, the support that SWDs receive from their peers with varied abilities builds up their confidence regarding the benefits of inclusive education.

Another important finding of this study is that the students have concerns about the abilities of their teachers being able to handle students with physical and sensory disabilities in the classroom. When students and teachers themselves hold similar concerns, the situation is grave and suggests a critical need to empower teachers through in-service and pre-service training and exposure to inclusive education. One of the most heartening signs is the positive attitude of students towards sharing classes with individuals and groups differing in terms of religion, caste or social status.

Parents:

Parents, like teachers and students too were generally positive towards inclusion in education, but their concerns for the well being of their children, whether with or without disabilities, made them negative towards the inclusion of students with severe and/or sensory disabilities. Parents also had the awareness that there is a need for a minimum support system to be developed for implementing inclusion effectively.

We did not find significant differences among the attitudes of parents based on their gender or due to their exposure to disabilities. Parents identified the abilities of teachers to be the most important factor for the success of inclusion.

Chapter 5: Strategies for teaching science to SVI

This chapter presents the teaching strategies used to conduct science learning activities with students that had or did not have visual impairments. Such strategies and learning aids may empower teachers to include SVI in science activities and provide them with desired learning experiences. The following strategies were developed and used:

- multimodal communication by the facilitator through verbal descriptions, adapted diagrams and models to aid conceptual understanding of the topic to be learned.
- cooperation among peers in groups to understand and learn the concept.
- representation of learning by students through verbal discussions and drawings (raised line drawings by SVI).

Regarding the use of drawing as a tool of representation for SVI a question may arise, 'why do we want SVI to draw?' To answer this question we should think about our use of drawing as an aid to thinking for persons with sight (Anning, 1997 and Tversky, 2002). If we detach a SVI from a tool easily available to others, a secondary disability occurs. Bodrova & Leong (2006) explain that a disability generally affects the 'primary lower mental functions' of a child, but if the mastering of cultural tools of learning is prevented due to any reason then secondary disabilities may develop thereby distorting the mental functioning of the child. Elaborating on this Smagorinsky, (2012) gives the example of a child with visual impairments who could attain the same level of development as a normal child, due to the opportunities of full participation in a culture's social life and mastering alternative tools like Braille instead of written language. Viewed from this perspective it appears that to prevent barriers to the higher mental function of SWD, full access to the available cultural tools for learning that include drawing must be facilitated.

The study was done in three successive parts. The parts two and three of the study were consequences of the earlier parts. An 'informal cooperative learning' approach was initiated among groups of learners to promote the learning experiences. The term 'informal' used in the approach refers to the freedom to facilitators while conducting activities from the specific procedures of group formation, duration of engagement and assessment procedures of existing cooperative learning strategies. The nature of cooperative activities also differed in different parts of the study which shall be specifically informed in the due course. The basic elements of the cooperative learning approach that were ensured during all the parts were: a suitable activity for group learning; interactions among students in small groups; structured interdependence within groups; individual responsibility and accountability and mutually helpful behavior among learners (Davidson & Worsham, 1992 and Davidson, 2002 as quoted in Davidson & Major, 2014).

5.1 Objectives

One of the objectives of the study was to understand more about the learning process in a situation where SWD cooperates with students without disabilities to learn about scientific concepts through the use of diagrams. Another objective was to understand how SWDs and SVIs would represent their visualization. Specifically, the following sub-questions were addressed:

1. What strategies are helpful for SWD and SVI for learning science at school?
2. What do students observe in diagrams in inclusive cooperative learning situations?
3. What questions are raised by students while observing diagrams?
4. What drawings are made by SVI while learning about atoms?
5. How do SVI represent their visualization?

5.2 Methodology

As informed earlier, the study was conducted in three parts. Parts one and two of the study were conducted in the same inclusive school in Delhi, but in two different classes, whereas part three was conducted in two different schools: one of them was an inclusive school in Mumbai, while the other was a special school for SVI in Delhi.

5.2.1 Part 1 of the study

This part of the study was conducted with raised-line diagrams of micro-organisms in an unguided, cooperative learning situation among school students. The study was done on two different days and we aimed to explore whether in an inclusive setting, SVI were able to draw out the information from raised-line colored diagrams that are accessible to students with vision and then recognize these after one day.

5.2.1.1 Sample

20 students (Grade 8, age-range 13-18) from an inclusive school were selected. Five groups of four students each were formed. Group 1 (3 girls, 1 boy, all had orthopedic disabilities); Group 2 (4 boys, 2 had orthopedic disabilities, 1 had no vision, 1 had low vision); Group 3 (2 boys, 2 girls, 1 boy had a learning disability, others had no disabilities); Group 4 (4 girls, 2 had hearing disabilities, 1 had hearing & speech disability, 1 had no disability); Group 5 (4 boys, 2 had orthopedic disabilities, 2 had no disabilities).

5.2.1.2 Tools and administration

Students performed two tasks:

A) unguided cooperative observation of 8 large, raised-line, colored and labeled diagrams of micro-organisms and B) recognizing these diagrams from 8 colorless, mirror-imaged and differently raised-line diagrams and recalling the names of the micro-organisms by students individually on the next day. During this recalling of names in the task (B), unlabeled, miniaturized, colorless, raised-line, mirror image representations of diagrams in task A were presented to all the students individually.

Table 10. Some of the responses of students to the diagrams of micro-organisms

 Rhizopus	**Student observations:** *There are some bacteria like dots in the three circles. (Sporangiospores in sporangia),* *There are some root like bushes at the lowest part. (Rhizoids),* *There is a (horizontal) green bamboo like wood. (Stolon).* **Questions:** *Where are they found? What are the harms and uses due to this? What are the causes of these spreading? What diseases can be caused by them?*
 Virus	**Student observations:** *It looks like an alien or robot. Legs are visible in it.* **Questions:** *What disease is caused by it? What is its colour? Where are they found?*

5.2.1.3 Observations

The cooperative observations of students resulted in analogies, such as, "looks like an alien or robot". The questions raised by the students based on these diagrams were also non-trivial. The next day, all students including the SVI recognized the diagrams that had been observed by their group from the complete set of 8 diagrams. The recognition of such mirror-imaged and miniaturized forms of diagrams by students indicates the manipulation of mental images by students with or without vision equally. This is in accord with Zimler & Keenan (1983). On the recall task, it was found that the name of Amoeba was recalled correctly by all students (8/8 students of the two groups who had viewed it) while Aspergillus and Chlamydomonas were recalled by none of the students (0/8 students of the two groups who had observed these).

