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

A Thesis

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by

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DECLARATION

This thesis is a presentation of my original work. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature, and acknowledgment of collaborative research and discussions.

The work was done under the guidance of Professor Sugra Chunawala, at the Tata Institute of Fundamental Research, Mumbai.

Amit Sharma

In my capacity as supervisor of the candidate's thesis, I certify that the above statements are true to the best of my knowledge.

Sugra Chunawala

Thesis Supervisor

Date: 16/07/2020

DEDICATION

This research is dedicated to three sets of people in my life: first my family; second all my teachers and third all my colleagues. These people have always inspired and encouraged me to believe in myself.

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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. 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). Societal efforts for the development of an education system that endeavors towards the *inclusion of all* the marginalized/deprived groups, including those with disabilities are crucial. Since the scope of a study focused on all marginalized groups would be extremely large, the present work has been aimed at studying the inclusion of persons with disabilities, the largest marginalized group in education. Using a mixed-methods approach, this study has made efforts to understand the status of inclusion of students with disabilities in general, and science education in particular, in the Indian context.

The need for inclusive science education for students with disabilities (SWDs) is scrutinized through literature and a number of surveys. These survey findings have contributed to the area of science education as essentially information was gathered about the aspirations of SWDs with respect to science education, as well as about the attitudes of teachers, parents and students towards inclusive education. An important finding of the study is that SWDs have high aspirations to participate in science, and in fact, science was their most preferred subject for higher education. This finding is in contrast to the low expectations that are held from SWDs by most stakeholders in general with respect to science education.

The survey of attitudes indicated that the negativity among the stakeholders towards the inclusion of students with severe or sensory disabilities has roots in their concerns regarding teachers' abilities to manage SWDs in classrooms. These concerns were equally shared by teachers who felt under-prepared for inclusion due to various reasons such as lack of experience of teaching SWDs as well as a lack of knowledge of adaptive technologies that may assist SWDs.

With challenges faced by SVIs in science education in mind, three different intervention studies were taken up to explore the tools and strategies that may be effective for SVIs in learning complex and difficult concepts of science. Part 1 and part 2 of these studies provided evidence that raised lined diagrams when used in inclusive settings and through cooperative peer group, learners with and without vision could effectively communicate science concepts. It was found that the students could represent and communicate their learning through drawings in part 3 of the study. This suggests a need to raise expectations from SVIs regarding science education and to promote the use of drawings as an aid while conducting science learning activities with SVIs for inclusion. However, it should be a thoughtful intervention, particularly in terms of availability of appropriate tools for drawing. Similar to the written or verbal discourse, diagrams drawn by SVIs can provide a window for teachers to understand how SVIs are thinking about the discussed ideas.

Contrary to the commonly held belief that inclusion in education is beneficial to SVIs (or in larger context, SWDs) only and efforts for inclusion may be taken up only in the spirit of providing SWDs equal opportunities, the study evidenced a number of instances when the flow of information was bi-directional, both from students with sight to SVIs in inclusive classes, as well as the learners with sight getting ideas of drawing from SVIs during cooperative learning activities. These instances provide evidence that in inclusive learning communities of students, both students with/without sight can contribute in the exchange of information.

Chapter 1

Introduction

1.1 Background and motivation

This research is the work of a teacher-researcher who undertook the study to overcome the dissatisfaction that arise because of difficulties in coping with the challenges that are a result of attempts to deal with the diverse learning needs of children in regular schools. The dissatisfaction led to a craving to find solutions or strategies that would create such an environment in which all learners get opportunity to learn. The opportunity to attend a course on the education of children with special needs, along with the other courses studied during the Ph.D. course work, exposed me to the students with disabilities whose learning needs are the most challenging to be fulfilled and also to the process of inclusion in education that endeavors to create better learning environment for all. Such an exposure has helped me to look at the very broad area of education through the window of inclusive education. The following is the description of background and motivation which has guided and shaped my craving into a meaningful research.

While dwelling deeper into the area through the literature survey an urgent need for inclusive science education was identified, specifically as the nature of science has been described as 'elitist' by some science educators (Fensham, 1986). This is because it tends to exclude students and 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, this exclusion in science is doubled in effect due to the very nature of educational institutions which have been developed by focusing on the so called "normal child" that is one who is close to the dominant ways of life or society, and by ignoring the disabilities or differences among children. As a result, even a general look in to schools and textbooks would suggest the invisibility of students with disabilities (SWDs) in classrooms. The news report (Sharma, 2015) has highlighted the inefficacy of educational institutions in providing quality education to the disabled. 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.

If one were to take the case of persons with visual impairments, India has a population of around 5 million persons with visual impairments. Verma et al. (2017) report that around 20% of SVIs in the age group of 5-19 years have never attended a school. Among around 0.4 million SVIs enrolled in grades I to VIII of schools, about 15000 students are getting an 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, it is noticed that most of these special schools and institutions are located in large towns and cities (Natsume & Thamburaj, 2001) thereby excluding rural persons with visual impairments from getting benefits of special education. The resulting sad state of education of SVIs is again pointed out by the study conducted by the National Centre for Promotion of Employment of Disabled (NCPEDP, 2005) which reported that only 311 SVIs were found enrolled in 119 Indian universities where the study was conducted. Such a pathetic condition puts a serious question mark on the present model of education followed in the country.

1.2 What is Disability?

Before moving further let us reach a common understanding about disability and persons with disabilities. In general, a disability refers to a condition due to which a person may differ in the ability to perform the tasks that are performed by people normally. The World Health Organization has adopted a bio-psycho-social classification system of disability and functioning through the International Classification of Functioning, Disability, and Health (ICF) (2001). This system categorizes the problems in functioning, that are faced by individuals, into the interconnected areas of-

(a) impairments, that may arise due to a deviation in structure, loss or defect of body

(b) activity limitations, that may arise in day to day life

(c) participation restrictions, that are faced in those areas, in which people commonly involve like, becoming a part of the work force or involving in recreational activities.

ICF adds that condition of health, body functions and structures, participation, activities, contextual factors, which include environmental factors (physical, social) and personal factors (self-esteem, motivation etc.) are also interconnected. A disability is caused when the contextual factors interact negatively with any or all of the above areas of functioning of an individual. Thus, the environment factors like, policies, systems, infrastructure, technology, products, behaviors, services etc. that are a facilitator for some, may become a barrier for others. This clearly identifies that the limitations in the functioning of those individuals, who face disabilities, must be overcome by modifying the environment. This special feature of ICF looks at the condition of disability as something that may occur to anyone, and does not categorize persons with disabilities separately.

On the basis of the above classification, the World Health Organization (2011), describes disability to be a condition that arise from the negative interaction of an individual’s body features (due to impairment or poor health) with the features of environment, which delimits the activities and restricts the participation of that person. In India, The Rights of persons with disability Act (RPWD) (2016) clarifies that a ‘person with a disability means a person with long term physical, mental, intellectual or sensory impairment which, in interaction with barriers, hinders his full and effective participation in society equally with others' (Ministry of Law and Justice, 2016, p. 3). This act specifies different types of disabilities among persons into the following 6 areas:

1. Physical disability:

   A) Locomotor disability- Cerebral palsy; Dwarfism; Muscular dystrophy; Leprosy cured person; and Acid attack victims
   B) Visual impairment- Blindness and low-vision
   C) Hearing impairment- Deaf and hard of hearing
   D) Speech and Language disability

2. Intellectual disability:

   A) Specific Learning Disabilities
   B) Autism Spectrum Disorder

3. Mental behavior:

   A) Mental illness

4. Disability caused due to:

   A) Chronic neurological conditions- Multiple sclerosis; Parkinson's disease
   B) Blood disorder: Hemophilia; Thalassemia; Sickle cell disease

5. Multiple disabilities: more than one of the disabilities that have been mentioned above

6. Any other category that may be specified by the central government.

1.2.1 Major models of disability

All over the world, different models of perceiving disability have been prevalent at differing times. These models are very important for a state, institution, researcher and a layperson because these provide a particular framework to define disability. It helps in determining which professions would be responsible to serve people with disabilities and may also help to shape identities that PWD form for themselves (Smart, 2009). Smart

(2009) and Retief and Letšosa (2018), describe some models of disability that have been guiding the discussion on issues of disability.

1.2.1.1 The Charity model (disability as victim-hood)

Under this model, a person with a disability is seen as someone who is suffering from a tragedy of being disabled and tries to evoke sentiments of other people to help such victims. It, therefore, encourages charitable special services and institutions to give 'humane treatment' to PWD.

This model has been criticized by groups of PWD for depicting them as helpless and dependent on others, thereby creating negative and harmful misconceptions about the abilities that a PWD may have.

1.2.1.2 The Limits model (disability as embodied experience)

This model accepts the fact that limitation in everyday life is experienced by all human beings, which varies not only for person to person but also for a person during different phases of life. It therefore accepts limits as a common aspect of human lives and equates limitation of humans regarding the ability to fly with someone who cannot walk. (Retief & Letšosa, 2018). Under this model, the categories like, disabled, able-bodied or normal body, are avoided whereas there is a focus on the 'a web of related experiences' that arise from the impairment and are physical as-well-as emotional in nature. In this way the experiences of a person with no vision are more alike a person who wears glasses with high power, than a person with locomotor disability. The model considers disability as an embodied experience which is similar to any other form of embodiment and denies any debate of normal versus abnormal and even the existence of categories of disabilities. It promotes the acknowledgment of individual experiences of disability in social interactions and practices so that none feels excluded and suggests to overcome limits through any possible ways.

1.2.1.3 The Medical model (disability as a disease)

This model, views disability to be present inside a person as a ‘defect’ or failure of some part of the body system. Therefore, disability is something abnormal and needs a cure. The interventions that are promoted under this model are a change in the physical condition through medical interventions and rehabilitation to habituate a person with a disability with the condition and environment.

This approach to disability has been observed in the definition of a ‘disabled person’ given by the United Nations, General Assembly, 1975, in the Declaration on Rights of Persons with Disabilities. According to the declaration, it is the deficiency in a person’s physical or mental capabilities that hinders the assurance of such necessities/ social life that are accessible to a ‘normal individual’.

This model has again been criticized by PWD groups who refuse to be called ‘sick’ or ‘deficient’. They blame the model for creating a notion that ‘able-bodied are somehow ‘better’ or superior to people with disabilities’ (Johnstone, 2012 as quoted in Retief & Letšosa, 2018). Moreover, this model also fails to differentiate between sickness and impairment.

1.2.1.4 The Social model (disability as a socially constructed phenomenon)

This model was developed in the early 1970s as a result of the criticism against the medical model of disability. This considers the social and physical environment to be the factors that disable persons with impairments. It, therefore, focuses on the change in social aspects of disability rather than bringing rehabilitation and adjustments to individuals. This model has also been referred to as the minority model and views disability to be a form of social oppression that happens due to the socially constructed disadvantage imposed by an ableist society on PWD. This model reflects in the Convention on the Rights of Persons with Disabilities (United Nations General Assembly, 2006), according to which, disability hinders a person’s full and effective participation in society due to the interaction of persons’ impairments with attitudinal and environmental barriers.

1.2.1.5 The Identity model (disability as an identity)

This has a similarity with the social model regarding disability being constructed socially, but at the same time, it denies it to be a form of oppression. This model rather affirms disability to be an identity that is positive. It emphasizes that all the PWD must be a part of one campaigning group to aid in the development of collective identity based on experiences and circumstances. Such campaigning groups have been quite successful in bringing about changes in the legal provisions and laws under the flagships of ‘civil rights’ and ‘equal opportunities’.

The identity model is sometimes criticized for making PWD outsiders to the mainstream society by identifying them as a separate cultural group.

1.2.1.6 The Human rights model (disability as a human rights issue)

This model too has commonality with the social model regarding the role of social factors in understanding disability, but it moves on still further by giving attention to the cultural identification while ‘encompassing both sets of human rights, civil and political as well as economic, social and cultural rights’ (Degener, 2017). In contrast to the social model of disability that criticizes the prevention of impairments through medical and health policies, the human right model brings into consideration the challenges, sufferings and pain that may be faced by PWD in their life while developing its theory of social justice and proposing prevention policies too that are properly formulated to protect human rights.

Through these six models of disability, we find the background behind the changes in the perceptions about the disability and PWD that has been reflected in various policies and societal norms from time-to-time. Regarding the model in which this research falls, it may be considered to be lying in the human rights model of disability.

1.3 Education status of students with disabilities (SWDs)

Coming back to the problem that has been identified as that of the low education status of SWDs in general and SVIs in particular, we can say that this is just a tip of the iceberg. The larger social problem is that of education faced by marginalized groups overall. In the case of PWD's, who form the world's largest minority group, Abu-Faraj (2012), points to the existence of a two-way link between disability and poverty. According to him, people who live in poverty lack access to safe living and working conditions, good health-care, nutrition, and sanitation. Due to these reasons, they are more at risk of acquiring a disability. Once disability occurs, they face barriers to education, public services and employment that again pushes them further into poverty. Table 1.1 provides data about PWD's in India.

Table 1.1: Distribution of persons by the type of disability in India

(Source: Verma et al., 2017)

Total population—1.21 billion			
Total disabled population- 20 million (2.21% of the total population)			
Vision 18.8% (5 million)	Hearing 18.9% (5 million)	Speech 7.4% (2 million)	Movement 20.3% (5.4 million)
Mental Retardation 5.6% (1.5 million)	Mental Illness 2.7% (0.7 million)	Other 18.4% (4.9 million)	Multiple Disability 7.9% (2.1 million)

The overall picture of education of SWDs is pathetic. Table 1.2 depicts a large number of out-of-school children with impairments at the elementary level of schooling and the extreme exclusion of the disabled at the university level.

Table 1.2: Status of education of children with disabilities

(Source: Social & Rural Research Institute, IMRB, 2014; Verma et al., 2017; Sharma, 2015)

Category of disabled children	**Number**
In 6-13 years age range	2.1 million
In above age range and enrolled in Elementary school	1.5 million (71.9% of above)
Out of school children in the above age range	0.6 million (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 levels of the population with disabilities is only 54.5 percent. Literacy rates for the female disabled population are even lower (around 44.6 percent) as compared to the national average of over 65 percent for the female population (Ministry of Home Affairs, 2011). The reasons for such a sorry state of education of SWDs have been elaborated in section 1.6.

1.3.1 Efforts made for the education of SWDs

Five major legislations that have some bearing on disability have been enacted by the Government of India and implemented at both the Central and State level. These are-

1. The Rehabilitation Council of India Act, 1992
2. The Persons with Disability Act, 1995
3. The National Trust Act, 1999
4. The Right of Children to Free and Compulsory Education (Amendment) Act, 2012
5. The Rights of Persons with Disabilities Act, 2016.

The education of children with disabilities 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 (National Council of Educational Research and Training. (2007), and the National Curriculum Framework for Teacher Education (National Council for Teacher Education, 2010). Despite the move towards inclusive education, a large number of SVIs still get educated in special schools due to various reasons, one of which is the lack of research on implementation aspects of inclusion (Jones et al., 2006).

The concerted and institutionalized efforts for uplifting the education status of SWDs 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 SWDs 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 SWDs in education.

Globally, the formal movement of inclusion is identified with the spread of the normalization principle, based largely on the writings of Bank-Mikkelsen and Bengt Nirje. This principle suggests that any action may be considered right only if it helps in providing such patterns of everyday living to persons with impairments, that are similar to regular circumstances and ways of living in their community (Billimoria, 1993). This principle was reflected in the Declaration on Rights of Disabled Persons (United Nations General Assembly, 1975) when it advocated the necessity of the promotion of **integration** of persons with physical and mental disabilities in normal life.

Based on the normalization principle, Wolf Wolfensberger developed his 'social role valorization theory' which specifies 'positive social roles' for all humans to counter the 'social devaluation' of the social roles of marginalized. The instances of social devaluation are reflected both in exclusion and rehabilitation and this may even be a 'tool for oppression' (Lemay, 1995).

The initial movement towards integration of the disabled and then the inclusion of all, gained momentum after the declaration of the year 1981 as the 'International Year of Persons with Disabilities'. This resulted in the formulation of such policies and plans in countries all over the world, including India, that would ensure exercising of rights of PWD by removing various obstacles (Tundawala, 2007). Some of the policies and programs that were implemented in India as an outcome of the International Year of Persons with Disabilities, 1981 are as follows-

- Project Integrated Education for the Disabled (PIED, launched by the Government of India in 1987) as a pilot project.
- The Program of Action (1992), which presented a chapter on the education of SWDs.
- The Rehabilitation Council of India Act, (RCI Act, enacted by Parliament of India in 1992), that laid the guidelines for the training of rehabilitation professionals and research in rehabilitation and special education.
- The District Primary Education Program (DPEP, launched in 1994), which implemented the PIED to all the districts of India.
- In the following year, the Persons With Disability (Equal opportunities, protection of rights and full participation) Act (1995), was passed by Government of India, which along with the specification of the do’s and don’ts for persons with disabilities, gave legal definitions for each disability and also extended the right of every SWD to free education till the age of eighteen years.

Importantly, all the programs, policies until this period focused on the integration of those SWDs into general schools and on accommodating them into the existing school and curricular structure. While India was following a model of integration, a shift of focus from **integration** to **inclusion** was initiated by United Nations Educational, Scientific and Cultural Organization (UNESCO, 1994). This was done through 'The Salamanca Statement on Special Needs Education to all Excluded Children in Regular Schools with Inclusive Orientation', which advocated the development of inclusive education systems for all children.