An interesting finding was related to group 2, where the name of the diagram was passed on to the SVI by the peers despite the name being neither embossed nor Brailled on the observed diagram. So, if the SVI in the study could recall the names of 2 out of 3 observed diagrams after one day, then it is indicative of the effectiveness of cooperative learning in an inclusive class, especially for SVI. This cooperative observation and the transfer of information can be related to the analogies made by students between familiar and unfamiliar objects. Analogies are considered to be important while developing and understanding new ideas (Brown & Salter, 2010).

5.2.2 Part 2 of the study

This part of the study was guided by part 1 of the study. Here cooperative observations and discussions were initiated among students for learning about different types of teeth through some raised-line diagrams which were followed by the representation of learning by students through drawings. Thus, the students including SVI not only drew information from the raised-line colorless diagrams (which are generally used by teachers for SVI) but also represented it through drawings. The tasks that were performed by students were:

- naming and drawing of diagrams of different types of teeth through previous knowledge
- cooperating with the group for observing and drawing diagrams of different types of teeth
- naming and drawing diagrams individually through memory after observation
- recognizing the observed diagrams individually from differently colored 9 diagrams.

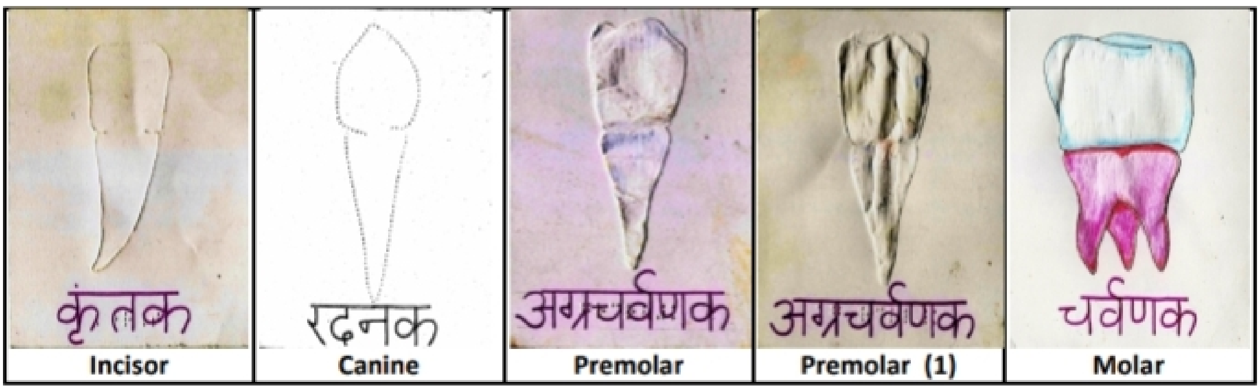
5.2.2.1 Sample

Eighteen students (Grade VII, age range 12-16) from the same school were selected. Students formed 4 groups of their own choice. The particulars of the members of groups are given below.

Group 1 had 4 girls: 1 had an orthopedic disability, others had no disability
Group 2 had 5 boys: 2 had a hearing disability, 1 had a learning disability, 2 had no disability
Group 3 had 5 boys: 1 had a hearing disability, 1 had a learning disability and 3 had no disability
Group 4 had 4 girls: 1 had no vision, 1 had an orthopedic disability, 1 had a learning disability, 1 had severe skin related illness.

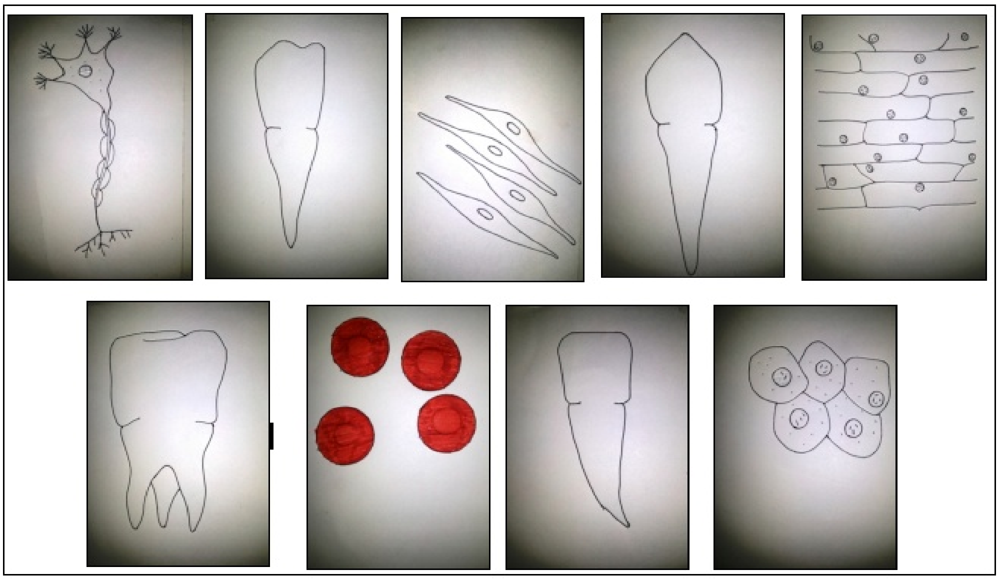
5.2.2.2 Tools and administration

Fig 4. Diagrams of teeth used for observation & drawing in part 2 of the study with SVI



Students recorded their unguided cooperative observations and questions related to the diagrams, and also drew the four observed diagrams of teeth on the observation sheet individually. The observation sheets for the SVI had instructions in Braille. A video of the digestive system was screened in the interval between the filling of observation sheet and the test sheet; the latter required students to name and draw all the observed four types of teeth based on recall. Next, students were presented 9 unlabeled raised line test diagrams with colored outlines, among which four represented the types of teeth shown earlier, while the other five represented different types of cells namely nerve cell, unstriated muscle cells, human cheek cells, onion peel cells and red blood cells. Students had to recognize the diagrams they had seen earlier.

Fig 5. Test diagrams used for recognition task in part 2 of study with SVI



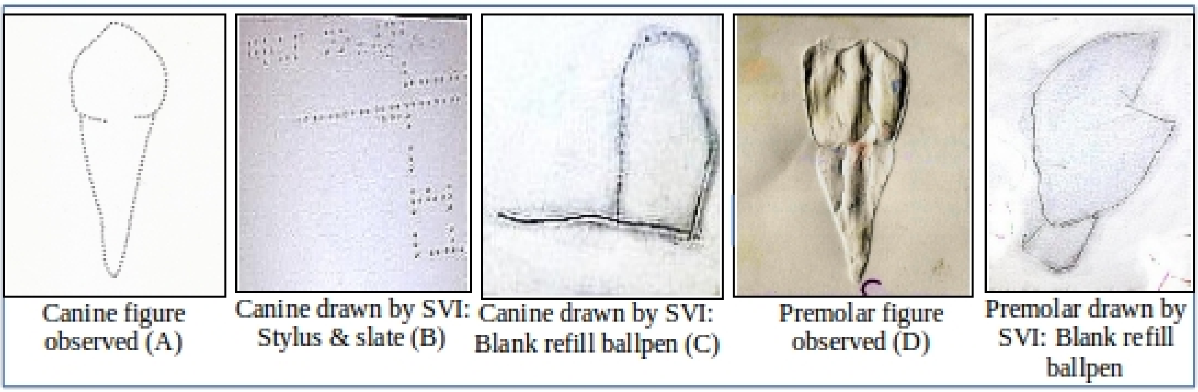
5.2.2.3 Observations

Only 2/18 students could draw the teeth-diagrams (partially correct) while 9 students could name all the types of teeth correctly. Students' observations of the diagrams often focused on the resemblance of the diagram with some known object. Even when asked to draw while observing the diagrams, only 13 students drew all of them correctly. Remaining students (5) either did not draw some diagrams or drew some of them incorrectly. The correctness of a diagram was decided by the presence of the differentiating features of the tooth, such as the outline of the teeth, inner contours, proportion of crown to root, etc.

When asked to draw the teeth diagrams from memory individually after observation, 15 students drew the molar correctly but other teeth (incisors, canines and premolars) were drawn correctly on an average by 9-10 students. Reasons, why more students drew the molar correctly, could be it's being the last observed diagram; or that the colored, raised lined and raised inner space diagrams are more effective aids for learning; or both. Students' performance on recalling the names of teeth was better; the molar was named correctly by 17 students while the other three teeth were named correctly on an average by 14-15 students. In the recognition task, all the 18 students including the SVI could recognize the shapes of previously observed four diagrams correctly out of the given 9 test diagrams.

Drawings by the SVI: The SVI stated that she had never drawn anything previously. Her first attempt to draw was by using the stylus and the braille sheet on a braille slate, as seen in (Fig 6), where she attempted to draw a canine tooth. Later, she attempted to draw the same on the braille sheet with a blank refill ball-pen. This attempt had the crown part but not the root. Lastly, her drawing of a pre-molar with a blank refill ball-pen, on a braille sheet showed both the root and crown. The practice of drawing and the changes in the instrument she used, led to better diagrams.

Fig 6. Drawings of teeth by SVI



5.2. Part 3 of the study

This part of the study was done to explore the use of 3-dimensional models, descriptions and cooperative discourses among students when trying to understand an abstract scientific topic regarding the structure of atoms. The study also required students to represent their understanding through drawings. It explored the conceptions that students held regarding atoms before the activities and the kind of drawings made by SVI while learning about atoms.

5.2.3.1 Methodology

This work was exploratory and was focused on understanding the conceptions of SVI through their verbal reports and drawings. Various activities were performed by the first author on four different days (around one hour each day) with two different groups of students in inclusive and special (SVI) educational settings. Video and audio records, classroom observations and field notes formed the various tools of data collection. Different science activities related to understanding the structure of atoms were conducted and a 'historical approach' to teaching and learning the structure of atoms was followed, similar to that presented in the text-books of the students. The sample and settings were selected through convenience sampling, which depended upon getting permission from school authorities. The number of students differed on different days and the details of the sample are provided in table 11.

Table 11. Details of sample for part 3 of the study with SVI

Educational setting	Student	Status of vision	Any experience of drawing earlier	Age	Gender	Class
Inclusive	F	Perception of light and darkness only (congenital)	No	15	Boy	8
	R	No vision (lost after the age of 9 years)	Yes	15	Girl	9
	P1	With vision	Yes	13	Girl	8
	P2	With vision	Yes	13	Girl	8
	B	Low vision	Yes	17	Girl	10
Special	S	No vision (congenital)	No	15	Boy	10
	N	No vision (lost after age of 4 years)	No	13	Boy	8
	D	No vision (congenital)	No	14	Boy	6
	K	Perception of light and darkness only (lost after the age of 8 years)	Yes	18	Boy	10
	J	No vision (lost after the age of 2 years)	No	18	Boy	10

5.2.3.2 Tools and administration

Pedagogic process:

The activities in both settings were facilitated by the researcher over 4 days and all activity plans and representations used were validated by two science education experts. Some initial activities were conducted with students to acquaint them with the cooperative learning situation and also with the drawing tools for SVI.

On day 1, students were asked to describe and draw atoms and give examples of things around them that have atoms. In the next 3 days, learning activities concerning the structure of atoms were conducted through verbal descriptions by the researcher. These descriptions presented atoms as conceptualized by scientists. Use of real objects & 3D models were also made and discussions were held with the students and finally, drawings were made by the learners to represent their understanding of atoms. After completion of their drawing, students were asked to explain it.

The historical development of the concept of atoms as theorized by ancient philosophers and scientists, including Dalton, Thomson, Rutherford and Neils Bohr was presented as the pedagogical strategy and for drawing, the SVIs used a drawing board (having a hard plastic net on its surface) with stylus and a drawing tool that had velcro slate and wool-pen (Shastri, 2016).