Another movement that looked into the issue of equality of educational opportunities was 'Education for All', led by UNESCO in 2000. This movement initially focused on the education of socially excluded children and overlooked the issue of disability. It was only after the flagship of Education of All (EFA), 2002, that 'the right to education for persons with disabilities: towards inclusion', got established and 'inclusive education' as a terminology began to be used for all groups of children including those excluded due to social, economical or disability reasons (Miles & Singal, 2008). The efforts for facilitating education of SWDs are highlighted in Table 1.3.

Table 1.3: Efforts made for the education of SWDs

Towards integration	**Towards inclusion**
International efforts	
1975, Declaration on Rights of Persons with Disabilities, United Nations, General Assembly 1981, International Year of Disabled Persons	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, MHRD 1992, Rehabilitation Council of India Act, MW 1994, District Primary Education Program, MHRD 1995, Persons With Disability Act, MLJCA	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, MHRD 2006, National Policy for Persons with Disabilities, MSJE 2009, National Curriculum Framework for Teacher Education, NCTE 2009, The Right of Children to Free and Compulsory Education (RTE) Act, MLJ 2012, The Amendment in RTE Act, MLJ 2016, Rights of Persons With Disability Act, MLJ

Note: The full forms of abbreviations used in Table 1.3 are as follows:

- MHRD- Ministry of Human Resource Development
- MW- Ministry of Welfare
- MLJCA- Ministry of Law, Justice and Company Affairs
- NCERT- National Council of Educational Research and Training
- MSJE- Ministry of Social Justice and Empowerment
- NCTE- National Council for Teacher Education
- MLJ- Ministry of Law and Justice

In India, the shift of educational model from the **integration** of children with disabilities to **inclusion of all** can be observed from the culmination of EFA in form of the Sarva Shiksha Abhiyan (SSA) launched in 2004 that emphasized the retention of SWDs in schools through various interventions. This inclusive process further got strengthened in India through the National Curriculum Framework (NCF) (National Council of Educational Research and Training, 2005), the National Policy for Persons with Disabilities (Ministry of Social Justice and Empowerment, 2006), and the National Curriculum Framework for Teacher Education (NCTE, 2010*)*. This has helped the education system to lay emphasis on making learning environments appropriate for all children with diverse backgrounds and needs, including children with disabilities.

The inclusive education movement in India also gets good support from the Constitution of India which guarantees a right to every child to get educated and that too in a school of choice. It ensures the *education of all* through Article 21A: The right of children to free and compulsory education act, 2009 (Ministry of Law and Justice, 2009). Also, *social equality* with equal access to all schools and colleges (maintained by public funds) is explained in Article 15: that prohibits discrimination on grounds of religion, race, caste, sex or place of birth.

To broaden the purview of attention towards inclusion in education, the Right To Education (RTE) amendment act, 2012 (Ministry of Law and Justice, 2012) considers SWDs as a disadvantaged group. Through this amendment, children with autism, cerebral palsy, and multiple disabilities have been included in the category of SWDs. The amended act also gives the right to free and compulsory education to SWDs in a neighborhood school till the completion of 18 years of age. Giving specific responsibility to government authorities regarding the above right, the RPWD Act, 2016 directs them to ensure that every child with a disability receives free education in an ‘appropriate environment’ till the age of eighteen years.

The review of literature regarding policies for education of SWDs suggests that currently in India there exist support to inclusive education from various educational programs, policies and laws. The only need is for a body of research to identify the areas that cause barriers to the implementation of these programs and policies and to find strategies to overcome these barriers.

1.3.2 Models of education for SWDs in India

Various models of education are being followed in different states of India for SWDs and the level of engagement of SWDs in the activities which are accessible to students without disabilities is different in each model of education. Some of these models are presented in detail below (Sources: Campbell & Mani, 2007; Natsume & Thamburaj, 2001; Sharma & Deppeler, 2005 and; Sood et al., 2004).

1.3.2.1 Special residential school model

This i**s** the most common, and the oldest, comprehensive and the most expensive model of service delivery for SWDs in India. It provides instructional, food, residential, extracurricular, recreational, health-care and administrative services all in one place. Generally, these schools provide education till elementary levels and in some cases till secondary level. This model has some issues that have been discussed in detail in section 1.4 where issues of special schooling are discussed.

1.3.2.2 Integrated education model

This model refers to the measures taken to provide educational resources within the general education system for children who need them, to whatever extent is feasible and beneficial. The aim here is to avoid or reduce restrictions on any aspects of child development which might result from segregated settings. Some of the models that come under this broad model of education are:

Resource model of integrated education, which encourages the admission of 8–10 SWDs into one school, where a special teacher provides support to the students and their teachers. Resource models with residential facilities are working in states of Tamilnadu, whereas such schools without residential are operational in Orissa and Madhya Pradesh.

The Self-contained classes model has been adopted by some private schools in India. In this model, the classroom of SWDs is separated from a general classroom within the regular school and the special education teacher is responsible for the instruction of all academic subjects.

In the ***Itinerant model*** of integrated education, SWDs are enrolled in local schools, but the visiting (itinerant) teachers provide support to the children and their teachers. Itinerant programs are operational in some places in Gujarat and Maharashtra.

The ***Composite Area Approach*** has been adopted by Project Integrated Education for the Disabled (PIED), under which all regular schools within a specified area, referred to as a block, are converted into integrated schools. These schools share resources such as special education teachers, specialized equipment, instructional materials, etc. An extensive multi-level teacher training program is made available to teachers in each selected block. Some of the teachers who undergo a one-year multi-category training program act as resource teachers.

The ***Cooperative model*** is the reverse of the resource model. Here SWDs are enrolled in a special school with a special (resource) teacher for learning and also go to the regular classroom for a part of the day in order to join the mainstream of regular learning with sighted children. The special teacher is here responsible for this program in co-operation with a regular teacher.

In the ***Dual teaching educational plan***, the regular teacher is also trained to be a special resource teacher. Such a plan is working in Mizoram and Nagaland where transportation between different localities is not easy.

Preparatory schools model provides one or two years of preparatory services to SWDs at a central place that may be a day school or residential center. Here the children are imparted training in skill development, pre-braille, Braille, orientation and mobility, as well as in activities of daily living and socialization. After this training, children are enrolled in regular schools, which may follow any model of integration.

1.3.2.3 Inclusive education model

As a principle, the inclusive approach to education requires schools to make appropriate adaptations in their learning environments so that each classroom is able to address the learning needs of all children, including children with disabilities. It requires a regular school teacher to be supported with a supply of special teaching aids and materials; assistance by parents, older students and special educators; modification or adaptation of physical environment, curriculum, time-table and evaluation procedures as per specific needs of the child; and in-service training to upgrade the skills and knowledge of teachers. Some of the models of inclusion that are functioning in schools have been reported by Mukhopadhyay (2019) and Essays (2018).

The ***consultive model*** of inclusive education is generally followed in government schools of Delhi and in central schools. Here the special educator is in the role of a consultant and assists the regular teacher in understanding the needs of SWDs. With the help of subject teachers, the special educator develops an Individualized Education Plan (IEP) for each SWD which suggests the appropriate accommodations that must be made to meet the needs of the child in the regular classroom. In addition to this, the special educator also works directly with the SWDs for sometime per month. Such a model helps in facilitating the transition of SWDs from special schools to general/inclusive schools.

Shadow teaching is another model of inclusion in some private schools in India. A resource/special education teacher and a general education teacher share the teaching responsibilities for the SWDs in a class. Both teachers are equally responsible for planning, the delivery of instruction, grading, IEP implementation, and classroom management but the focus of the shadow teacher remains more towards the educational goals of the SWDs. The presence of a shadow teacher facilitates the differentiation of instruction of SWDs as per their learning needs. The model works with a belief that instruction is enhanced for SWDs when there are two teachers in a room with different areas of expertise.

In the ***preparatory schools model,*** the school provides one or two years of preparatory services to SWDs at a day school or residential center to impart training in skill development like pre-braille, Braille, orientation and mobility, etc. After completing such a preparatory period, the children are included in regular classes. The other model that some of the schools follow to provide such specialized skills is **the *resource classroom model***. In this model, a small group of SWDs are detached from the regular classroom to receive basic academic skills or acquire learning strategies in the resource room of the school. This intervention is provided by a special educator who is highly qualified to provide learning experiences to SWDs in that specific academic area. The learning experiences that are provided in the resource room are determined by the student’s IEP. Such IEP’s are again specified by the IEP committee which is formed and includes the special educator, subject teachers and parents of the students.

Although the existence of these models suggests that there is momentum towards inclusion, there is also a need to resolve some severe challenges of the unique learning needs of SWDs. Such challenges generally arise from the requirement of the use of special assistive devices and alternative forms of media, such as Braille in the classroom. Many a time these children may also need additional areas of instruction, including reading and writing Braille, sign language, orientation and mobility, and daily living activities. All these models that have been discussed above practice a partial inclusion in one way or the other, but the two models that have been said to be examples of full inclusion (Essays, 2018) are ***Collaborative teaching*** and ***Mainstream experiences for learning disabled.*** In the former, there is a collaboration between the subject teacher and special educator for the day to day learning activities in schools. Through their daily contact, they decide who will teach what, they teach together and they both aid all the pupils. In the latter model, all the SWDs are encouraged to attend regular classes in general schools and the highly trained special educator does weekly co-planning with subject teachers regarding the resources required and the classroom strategies for inclusive learning sessions.

Looking at a large number of different models of inclusive education it can be said that inclusive education is still in an experimental stage in India and a national consensus in implementing the strategies has not yet emerged. This makes the present research even more important.

1.4 Issues with special schooling

As discussed earlier, special schools form the oldest organized efforts that have been made specifically towards the education of SWDs and are generally rooted in the charity model of disability (Das & Shah, 2014). They provide instructions that are specifically tailored to cater to the needs of those learners with a disability who could not be provided education in regular schools due to some reason. Special schools manage resources and services for accommodations, modifications, or remediations through academic and psychological counselling, tutoring programs, speech-language therapy, physical and occupational therapy, and learning aids that are crucial for children with particular disabilities at a single place. A larger number of special schools tend to be residential too. Though often, if not always, these schools were well-intentioned initiatives but due to various issues this model of schooling is being discouraged now.

The foremost objection that is raised against special schooling is that it actually leads to ***social segregation*** of young learners by either confining them away from the family and home environment (in case of residential special schools) or prevents them as well as other students a chance to interact with each other. In this way, the students may interact and learn only with peers who have similar needs, abilities, or disabilities and thus lack diversity in peer/social experiences and influences. Even if this segregation is done in the name of securing/fulfilling the specific learning needs that are not being addressed in regular schools due to the insensitivity of the stakeholders, it can never be justified. Through such segregating practices, special schooling becomes a means of ensuring no changes occur in the mainstream education to responding to ‘students' real needs’ (Clark et al., 1999). In a sense, such schooling is ***against the social model of disability*** which understands disability to be arising not due to the embodied differences, but from processes of interaction and inaccessible institutions (Powell, 2016).

Another issue with special schools is that while catering to the needs of children with a particular disability, they ignore the learning needs of other learners. Due to a focus on a single disability, the school becomes inaccessible to other students, thereby leading to low enrollment. In a country, where single teacher schools are still running with minimal resources, such a special system becomes ***uneconomical.*** Moreover, It as mentioned before most of these special schools and institutions are located in large towns and cities (Natsume & Thamburaj, 2001) thereby becoming inaccessible to rural persons with impairments.

Also, in the Indian scenario, special schools generally offer less rigorous courses in their secondary schooling and drop subjects like mathematics and science which are considered to be 'difficult' for the SWDs. Lack of science teachers and science learning materials is a regular feature in special schools. This is largely due to ***low expectations*** of curriculum planners, teachers, parents and society from SWDs (Sacks et al., 1992) which gets reinforced in special schools. Such practices hinder SWDs from opting for subjects of their interest at higher levels of education and also results in reducing their career options.

The website ‘Our kids’ (https://www.ourkids.net/school/special-needs-school-benefits) reports that the transition phase from a special school to a regular school is a great challenge for SWDs. Such challenges generally arise from the long term alienation of SWDs and regular school students from each other’s ‘worlds’ that results in severely impeding the academic, emotional and social growth of SWDs. In addition to this, the ***stigma*** that arises from the labeling that students from special schools get during the transition to regular schools may also cause problems with other kids in class or school. At the same time the lack of exposure to diversity makes the children in regular schools insular and prevents them from developing healthy interactions with SWDs.

1.5 Need for inclusion in education

Inclusion is not merely a way of education, it indicates the progress of humanity considering the benefit of all. This philosophy may not be a key to success but it does ensure an enlightened citizenry capable of making rational decisions. Inclusion in education has received support from research literature all over the world and also from the constitution of India.

1.5.1 Literature support

The United Nations Educational, Scientific and Cultural Organization (UNESCO,1994), proposes an inclusive orientation in regular schools to build an inclusive society, overcome discriminatory attitudes and achieve 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. Thus, students are not to be excluded from any key educational processes because of their gender, class, race, or ability but have to 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.

Research studies report positive effects of inclusion in education on students’ academic achievement, basic communication and motor skills (Katz & Mirenda, 2002). Studies have also reported social benefits of inclusive education for all students, with or without disabilities (Rule et al., 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). Also there have been studies that have indicated that there were no significant differences in language skills and social behaviour of SWDs at elementary levels of schooling, studying in inclusive and special education settings in the USA (Lal, 2005). Such studies have played an important role by relieving educationists from the anxiety of any disadvantage that SWDs may face in inclusive settings as compared to special education settings.

The foreword of United Nations International Children's Emergency Fund (UNICEF) (United Nations Children's Fund, Nepal & UNICEF, 2003), focused on inclusive education in India, estimates that merely through positive approach and accessible environment of institutions, 70% of children with disabilities (including children with mild intellectual disabilities) can be accommodated in regular schools.

1.5.2 Constitutional obligations

There are certain provisions in the constitution of India in the form of duties and rights, for the fulfillment of which, the inclusion of all students in education is a must. These constitutional provisions are:

- *Article 21A*: Right to Education (RTE) places responsibility on the State to provide, free and compulsory education to all children in the age range of 6 to 14 years (18 years in case of SWDs through amendment, 2012 in ‘neighborhood school’) (MLJ, 2009 and MLJ, 2012), thus, making education a fundamental right in India.
- The constitution also gives all its citizens a fundamental Right to Equality through *Article 15 (i)* and *Article 25 (ii.b)* for social equality and equal access to public areas which includes all schools and colleges maintained by public funds. It thereby makes it mandatory to every government and government-aided school to make its infrastructure accessible to each child.
- Rights of PWD Act, 2016 directs the state to ensure the right of every child with a disability to receive free education in an ‘appropriate environment’ till the age of eighteen years (MLJ, 2016).

- *The Article 51A (h)* of the Indian constitution makes it a fundamental duty of every citizen to develop scientific temper, humanism and the spirit of inquiry and reform. Thus, the constitution acknowledges the significance of science for a rational and egalitarian society. Therefore, it is a violation of this fundamental duty when a child is prevented from acquiring science education on the pretext of its being difficult or due to a lack of available facilities.

1.6 Barriers to inclusion

Purely from observation of the schools in India it becomes clear that despite legal provisions and policies, inclusive education is not yet a reality. The reason for this could be that some barriers have to be overcome for the successful implementation of an inclusive educational program. While it is important to note that all barriers cannot be addressed through policies alone; what is actually needed is sensitization of masses towards the loss that is incurred as the potential of individuals is not tapped and they are prevented from contributing progressively to society.

In the words of Stephen Hawking…

> *People with disabilities are vulnerable because of the many barriers we face: attitudinal, physical, and financial. Addressing these barriers is within our reach and we have a moral duty to do so...... But most important, addressing these barriers will unlock the potential of so many people with so much to contribute to the world.* (Verma et al., 2017, p. 1).

Let us now have a look at the barriers that have led to the very slow implementation of inclusion in education.

1.6.1 Attitudinal barriers

It has been identified by UNESCO (2010), that it is public attitudes, which pose a big barrier to equal opportunity of education in India. Sharma, Forlin, Loreman and Earle (2006) in their research indicate that negative attitudes towards PWD may lead to low expectations which in turn can lead to reduced learning opportunities for them. In a similar way, Changpinit et al. (2007), in their study report that educators having relatively positive attitudes towards inclusion of SWDs also have good knowledge and relatively low concerns about it. A common attitude among stakeholders towards marginalized groups, including the disabled that 'they cannot learn' is a major barrier to inclusion in education. Such an attitude among educators, parents, and peers towards SWDs creates a dire condition of low expectations from them, which in turn creates a poor self-concept in SWDs regarding themselves in the context of education (Fraser & Maguvhe, 2008). Sharma, et al. (2006) suggest that positive attitudes towards SWDs and better confidence in implementing inclusion in education can be developed among pre-service teachers through additional training and/or experience with disabled persons.

1.6.2 Lack of accessibility

The policies regarding inclusive education remain ineffective if a student with a disability does not have access to the classroom. The first and foremost barrier faced by a student is while getting enrolled in schools. Sometimes, the distant location of the school, lack of transport facilities to reach school and even the economic condition of the family render the school inaccessible to students.