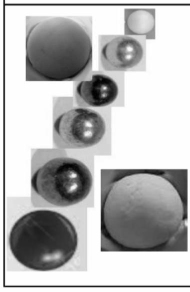
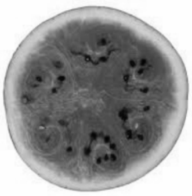
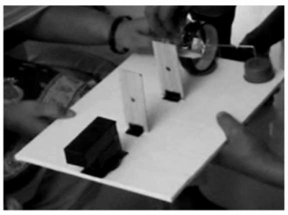
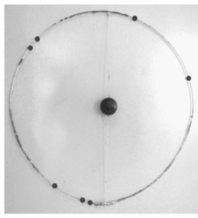
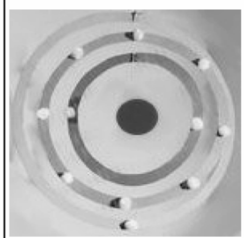
Fig 7. Drawing tools used by SVI during part 3 of the study

	 Techtile Drawing board-stylus

Models used for representations:

To understand Dalton's concept of atom, 8 balls of different sizes were used; a watermelon (whole fruit later cut to pieces) was used to represent Thomson's concept of atom; a ball surrounded by a beaded ring was used to represent Rutherford's concept of atom; 3 concentric rings with 2, 8 and 2 beads in one plane with a ball in the center was used to represent Bohr's concept of atom and; a 3D representation of the gold-foil experiment was used.

Fig 8. Models used for representation in part 3 of the study with SVI

Dalton's concept of atom	Thomson's concept of atom	Gold foil experiment	Rutherford's concept of atom	Bohr's concept of atom
				

Data and tool for analysis:

Vygotsky (2004) has reported four stages (Level 1-4) of the development of drawing in children, which we have used in this study to categorize the drawings. An additional stage was incorporated in the categorization, termed level 0. The levels are;

(0) Random scribbles: No attempt at representation.

(1) Schematic drawing: Attempts at representation but the little resemblance of drawing to the object.

(2) List drawings: Attempts made to draw with a resemblance to object, but the relation between elements may not be correct.
(3) Realistic depiction: Drawing resembles the actual object, but there is no sense of depth or 3D aspect of the object.
(4) Vantage point drawing: Drawing resembles the 3D object with depth, light and shade.

The transcripts and videos were also analyzed iteratively to find instances and evidence of visualization done by SVI during discussions. The assumptions of the dual coding theory (DCT) were used (Vavra et al., 2011), whereby the responses that represented transformations in mental images were selected and based on the nature of visualized image they were categorized as -

(1) Visualization objects
(2) Introspective visualizations
(3) Interpretive visualizations

5.2.3.3 Observations

5.2.3.3.1 Students' Conceptions of Atoms Before Intervention

The shape of atom: The drawings made by students revealed that students in the lower classes had a particulate conception of an atom, mostly depicted by balls or spheres.

Size of atom: All the four students from the inclusive setting considered atoms to be small in size, which is an obvious response from students who may have learned about atoms as the smallest unit of matter.

Analogies for atom: Student F had used the analogy of balls to suggest the shape of atoms, and R had used the analogy of water to explain her understanding that the shape of atoms in water is indefinite. The student with vision (P1), who had some misunderstanding about the term atom, made the analogy with thin capsules of cotton (confusing atoms with fungi).

Location of atoms*:* Three students said that atoms are present in every matter, whereas student P1 said that atoms are located on bread, chapattis, (unleavened flatbread), water and inside stomach.

(II) *Special setting:*

When asked about atoms the responses from 4 the students indicated that their knowledge of atoms was connected to having heard about atom bombs in their history classes and one student D reported that he had never heard the term atom before.

5.2.3.3.2 Drawings made by students

Fig 9. Drawings made by students in the inclusive setting

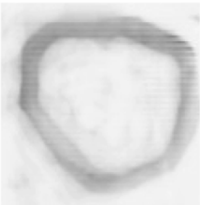
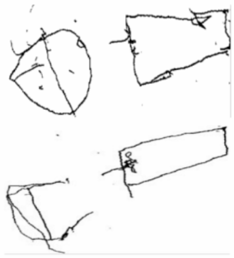
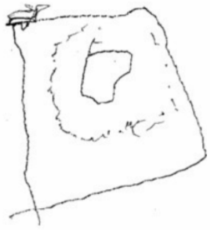
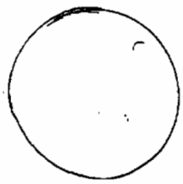
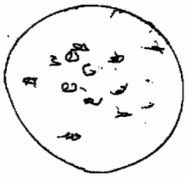
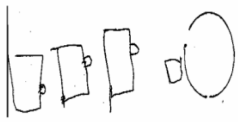
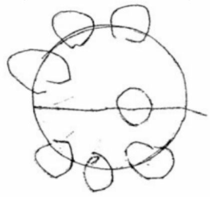
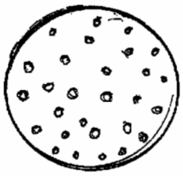
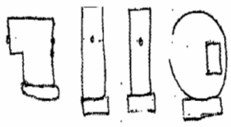
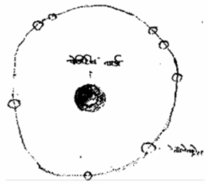
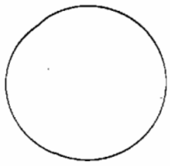
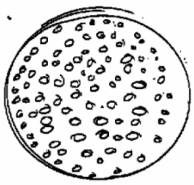
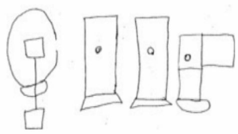
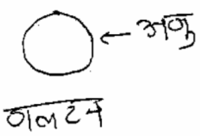
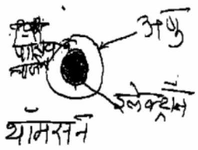
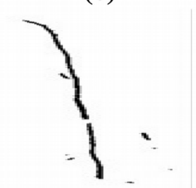
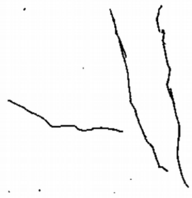
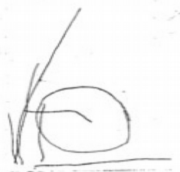
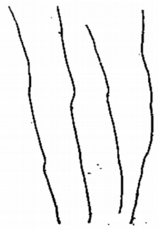
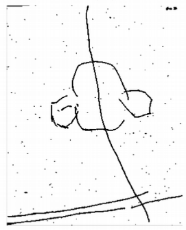
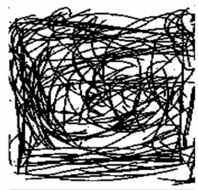
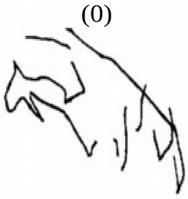
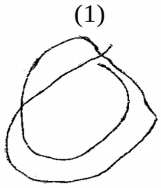
Student	Single atom through previous knowledge	Dalton's atom	Thomson's atom	Gold foil experiment	Rutherford's atom
F	(2) 	(Between 1 & 2) 	(Between 1 & 2) 	(Between 1 & 2) 	(Between 1 & 2) 
R	(2) 	(2) 	(2) 	(Between 2 & 3) 	(Between 2 & 3) 
P1	(2) 	(2) 	(2) 	(Between 2 & 3) 	(3) 
P2	(2) 	(2) 	(2) 	(3) 	Did not draw
B	Did not participate	(2) 	(2) 	Did not draw	Did not draw

Fig 10. Drawings made by students in the special setting (SVI)

Student	Single atom through previous knowledge	Dalton's atom	Thomson's atom	Gold foil experiment	Rutherford's atom
N	(0) 	(0) 	(0) 	Did not draw	(0) 
S	(1)  Helped by teacher to draw circle	(0) 	(0) 	Did not draw	(1) 
D	Do not know	(0) 	(0) 	Did not draw	(0) 
J	(0) 	Did not participate	Did not participate	Did not participate	Did not participate
K	(1) 	Did not participate	Did not participate	Did not participate	Did not participate

5.2.3.3.3 Instances of visualization observed during the verbal discussions

Visualizing object

While observing (and even eating) the watermelon as a representation of Thomson's model of atom, there were dialogues between students which indicate that the pulp and seeds of watermelon were being visualized as the positive charge and electrons as conceived by Thomson's structure of atom.

Introspective visualization

After the introduction of the concrete model of Rutherford's atom, student F tried to compare the same with Thomson's model of atom which was represented and discussed earlier. This comparison of the earlier model with the new is a clear indication of the introspective visualization. Another instance of introspective visualization was noticed after the observation of the model of Rutherford's gold foil experiment by the students. During discussions among students and the researcher about why some of the alpha particles bounced back after hitting the gold foil, the students brought up Thomson's atomic model which had been introduced the previous day.

Interpretive visualization

While reasoning with Dalton's theory after the observation of balls of different sizes, instances of transfer from concrete to an abstract mode of thinking was observed which indicates interpretive visualization. Another instance of interpretive visualization involved gestures used by SVI during the discussion. This was after the explanation of the momentum of alpha particles and repulsion by the central large positive charge. Another instance of interpretive visualization was observed after the introduction of largely empty space in atoms through a model, as proposed by Rutherford. During the discussions, student F used the learning from Rutherford's model of atom and that from the model of Rutherford's gold foil experiment to interpret the observations. Evidence of all the three forms of visualizations being done by SVI were obtained through analysis of their verbal discussions.

5.2.3.3.4 Instance of learning through cooper*ation*

While drawing the representation of atom as theorized by Dalton, students were seen to be cooperating while drawing the 3D representation on paper. The challenge that the students faced was to depict the properties of atom as conceptualized by Dalton to be solid, spherical and indivisible. Representing the atom as conceptualized by Dalton, led the students to a conflicting situation. Student F tried telling B to fill the inner space of the representation of Dalton's spherical atomic model, but B was not ready to do so, as this would give an impression of something represented inside the atom so insisted on drawing only in the margins. Finally, student R suggested that an outline of a circle be drawn and this was accepted by others as well.

The dialogues between students give a good instance of the cooperation among students regarding the drawing task and their attempts to reach a constructive solution. The figures drawn by the three students and the others can be referred from figure 9, under the column of Dalton's atom.

5.3 Summary and findings of the three studies

Through the three studies reported in this chapter, an attempt was made to achieve the objective of the study and the research sub-questions about the learning process when SVI cooperates with students having the vision to learn about scientific concepts through diagrams. The other objective of understanding how SVIs would represent their visualization was also attempted in these students.

It was found that through the use of multiple representations complimented with verbal descriptions and discussion, the complex information that is accessible to students with vision can be effectively transmitted to SVI in cooperative, inclusive settings. This may be due to the explicit verbal communication about the diagram that took place between the peers and SVI along with the haptic information received through touch (Figueiras & Arcavi, 2012). The use of raised line diagrams and/or models facilitated the process of visualization among students including the SVI. The use of analogy to compare the observed object with the known objects was found to be a good strategy to introduce concepts related to the structures of objects.

As evident in the study, SVI can represent their learning about structures of objects through drawings, if practice for using proper drawing tools is given to them. Also the diagrams with colors and raised outlines; without colors & with raised lines (continuous and dotted); raised lined and raised inner space (colorless and colored) were found to be recognizable by students with vision as well. In the existing conditions that were observed during the study, there are more chances of learning science for SVI in inclusive settings as compared to the special school settings.

The students observed the diagrams used in the study both as objects as well as the representations of objects. The students observed the names; the material used; the color; features of diagrams; the aesthetics in the diagram; the shape through the analogy of represented object with the familiar ones; their functions in humans and the location of the parts of represented objects.

The questions raised by students in this study may be related to the information that is expected by them to be accompanied by the raised lined diagrams. These are: the reasons for naming ; reason of particular color or shape; harms or benefits to humans; the location, effect, mode of development and mode of action of actual object that is represented through diagram; the material used in diagrams, and; a comparison between the objects represented in all the related diagrams.

The SVI in this study expressed their knowledge about the objects that can be represented through models and diagrams in three different forms (a) shapes (b) names and (c) characteristics. All these may occur in combination or isolation and the tools of expression may be verbal discussions or drawings.