Next the lack of inclusive infrastructure poses a serious barrier to the process of inclusion in education. The entry of a SWDs into classrooms should ensure that the classroom accommodates students' assistive devices, as well as other furniture to meet their individual needs. Many schools are still inaccessible to students who use wheelchairs as there is a lack of elevators, ramps, paved pathways and lifts for going around in buildings (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 intellectual 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, the school activities like assembly, annual functions, sports day, within/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.

1.6.3 Lack of trained teachers

Julka (2012) and Ahmed (2018) report on 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 especially in inclusive classrooms. Due to this lack of training, a teacher, despite a positive attitude and good intentions often feels unprepared to educate SWD in his/her classroom. In addition a general observation is the lack of candidates with a science background who apply for the pre-service training in special education. Special educators are thus generally not able to suggest inclusive strategies for learning of science. These factors create a dual barrier regarding the competency of teachers for imparting quality learning experiences in science to SWDs.

1.6.4 Curricular barriers

An education system focused on competency in the learning of 3R's (reading, writing and arithmetic) cannot move further to experiential learning, thus leaving behind a large section of learners marginalized. In the case of parents of SWDs, the ‘fear of their abuse or neglect in the classroom’ due to their inability to keep with the curriculum and the ‘distrust in both the special and mainstream education systems’ force them to keep their children at home (Giffard-Lindsay, 2007). Christine (2008) points at almost no attempt made to address the exclusionary nature of the curriculum, especially the evaluation procedures, which has kept the process of inclusion ineffective for a very long time.

1.6.5 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 practices in schools; lack of knowledge among the education stakeholders regarding the effect of impairments on the learning process and lack of special co-educators in schools (Auluck, 2012). Gillies and Carrington (2004) point to a dire need to review the attitudes of administrators and instructors, organizational structures as well as curriculum and pedagogical practices of science education, to bring about a transformation in the inclusion of all children.

1.6.6 Lack of adaptive technology

For efficacy in the educational program, SWDs need an access to modified aids, and equipment and content materials that are appropriate to their needs, modes of perceptions and learning preferences (Broderick et al, 2005). Such adaptations 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 diagrams, peer support, additional time, fewer items or questions to address and multi-modal presentations, etc. But there is a marked shortage of such resources in Indian classrooms.

1.6.7 Lack of communication among stakeholders

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

1.7 Services required for the education of SWDs

To overcome the barriers to inclusion of SWDs in education, a system needs to be developed that delivers and monitors different services required in this direction. Such services, under any model of education, can be categorized under five main headings namely administrative, curriculum, support services, communication and external support agencies. All these required services, as described by Natsume and Thamburaj (2001); Sood et al. (2004) and; Mukhopadhyay (2015) may be further subdivided:

Administrative services would be required to concentrate on-

- specific funding by the government for providing allowances to SWDs
- development of inclusive infrastructure and other facilities
- making of appropriate and clear admission policy for ensuring easy admission to SWDs in schools
- decisions regarding the location where education or extra intervention must be provided to SWDs. This may be a regular class, activity class or a special section as per the policy and norms

The curriculum specifically designed to ensure the inclusion of SWDs would require:

- development and implementation of inclusive courses
- developing and providing adapted teaching-learning material (like, with Braille/ tactile markings or any other modifications) to teachers and learners
- flexibility in examination system by taking decision regarding making some adaptation in exams or giving relaxation to SWDs or conducting common exam
- transaction of the adapted curriculum in classrooms through the individualized educational program (IEP).

Some specific **support services** that are needed for SWDs are:

- transport facilities specifically developed for catering to needs of students while traveling to and from schools
- making Braille books, magazines and talking books and other relevant learning material, readily available in libraries

- providing reader and recording services to those who need them
- providing special educators in every school
- conducting teacher training and workshops to update teachers with information and strategies regarding effective, inclusive practices in classrooms
- developing specialized services for an assessment of educational institution as per the norms
- providing medical support services to the SWDs
- community and parental support
- arrangement of training to SWDs for using assistive devices like talking computers and optical aids.

Communication among stakeholders is another important service that is required for:

- creating mass awareness regarding legal provisions and policies for education of SWDs
- interaction and exchange of educational expertise between different institutions that are working for a common cause
- maintaining coordination among agencies to help and monitor the implementation of an inclusive process.

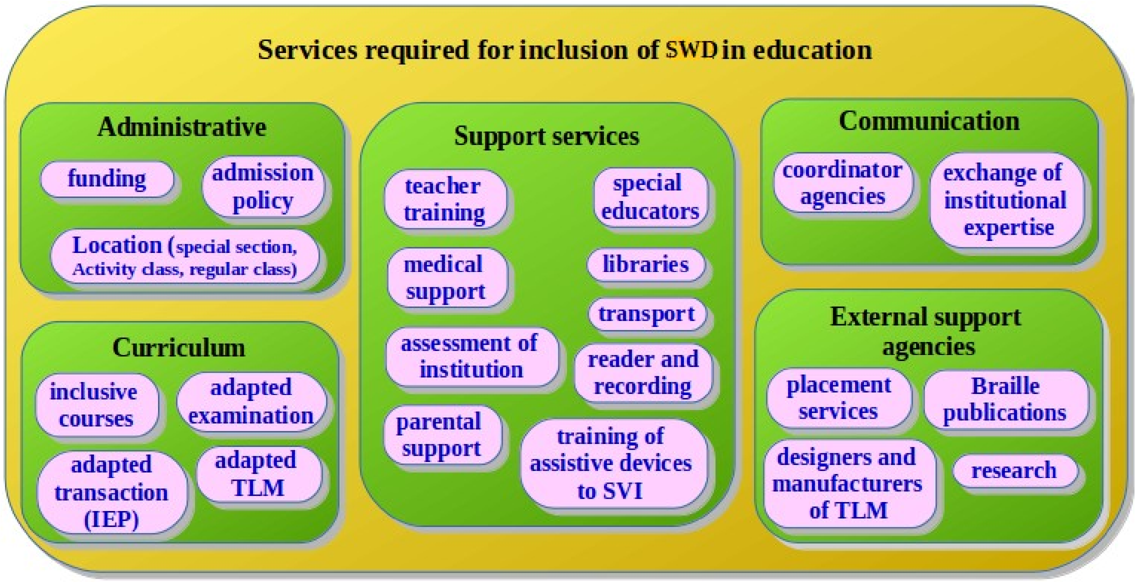
External support agencies are a must for the proper implementation of all other services. Some such agencies can be:

- specialized organizations for the development of affordable technologies and teaching-learning material to facilitate learning to SWDs
- Braille presses and publications
- research organizations for identification of areas where specific impairment poses severe learning difficulties and devising suitable strategies and pedagogy for resolving them
- job training and placement services.

Figure 1.1 gives a diagrammatic representation of the above-mentioned services for inclusive education.

Figure 1.1: Services required for inclusion of SWDs in education

(Source: Adapted from Mukhopadhyay, 2015)



1.8 Status of science education in India

Despite a sincere constitutional obligation towards scientific literacy, science education acts as an exclusionary device in India. The criteria of high over-all percentages in class X to get admission to science courses in junior colleges disproportionately filters out many children largely from disadvantaged groups. In some states of India like, Delhi and Maharashtra, the medium of instruction of science has formally been declared to be English at the senior secondary level. The need of learning a foreign language in order to learn science creates an extra cognitive load on students and becomes a strong cognitive, elitist language barrier for students from marginalized groups. That limited number of schools/junior colleges offer science after class X and that these are often located in select urban locations and are also elite private institutions creates another filter, as do the poor facilities for science learning at elementary and secondary levels in institutions located in rural and backward areas. Besides, the lack/ unavailability of supportive facilities that are required for children with disabilities, greatly hampers their science learning. How sad it is to find instances of unequal access to science education in India, even after a period of 70 years of the Indian Constitution!

The India Science Report (Shukla, 2005) states that better employment opportunities are available to persons with higher qualifications in science and related courses but the claims of equity actually prove out to be an illusion because the weaker sections of society still lack access to science education. After acknowledging the role of science education in accelerating the national economic growth, the National Policy on Education, 1968, (MHRD, 1998) recommended science as an integral part of general education till the end of the school stage. Again the National Policy of Education, 1986 (MHRD, 1998), made reforms in the curriculum to ‘extend science to the vast numbers who have remained outside the pale of formal education’. But all these steps are insufficient as there is no focus on 'Science for All'. Instead Mukherjee and Varma (2001) and; Garg and Gupta (2003) report a decline in enrollment in science education at the higher levels. The reason for this decline as reported in India Science Report (Shukla, 2005), is that at the +2 level, a larger number of students do not opt for science and state that this is because it is uninteresting and costly. This points to the ineffectiveness of the earlier attempts that have been made to make science accessible.