Chapter 6: Conclusions and Recommendations

The study presents the sad state of the inclusive process for SWD in science education. The participation of SWD in learning science and then in the discipline of science itself is found to be negligible. And this poor state is despite the strong legislations and policies that have been carefully formulated with good intentions to accelerate the process of inclusion for SWD. The study also reports high aspirations that SWD have regarding participation in science, as this was the most preferred subject for higher education. This is in contrast with the already stated low expectations of stakeholders of education which creates a barrier for the effective inclusion of SWD in the science curriculum. The reporting by more students from inclusive settings that they do not face difficulties in science indicates better science education conditions in inclusive settings. A larger number of SWD in the study wished to learn the processes of science as compared to those who wanted to learn different areas of knowledge in science. SWD do face difficulties in learning science which they have reported, but they still have a positive attitude towards science and perceive it as important, interesting and useful.

Regarding the negativity among all the stakeholders towards the inclusion of students with severe or sensory disabilities, it was found to have roots in the concerns for the abilities of teachers for handling SWD in the classroom. The concerns were corroborated by the teachers themselves who reported that they are under-prepared for inclusion due to lack of experience of teaching SWD; lack of knowledge of adaptive technologies that may assist SWD; lack of specialized training and lack of information regarding specific pedagogies for inclusive settings. In addition to the negativity towards the inclusion of students with sensory and severe disabilities, the students, in particular, were also negative towards the inclusion of those who show delinquent behavior. Such behavior, although not a larger concern for teachers and parents, is a matter of deep concern for students. The ray of hopes was again found to be emitting from the inclusive schools where students were more positive in attitude towards inclusion as compared to students from special as well as general schools. This is a reflection of their experiences of the successful process of inclusion.

As described in chapter 5, the strategies of cooperative learning among SVI and students with diverse abilities; use of multiple representations in form of raised lined diagrams, models, descriptions, discussions; and representing the learning through drawings were found to be effective for SVI for learning scientific concepts. The part 1 and part 2 of the study reported in chapter 5 give evidence that raised lined diagrams when used in inclusive settings through cooperation among learners with and without vision, could effectively communicate science to the SVI. Moreover, in part 3 of the same study, SVI in inclusive settings were able to represent and communicate their scientific learning through drawings. Therefore these strategies are suggested for use with SVI in inclusive learning settings.

Regarding the drawings that were made by the participant SVIs from inclusive and special education settings, the drawing of SVIs from inclusive settings was found to resemble the observed object and the models of atoms as well as the model of Rutherford's experimental setup. This suggests that drawings could be promoted as aids for inclusion and to benefit SVI in conducting science learning activities.

6.1 Contribution to body of knowledge

This research has substantially contributed to the area of science education by the use of surveys to give information about the aspirations of SWD for science education. Information about the attitudes of teachers, parents and students towards inclusive education in quantitative and qualitative ways was also presented in this thesis. Finally, some suggestions are made towards developing a pedagogy for aiding SVI in learning science.

The studies regarding attitudes of teachers, students and parents towards inclusive education indicate that inclusive settings were more effective in developing positive attitudes among the teachers and peers towards the inclusion of SWD. The finding regarding similarities in the abilities of students with and without vision to manipulate mental images (visual or spatial), gives good reasons to raise expectations from SVI in science in terms of their skills to observe and draw diagrams. This would suggest the need to printing embossed diagrams in the braille science textbooks, as well as using embossed colored diagrams in inclusive classes and focus on using methods to develop drawing skills in SVI. The strategies of cooperative learning among SVI and students with diverse abilities; use of analogy to compare unknown objects with known; use of multiple representations in form of raised lined diagrams, models, descriptions and discussions and representing the learning through drawings have been tried in this study for giving learning experiences to SVI in science classrooms. The instances of mutual learning among SVI as well as students with vision, from each other suggest that these strategies (especially the cooperative learning) are beneficial to all.

The method of triangulating the quantitative study regarding the attitude of teachers, students and parents towards inclusive education through ATIEIS with the deeply probed structured interviews has helped to demystify the reasons for negative attitudes of stakeholders towards the inclusion of groups with specific sensory disabilities and thereby contributed to the body of knowledge.

6.2 Limitations of the study

In the form of inclusion in education, this study has taken up a very broad area that cannot be bound in one thesis. Therefore this research had to be de-limited in many ways which are being presented:

- The sample of this study has been limited to metropolitan cities of India, Delhi and Mumbai which are although main centers of knowledge and business in many ways, but not representative of the entire country.
- The study of aspirations in science was done only with students with disabilities. To make a comparison between the aspirations of students with and without disabilities, a study with the students without disabilities would have helped.

- The study also missed a comparison between the efficacy of different kinds of drawings that are being used for SVI and also the drawing tools that are available or are proposed for being used by SVI. Such a study could have helped suggest more specifically the tools that may be used by SVI for easy and effective learning.
- This study has used drawings as a tool for SVI's to represent their learning, but there are other tools like, clay modeling that may be used by students for representing their learned concepts. An exploration of such different tools could have made the study richer.

6.3 Recommendations for further research

The present research suggests another study regarding aspirations of students with and without disabilities for future education and career in science. Such a study may help relate the curriculum to the lives of the learners.

Another study regarding the use of visits, excursions, computer-aided learning, haptic tools, different types of drawing/modeling tools and audio recorders for making science learning effective for SVI would add to the body of knowledge regarding effective science learning strategies. Also, a study to explore the learning strategies for SVI specifically in special education settings may balance the choice of learning settings available to SVI.

6.4 Recommendations for changes in existing practices

This study has some evidence to recommend that the expectations of society from SWD regarding the learning of rigorous science can and must be raised. As suggested by SWD in our study and as evident through the intervention with SVI for learning concepts of science, an inclusive setup, as well as drawings and diagrams would make science more interesting, useful and effective. An urgent need for giving training to science teachers in the pedagogies that are more effective in transacting science in inclusive settings is also highly recommended. Such pedagogies may involve peer-group cooperative strategies; multiple representation strategies complemented with descriptions and discussions; use of drawings as a representational tool and use of technological devices specifically designed for SWD to learn science. For more effective teacher training, we recommend that teachers with prior experience of inclusive settings be involved in pre-service or in-service teacher training programs.

The study also recommends that inclusive settings should be promoted for raising the learning level of SVI as well as that of other SWD in science.

6.5 Personal postscript

This research has been a lifetime learning experience for me. It transformed me from a teacher to a teacher-researcher. Every part of this study has been lived by me as a learning experience and has brought about so many positive changes. The study on aspirations of SWD gave insight regarding how innocent these children are, unaffected with what adults perceive about them and unaffected by the low expectations that adults have about them. The thing that we as adults must understand that in a world created by us if someone is not able to contribute his/her part with full potential then it is a sign of a need of change in the system and not that of an anomaly in the person. Therefore, the onus of evolving the systems that cater to everyone’s development lies in all those who contribute to run the system.

The study regarding attitudes towards inclusion gave insight regarding the good intentions of everyone. Initially, the avalanche of negative attitudes of teachers, parents and peers regarding the inclusion of SWD with severe and sensory disabilities was a great setback to my personal feelings about inclusion. But, the responses of all the interviewees cleared the mist that had fallen upon my beliefs. The responses clarified that the negative attitudes were deeply rooted in the concerns that everyone had for SWD in good faith. All the stakeholders wholeheartedly supported the cause of inclusion and disclosed their concerns and also suggested the ways for bringing about the inclusive transformation in education for all.

My further exploration of the field in some inclusive and special schools strengthened my belief that SVI can learn science as effectively and easily as anybody else. The difficulties faced by SVI in science can be equated with anyone who has a lack of interest in science due to a lack of proper pedagogy for delivering science in the classroom. This research has given me full confidence as a researcher that inclusion of all in learning science with appropriate support, training and pedagogy is not a day very far.

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With deep gratitude in my heart, I would first of all like to acknowledge the contribution of Prof. Sugra Chunawala to this research who has always guided me at every step of this study. It is the guidance received from my guide that has transformed a study done by a teacher (me) into a body of research.

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Appendix 1

Mean scores on ATIEIS

Note: + sign is for positive attitude; – for negative attitude; * for significant difference on t-test at .05 level

Table 12. Mean responses of students, parents and teachers on ATIEIS

Statements in ATIEIS	Parents (166)	Teachers (97)	Students (522)
General non-acceptable behavior of students			
who fail in exams	3.12 +	4.04 +	3.64+
who are shy & withdrawn	3.47 +	4.41 +	3.46 +
who have language disabilities	3.24 +	3.23 +	3.20 +
who are verbally aggressive	3.15 +	3.54 +	2.73 -
who do not follow school rules	3.13 +	3.58 +	2.69 -
who are frequently absent	2.79 -	3.40 +	2.59 -
who are inattentive in class	2.91 -	3.86 +	2.50 -
who physically harms others	3.14 +	3.65 +	2.71 -
Inclusion of SWD in classroom			
with orthopedic disabilities	3.30 +	3.66 +	3.38 +
with visual disabilities	**2.84 -**	**2.77 -**	**2.91 -**
who are dependent on others for daily activities	3.30 +	3.50 +	3.30 +
with speech disabilities	2.89 -	2.80 -	3.27 +
who display uncontrolled behavior	2.41 -	3.76 +	1.76 -
with learning disabilities	3.54 +	3.39 +	3.42 +
with hearing disabilities	**2.82 -**	**2.63 -**	**2.64 -**
with appropriate support all students should be included	4.08 +	4.39 +	4.22 +
Effect of inclusion of SWD in classroom			
does not make teaching/ learning stressful	3.52 +	3.56 +	3.41 +
does not effect the academic achievement of peers negatively	3.60 +	3.77 +	3.35 +
does not divert attention of teachers from peers	3.26 +	3.39 +	3.08 +
will be accepted by peers	3.15 +	3.32 +	3.16 +
Teachers can handle SWD (orthopedic)	3.14 +	3.30 +	2.97 -
Teachers can handle SWD (sensory + speech)	2.91 -	3.18 +	2.91 -

Table 13: Mean scores of teachers (total and on demographic variables) on ATIEIS

Statements in ATIEIS	Gender		Experience of teaching SWD		Exposure to disabilities		Total Mean
	Female (35)	Male (62)	Yes (32)	No (65)	Yes (30)	No (67)	
General non-acceptable behavior of students							
who fail in exams	3.73+	4.23+	4.25+	3.94+	3.87+	4.10+	4.04
who are shy & withdrawn	4.25+	4.50+	4.63+	4.31+	4.67+	4.30+	4.41
who have language difficulties	3.03+	3.34+	3.56+	3.06+	3.37+	3.20+	3.23
who are verbally aggressive in class	3.20+	3.72+	3.97+*	3.32+*	3.40+	3.62+	3.54
who do not follow school rules	3.43+	3.66+	4.00+*	3.37+*	3.73+	3.51+	3.58
who are frequently absent	3.20+	3.52+	3.46+	3.36+	3.17+	3.53+	3.40
who are inattentive in class	3.77+	3.92+	3.84+	3.87+	3.80+	3.88+	3.86
who physically harm others	3.57+	3.69+	3.81+	3.57+	3.77+	3.59+	3.65
Inclusion of SWD in classroom							
with orthopedic disabilities	3.5+	3.75+	4.19+*	3.4+*	3.93+	3.53+	3.66
with visual disabilities	2.79-	2.72-	3.41+*	2.46-*	3.03+	2.65-	2.77-
who are dependent on others for daily activities	3.00-*	3.79+*	4.16+*	3.18+*	3.73+	3.41+	3.50
with speech disabilities	2.86-	2.77-	3.37+*	2.52-*	2.93-	2.77-	2.80-
who display uncontrolled behavior	3.51+	3.90+	3.97+	3.66+	3.87+	3.71+	3.76
with learning disabilities	3.57+	3.29+	3.78+*	3.20+*	3.43+	3.36+	3.39
with hearing disabilities	2.60-	2.64-	3.34+*	2.27-*	2.80-	2.53-	2.62-
with appropriate support all students should be included	4.37+	4.40+	4.71+*	4.23+*	4.60+	4.29+	4.39
Effect of inclusion of SWD in classroom							
does not make teaching/ learning stressful	3.28+	3.71+	3.91+*	3.38+*	3.60+	3.53+	3.56
does not affect the academic achievement of peers negatively	3.46+*	3.95+*	4.37+*	3.48+*	4.10+	3.64+	3.77
does not divert attention of teachers from peers	3.23+	3.48+	4.00+*	3.09+*	3.87+*	3.21+ *	3.39
will be accepted by peers	3.31+	3.32+	3.28+	3.34+	3.23+	3.38+	3.32
Teachers can handle SWD (orthopedic)	3.20+	3.35+	3.62+	3.14+	3.47+	3.24+	3.23
Teachers can handle SWD (sensory + speech)	3.03+	3.26+	3.50+	3.01+	3.23+	3.18+	3.18