1.8.1 Need for inclusion in Science

In order to make the Right to Education a real success in India, the boosting up of science education by making it all-inclusive is a must. Such an inclusive thrust to 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 the human society. By adding new dimensions of cultural and sensory diversity into science more holistic and lively progress is expected to take place in science. This would require the implementation of the existing body of research in inclusive education to science education from the initial stage of planning itself, be it curriculum, infrastructure, training, or the social aspects of schooling.

Research exemplifies that inclusion in science is possible but the statistics give evidence that in spite of several efforts made towards achieving inclusion in education, the inclusion movement in India has not yet lost its inertia. It is most imperative to focus on what are the barriers to inclusion in science. It is proposed that science education can be made inclusive through-

- development of positive attitudes towards inclusion in science
- improving the academic environment in classrooms
- systematization of strategies that have been found to be effective in making science education inclusive
- use of adaptive technologies
- raising expectations of students who have disabilities as well as societal expectations.

1.9 Focus of the study: Science education and students with visual impairments (SVIs)

In today's world of information explosion, a lack of knowledge of science and technology can prevent active participation in society. Regarding science for SVIs, Jaworska-Biskup (2011) identifies that-

- limited hands-on-experiences with scientific equipment and aids
- delayed de-contextualization due to overemphasis on visual mode
- high dependence on the contextual cues among the SVIs due to lack of awareness of effective pedagogy for teaching science to SVIs

- cause a delay in conceptual understanding and excessive egocentric responses among SVIs. This indicates that the academic difficulties faced by SVIs are a consequence of the in-built structure of the science teaching-learning process that is heavily dependent on visual modes. While SVIs have the same range of cognitive abilities as other students, the excessive reliance on the visual mode for teaching science causes academic problems for them. 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 SVIs.

Such practices often puts undue pressure on SVIs to opt for subjects other than science despite their having high aspirations to excel in science. Also, the provision of the choice of less rigorous subjects for SVIs 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 SVIs to not opt for science. This is largely because schools take the easier path rather than involve SVIs in science experimentation and laboratories. In this way, the system that is actually intended for the benefit of SVIs debars them from a very important area of learning.

A live example of the sad state of the science for SVIs 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 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).

Some other problems that have been identified as being faced by SVIs are-

- Inaccessible school infrastructure and activities (Ahmed, 2018).
- Lack of confidence and motivation due to excessive dependence on visual mode in teaching.
- Rigid curricula, especially the evaluation (Christine, 2008).
- Lack of research on pedagogy (Kumar et al., 2000).
- Pessimistic attitude, (UNESCO, 2010) and low expectations held by education stakeholders (Fraser & Maguvhe, 2008), which get strengthened by the provision of a choice of less rigorous subjects for SVIs.

- Limited availability of sources of reference, encyclopedias, relevant publications and adaptive technology (Taraporevala et al., 2013).
- Lack of trained teachers (Julka, 2012; Ahmed, 2018).
- Low-quality education in schools (Peters, 2004; Auluck, 2012).
- Lack of communication among stakeholders (Sharma & Deppeler, 2005; Heyne, 2003).

Considering that the excessive dependence on the visual mode of teaching is a major challenge to learning of science by SVIs, it is reasonable to explore a variety of experiences that are useful to SVIs as-well-as others for learning and doing science that are not dependent only on visual modes. Several studies have focused on modifications that can readily make the experimental as well as theoretical aspects of science education accessible to SVIs (Wedler et al., 2013 and Kumar et al., 2001). Experiences that have been found effective for science learning for SVIs 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. Kizilaslan and Sozbilir (2019) and Kizilaslan et al. (2019) in their study with SVIs in special school found that by using low cost tactile material and through the use of interactive science activities, science can be made more accessible to SVIs. Kizilaslan et al. (2020a and 2020b) in their studies with SVIs, again in a special school, found that in addition to the above, the peer learning opportunities are also helpful in effective science learning. Also, to increase the accessibility of science for SVIs we need to raise expectations from SVIs, identify their learning needs/styles and make adaptations in the education process accordingly. Jones et al. (2006) envisage an urgent need for studies to focus on inclusive curriculum. It has been proposed that inclusive education which focuses on considering the learning needs of SVIs would be beneficial not only to SVIs but also would raise the quality of education for all, regardless of the difference in abilities or disabilities (Sharma & Chunawala, 2013a).

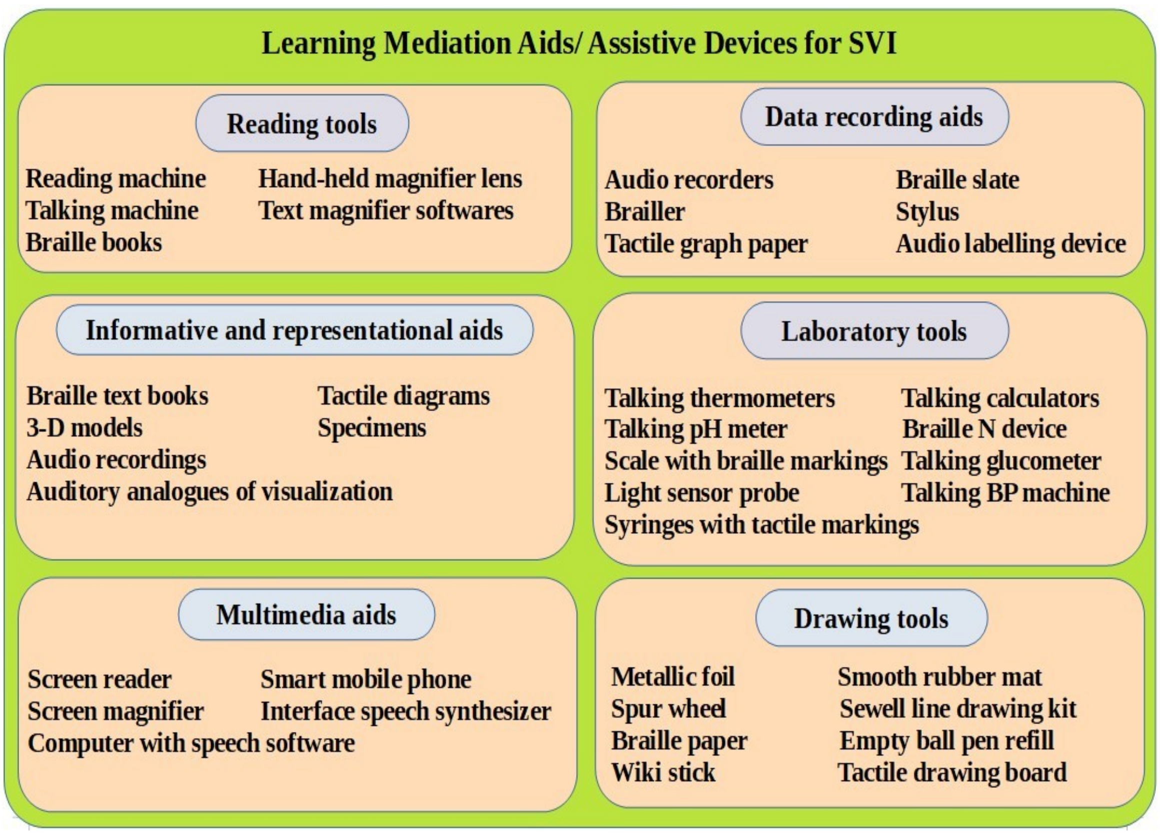
1.9.1 Learning mediation aids/assistive devices for SVIs

Some of the available learning mediation aids that have been reported by Fraser and Maguvhe (2008); Hill (1995) and the Taraporevala et al. (2013) to make science learning more accessible for SVIs 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.

Figure 1.2: Learning mediation aids/assistive devices for SVIs



Laboratory tools: Talking thermometers; talking calculators; talking pH meter; Braille N device for reading outputs of balances; scales with Braille markings of numbers at specified distances; syringes with the tactile marking for measuring out accurate amounts of liquids (as a substitute of the 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; tactile drawing board.

1.10 Definitions of important terms

The important terms that have been used in the study are:

- *Students with disabilities (SWDs):* Those students whose full and effective participation in the learning process may get hindered due to either one or more of the disabling conditions as mentioned above are generally termed as students with disabilities.

- *Students with visual impairments (SVIs):* This terminology is used for those students whose learning process may differ from other students due to either one or more of the conditions as mentioned in the Persons With Disabilities Act (Ministry of Law, Justice and Company Affairs, 1996), such as, (i) total absence of sight (ii) equal or lower than 6/60 Snellen visual acuity in the better eye with correcting lenses (iii) 20 degree or lesser angle of the field of vision.

- *Inclusion*: Refers to a broad social model of adapting organizational or community facilities and processes to diversity, thus including persons with disabilities and other vulnerable or oppressed groups.

- *Inclusive education:* A system of education that endeavors to ensure that whatever is happening in an educational setting, all students must feel part of it, without making some feel special or disabled. It does not support special arrangements for the benefit of underprivileged or gifted children, yet it urges creating an environment that supports the optimal development of all students, regardless of their differences in abilities. The Rights of Persons with Disabilities Act (RPWD Act), 2016 defines inclusive education as, "a system of education wherein students with and without disability learn together and the system of teaching and learning is suitably adapted to meet the learning needs of different types of students with disabilities." (Ministry of law and Justice, 2016).

- *Aspirations in science:* These are the goals, expectations and intentions of a person regarding science.

- *Attitude:* It is defined as, "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 2007).

- *Representation:* Those verbal or non-verbal experiences of entities and/or phenomena that are not actual but may provide learning that has similarity with actual experiences and leads to the transformation of original experience are called representations. Representations may be **(1)** *internal*, which are the internal translations of external stimuli. These not only eliminate information from the external world but also add to it and distort it in the service of interpretation or behavior defined (Tversky, 2004) **(2)** *external*, which are displayed through variety of modes including gesture or kinesthetic experience. The external representations may or may not result in internal representation (Gilbert, 2008).

- *Visualization*: It is the mental representation of something that is not physically present. As described by Gilbert (2008), visualization involves the mental representation of an entity on the basis of its external representation and this occurs in such a way that the spatial relationship between the components of the entity remains unchanged.

- *Cooperative learning:* It is a specialized teaching-learning strategy that provides social contexts of learning which traverses the distance from what children cannot do towards what they can do (zone of proximal development) and is mediated through peer cooperation. This strategy has gained momentum through the social development theory of Vygotsky and is used by teachers with small groups of students in classrooms to perform learning activities to facilate the learning of the group members. According to Roschelle and Teasely (1995, p 70), cooperative learning is a “coordinated and synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of the problem”.

1.11 Related terminologies and their meanings

Given below are some of the terminologies that are either used in this thesis or in the concerned literature. These are closely related to the study and clarity on them is necessary to avoid any miscommunication.

1.11.1 Terms closely related to disability

The terms impairment, disability and handicap are closely related and often confused by people. These have been clearly defined by the World Health Organization (WHO, 1980) as,

Impairment refers to any abnormality or loss that may occur in the physiology, psychology or anatomy of the affected person.

Disability refers to an externally imposed condition, in which a person with some impairment lacks the capacity to do something which a person without the impairment could do easily in otherwise similar conditions.

A *handicap* refers to a detrimental result of impairment due to which a person may not be able to perform his/her role to the extent that is considered normal for anyone with similar age, society, gender or culture. It is preferable to replace ‘handicap with disability because the conceptual meaning of ‘handicap’ emphasizes the disadvantage being located within the person (Jablensky, 2000).

1.11.2 Terminology used for persons with disabilities

The terminology used for persons with disabilities has also seen major changes over time. Terms that were acceptable in past like, 'cripple', 'retarded', 'wheelchair-bound', 'sufferer', 'victim', 'patient' are now in disrepute among disability advocates, practitioners in this area, researchers, and scholars. Terms like, 'the disabled', 'the handicapped' are considered to be equating the person with a disability, denying the individuality (Auslander & Gold, 1999), whereas, terms like 'challenged' point at the conditions arising from non-supportive environments, which can be modified.

The term which has been recommended to be used is “person with a disability, which follows the thumb rule of 'person first', thus, emphasizing the person-hood or individuality of the person. The preposition 'with' separates the disability from a person, both grammatically and figuratively” (Zola, 1993, as quoted in Auslander & Gold, 1999). An example of an acceptable terminology is 'person with visual impairment' or 'person who is blind'.

As defined legally in the Persons with Disability Act (MLJCA, 1995), “Person with a disability means a person suffering from not less than forty percent of any disability as certified by a medical authority”.

In an educational context, the phrase 'Children with Special Education Needs' (SEN) is used for students whose education program needs to be officially altered from what would normally be provided to other students. Generally, such students are those with disabilities (Wikipedia, http://en.wikipedia.org/wiki/Special_needs). In 2014, the term 'differently-abled children' was found to be used in the circulars made by officials of the Directorate of education in Government of National Capital Region, Delhi to avoid the term disability. The term 'divyang' (divine body) was also proposed by the Prime Minister of India to be used in place of the ‘persons with disability', but the term is still contested and has not been accepted by all.

1.11.3 Terms closely related to inclusion

Mainstream: The educational settings in which children with disabilities study in the general schools. However, this may refer to attending some general education classes for less academically rigorous subjects like physical education, drawing or music, but attend classes for more rigorous subjects like science, mathematics, language, in separate classrooms with students having similar disabilities.

Integrated education: Here children with disabilities attend a regular school whenever possible. The emphasis is upon the student to fit into the system rather than the system to adapt to meet the educational needs of the student.

Full inclusion: This setting endeavors to make the learning environment available, accessible, affordable and appropriate to all children by taking into consideration their abilities and disabilities.

Partial inclusion: In such settings, the students with special needs are educated in regular classes, but are required to occasionally leave the classroom to receive specialized services that either requires special equipment or are disruptive to the rest of the class.

Segregation: In such settings students with specific disabilities like autism, cerebral palsy, vision impairments, hearing impairments, etc. attend special schools that have students with similar disabilities and undergo a specialized curriculum aimed at making the students capable of earning their livelihood or developing skills for accessing education in general settings.

1.12 Overview and structure of the thesis

This thesis reports-

i. the development of inclusive education movement and status of inclusion in science education through literature survey

ii. the aspirations of students with disabilities in science through a survey

iii. the level of social acceptance of inclusion in education among teachers, parents and students through qualitative and quantitative survey and

iv. the strategies of teaching science to children with visual impairments currently being used by educators as well as those developed by the researcher in this study.

The thesis has been divided into 7 chapters. The **chapter 1** has described the motivation behind this research which arose due to the sad state of education faced by SWDs in general and specifically the difficulties faced by SVIs in science. The chapter has presented the process that has given momentum to inclusive education and the status of inclusion in science education, specifically focusing on the status of SVIs in science education. A scrutiny of the status and efforts that are being made in India for the education of SWDs gives us a clear picture that certain barriers to inclusion of SWDs have hindered the administrative and legal efforts made to raise the educational standards for all the learners in the country. The literature shows that a vast amount of information and a large number of resources are already available in the field, but there is need for research into appropriate implementation of policies. The literature survey in this chapter also informs that science education for SVIs is still a challenging area and perhaps the solution is an inclusive approach in education. The later part of the chapter also introduces the field of inclusive education through some definitions and clarifications of related terminologies. The current study attempts to collects first-hand information about the need and status of inclusion for SWDs in India and then uses the research literature for developing and testing some strategies that would be effective in giving science learning experiences to SVIs in Indian classrooms.

Chapter 2 presents the literature that has been reviewed to understand various important aspects related to the study such as, aspirations of students in science; attitudes of teachers, parents and students towards the inclusion of SWDs in education and; strategies that may be helpful in making science education inclusive and effective for learners. This is followed by **chapter 3** that presents the gaps in the research literature, the research objectives and research questions that have been addressed and sought to be answered through this study. This chapter also shares the methodology and ethical considerations that would be helpful for the readers to form a mental picture of the thesis. The details of the data collection tools, sample, administration of tools and analysis have also been added in chapters 4, 5 and 6.

Chapters 4 and **5** 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; the gap between the actual status of science education for SWDs and their expectations from it and; the social acceptance of inclusive education among the stakeholders (teachers, students and parents).

Chapter 6 presents the three studies that have been done to learn the process of learning science in some learning situations with SVIs, developed by the researcher of this study. These learning situations have formed the basis of the strategies found to make science education effective for SVIs. These strategies have been identified as- cooperative learning in inclusive settings; opportunities for visualization and the use of multiple representations in teaching-learning.

Finally, **chapter 7** presents a summary of the answers to research questions as obtained through the various stages of this research. The most substantial part of this thesis, the findings and methodological as well as literature contributions of this research have also been reported in this chapter. The other important segments of this chapter are regarding the limitations of the study and recommendations for the stakeholders and future researchers. This last chapter ends with a personal postscript that presents the growth of the researcher while experiencing this research.

Chapter 2

Review of Literature

As introduced in chapter 1, this thesis explores the need and status of inclusion in science education in India and the strategies for teaching science to students with visual impairments (SVIs). This chapter reviews some literature on the i) aspirations of children in science ii) attitudes that different stakeholders have regarding the inclusion of SWDs in education and iii) the learning strategies that have been reported to be effective in science classrooms by different researchers. This literature review has formed the basis of the surveys and interventions done in this study and each review area mentioned above forms a chapter of this thesis.