Table 14. Mean scores of students (total and on demographic variables) on ATIEIS

Statements in ATIEIS	Total students (521)	Gender		Disability in self		Type of school		
		Girls (206)	Boys (315)	SWD (67)	Students without disabilities (454)	From special school (39)	From inclusive school (30)	From general school (452)
General non-acceptable behavior of students								
who fail in exams	3.64+	3.45+*	3.77+*	3.95+*	3.59+*	4.05+	4.17+	3.57+
who are shy & withdrawn	3.46 +	3.32+	3.55+	3.50+	3.45+	3.74+	3.90+	3.40+
who have language disabilities	3.20 +	3.21+	3.27+	3.43+*	3.21+*	3.61+	3.77+	3.18+
who are verbally aggressive	2.73 -	2.83-	2.63-	2.78-	2.70-	2.61-	3.03+	2.70-
who do not follow school rules	2.69 -	2.50-*	2.79-*	3.09+*	2.62-*	2.85-	3.23+	2.63-
who are frequently absent	2.59 -	2.52-	2.64-	3.33+*	2.48-*	3.26+	3.67+	2.46-
who are inattentive in class	2.50 -	2.52-	2.45-	2.79-	2.46-	2.97-	3.43+	2.40-
who physically harms others	2.71 -	2.79-	2.64-	2.88-	2.67-	2.69-	3.10+	2.67-
Inclusion of SWD in classroom								
with orthopedic disabilities	3.38 +	3.47+	3.32+	3.83+*	3.31+*	4.02+	3.27+	3.33+
with visual disabilities	2.91 -	2.90-	2.92-	3.83+*	2.78-*	4.28+	3.83+	2.74-
who are dependent on others for daily activities	3.30 +	3.47+*	3.12+*	3.52+	3.22+	4.05+	4.27+	3.13+
with speech disabilities	3.27 +	3.57+*	3.07+*	3.57+*	3.23+*	3.82+	3.90+	3.18+
who display uncontrolled behavior	1.76 -	1.68-	1.82-	2.43-*	1.66-*	2.61-	2.47-	1.64-
with learning disabilities	3.42 +	3.24+*	3.53+*	3.95+*	3.34+*	4.03+	4.27+	3.31+
with hearing disabilities	2.64 -	2.56-	2.68-	3.42+*	2.52-*	3.64+	4.07+	2.45-
with appropriate support all students should be included	4.22 +	4.39+*	4.11+*	4.49+*	4.18+*	4.77+	4.70+	4.14+
Effect of inclusion of SWD in classroom								
does not make teaching/ learning stressful	3.41 +	3.46+	3.36+	3.54+	3.37+	3.85+	3.37+	3.36+
does not effect the academic achievement of peers negatively	3.35 +	3.21+	3.43+	3.80+*	3.27+*	4.15+	4.00+	3.23+
does not divert attention of teachers from peers	3.08 +	3.14+	3.02+	3.66+*	2.98+*	4.08+	3.80+	2.93-
will be accepted by peers	3.16 +	2.92-*	3.30+*	3.55+*	3.09+*	3.69+	4.26+	3.03+
Teachers can handle SWD (orthopedic)	2.97 -	2.92-	2.98-	3.29+*	2.90-*	3.59+	3.32+	2.88+
Teachers can handle SWD (sensory + speech)	2.91 -	2.98-	2.83-	3.39+*	2.82-*	3.72+	3.31+	2.79+

Table 15. Mean scores of parents (total and on demographic variables) on ATIEIS

Statements in ATIEIS	Total Parents (166)	Disability and/or exposure		Gender	
		With disability or exposure (29)	No disability & no exposure (132)	Female parents (50)	Male parents (102)
General non-acceptable behavior of students					
who fail in exams	3.12+	3.10+	3.17+	3.46+	3.01+
who are shy & withdrawn	3.47+	2.86-*	3.59+*	3.48+	3.46+
who have language disabilities	3.24+	3.48+	3.24+	3.24+	3.29+
who are verbally aggressive	3.15+	3.38+	3.09+	3.24+	3.11+
who do not follow school rules	3.13+	3.10+	3.11+	3.40+	3.02+
who are frequently absent	2.79-	2.86-	2.79-	2.98-	2.74-
who are inattentive in class	2.91-	2.59-	3.00-	3.12+	2.89-
who physically harms others	3.14+	3.10+	3.11+	3.34+	3.04+
Inclusion of SWD in classroom					
with orthopedic disabilities	3.30+	3.25+	3.29+	3.14+	3.35+
with visual disabilities	2.84-	3.10+	2.78-	2.52-	2.99-
who are dependent on others for daily activities	3.30+	3.27+	3.36+	3.10+	3.48+
with speech disabilities	2.89-	2.96-	2.90-	2.44-*	3.06+*
who display uncontrolled behavior	2.41-	2.21-	2.47-	2.28-	2.53-
with learning disabilities	3.54+	3.55+	3.56+	3.40+	3.60+
with hearing disabilities	2.82-	2.96-	2.76-	2.24-*	3.05+*
with appropriate support all students should be included	4.08+	4.10+	4.12+	4.10+	4.11+
Effect of inclusion of SWD in classroom					
does not make teaching/ learning stressful	3.52+	3.45+	3.54+	3.58+	3.51+
does not effect the academic achievement of peers negatively	3.60+	3.69+	3.56+	3.50+	3.60+
does not divert attention of teachers from peers	3.26+	3.31+	3.23+	3.16+	3.20+
will be accepted by peers	3.15+	3.21+	3.15+	3.14+	3.15+
Teachers can handle SWD (orthopedic)	3.14+	2.96-	3.16+	3.23+	3.02+
Teachers can handle SWD (sensory + speech)	2.91-	2.69-	2.90-	3.00-	2.69-