2.1 Students' aspirations in science

The term ‘aspirations’ has several different meanings and for this study, it needs clarification. Ball and Wiley, (2005 p. 37) state that aspirations of children are ‘a reflection of what they wish to become and (these) subsequently guide many factors that impact what they will eventually do in life.’ The importance of aspirations is highlighted by Sherwood (1989, p.61), who associates aspiration with goals and states that aspirations develop in students to ‘invest time, effort or money to attain a goal’. According to Quaglia and Cobb (1996), the term aspiration refers to goals, expectations, dreams, intentions and performance motivation.

Many studies have tried to identify the factors that affect the aspirations of learners in science while in school and whether these were later pursued. For instance, Tai et al’s. (2006), longitudinal study in the USA, reports that students, around 14 years who had aspirations in science-related careers, tended to pursue science in higher education, 3.4 times more than those students who did not have such aspirations. Also, Mau (2003), in a nationwide quantitative study conducted in the USA, reported that persistence in aspirations regarding careers in science and engineering can be predicted through the academic achievement and self-efficacy in mathematics of 8^{th} grade students.

A longitudinal study by Aschbacher et al. (2010) of 33 high school students found that persistent high aspirations in science are dependent on the quality of teaching and courses in science; counseling; the academic attitude of peers; exposure to works of scientists and; support of family for pursuing science. Again, Archer et al. (2012), were able to establish a relation between the aspirations in science of 10-11 year old children with the role of their families in shaping them. Studies have found that aspirations of students in science may be raised by provision of information about career opportunities (Tytler and Osborne 2012). The role of parents in career aspirations of students is also highlighted by Dewitt et al. (2013), in their study with 9000, 10-11 year old students in England. An important finding by Bevins et al. (2005) is the contrast between a large number of school students of developing countries valuing careers in science to a much smaller number of their counterparts from industrialized countries aspiring to become scientists or technologists.

Among studies from India, the India Science Report (Shukla, 2005) reports that 60% of students of sixth to eight graders in India prefer to study science in higher education. Similarly, the researcher of this thesis too, in the study with SWDs, found a generally positive attitude of school students towards science (Sharma & Chunawala, 2013b, p. 78).

2.2 Attitudes towards inclusion

The attitude of various stakeholders in education have been identified as an important factor that can pose a challenge to the process of inclusion in education (Peters, 2004). These challenges are in the form of the negative attitudes of various personnel related to the education of SWDs such as, government officials, teachers and above all family members who may experience shame, guilt, or have low expectations from SWDs and try to shelter/patronize them.

2.2.1 Teachers' attitudes and inclusion

A number of researchers have reported that effective teachers in inclusive settings hold positive attitudes towards the philosophy of inclusion. Alternatively, having a fair knowledge of inclusive practices could lead to positive attitudes towards SWDs (Reusen et al., 2001 and Alsheikh & Elhoweris, 2006). Studies have reported that the following factors as impacting teachers' attitudes towards inclusive education, namely: teachers' prior training, their feeling of self-efficacy, the support system that teachers have for implementing inclusion, their confidence in catering to diverse needs of SWDs, access to professional development centers and severity of the disabling condition of students (Kakkar, 2014; Loreman et al., 2013; Kuhl et al., 2015).

A qualitative survey of teachers in Uganda (Peter, 2004) revealed that teachers who initially had negative attitudes to SWDs reported increased confidence and changed attitudes towards SWDs after intervention. Numerous studies have highlighted the negative effects on SWDs of unfavorable attitudes of teachers towards inclusion (Peters, 2004; Sharma et al., 2006).

In the Indian context, Parasuram (2006) surveyed 340 teachers from Mumbai, India, using the Attitudes Towards Inclusive Education Scale (ATIES) to understand factors that affect attitudes of teachers towards inclusion. The study found that prior acquaintance with a person with disability was an important variable in teacher attitudes to inclusion. Again, using ATIES, Bhatnagar and Das (2014a) surveyed 470 teachers from 35 private secondary schools in Delhi, India and reported that younger, male, less experienced teachers with post-graduate qualifications had a more positive attitude towards inclusion of SWDs. Bhatnagar and Das (2013) also reported moderate levels of concerns among teachers regarding the lack of teaching resources for SWDs and lower acceptance of SWDs. A majority of teachers in their study had not received any training in inclusive or special education. The authors further conducted interviews with 20 teachers from private schools in Delhi to understand teachers’ views on ‘barriers’ to inclusion. They summarized 'poor infrastructure of school', 'large class sizes', and 'lack of training for inclusion’ as some of these barriers (Bhatnagar & Das, 2014b).

In contrast Prakash (2012) found positive attitudes of government school teachers towards inclusion as compared to teachers from non-government schools and more positive attitudes of female teachers as compared to male teachers. This study also found more positive attitudes towards inclusion of SWDs among primary school teachers and teachers with more than 10 years of experience and teachers with higher qualifications. However, Chowdhury (2015) reported no significant difference in attitudes of trained and untrained teachers towards inclusion, while a study by Das et al. (2013) reported that a majority of teachers surveyed had a lack of training and experience to implement inclusion for SWDs as well as a lack of support systems. Kakkar (2014) in her review of studies in India summarized that, overall, teachers are positive towards including SWDs but several factors like the absence of training and support system for teachers and the severity of the disabling condition of students are crucial in determining teacher attitudes.

2.2.2 Parents' attitudes and inclusion

Studies on parental attitudes to inclusion in education have reported positive attitudes of parents of pre-school students towards persons with disabilities, but these attitudes were not consonant with the attitudes of their children, Hong et al. (2014, p. 188) In one study with parents of SWDs, Elkins et al. (2003) surveyed 354 parents in Australia and found that a majority of parents favored the inclusion of their children in regular schools. However, a small group favored education in special schools and indicated the need for in-service education of teachers regarding inclusion. A literature review of 10 studies by de Boer et al. (2010, p. 176) suggested that parents with higher socioeconomic status, with more experience of inclusion and with higher academic levels had a more positive attitude towards inclusion of SWDs as compared to their counterparts. Also, parents had more positive attitudes towards students with sensory and physical disabilities as compared to students with behavioral and cognitive disabilities.

2.2.3 Students' attitudes and inclusion

Osler and Osler (2002, p. 52) in their case study, shared the distress of a child with Asperger syndrome on being excluded from school due to the disability. The study gives the perspective of a child with a disability regarding the responsibility of the institution to adapt itself to the needs of learners and become inclusive. The report highlights the deep desire of students with disabilities to be included in regular schools.

Hong et al. (2014, p. 189) have reported that a better understanding of disabilities among young students is significantly associated with their positive attitudes towards persons with disabilities. A literature survey by Koster et al. (2009) revealed the following four themes regarding the 'social participation' of SWDs in regular education: positive interactions with peers; acceptance by peers; friendship with peers and; their perception of acceptance by peers. In another review of 20 studies, de Boer et al., (2012, p. 390), concluded that for the success of inclusive education, understanding and knowledge about SWDs must be provided to peers so that positive attitudes towards SWDs can be developed among them.

2.3 Learning strategies in science classrooms for inclusion

Several studies have focused on strategies that help in making science learning effective in inclusive classrooms. Only a few among these have specifically focused on settings in which SVIs have been included but since inclusion is far broader than just a single aspect, we have adopted these strategies in classrooms during the intervention part of the study. Also, since education is an amalgamation of several approaches and no approach fits in every situation, these strategies must not be looked at in isolation. In fact, during the intervention part of our study, these strategies have been used in combination with each other to improve the efficacy of resultant learning.

2.3.1 Cooperative learning

In any classroom, one may 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 heterogeneous classrooms. It adopts heterogeneity as a principle and tries to incorporate all students. In this strategy, students work together by helping each other and participating in the learning process according to their abilities. This strategy makes it difficult for a student to 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). Abels (2015) specifies cooperative learning and heterogeneous grouping, among the crucial factors that must be implemented for the successful inclusion of SWDs in classrooms.

A vast body of research has demonstrated that cooperative learning strategy in classrooms maximizes the learning of students, even on topics that are complex and otherwise difficult to learn. In addition to the academic benefits, the social outcome of interpersonal relationship skills development is also possible through cooperative learning. A cooperative learning situation develops a feeling of positive interdependence among those cooperating to reach common goals (Johnson et al., 2007). The effectiveness of cooperative learning strategy in a classroom, where the linguistic diversity, which otherwise is a hindrance, was demonstrated by O’Byrne (2003). Feyerer (2007) (as quoted in Markic & Abels, 2014) also suggests a culture of cooperative learning among learners for making inclusive classrooms more supportive and Haskell (2000), describes co-operative learning along with some other strategies as effective in teaching students with learning disabilities and other students too in a classroom.

According to Deutsch (2006) the psychological processes that are involved in positive interdependence through cooperation are:

1. *Substitutability*: The acceptance of the activities of the other group mates to fulfill one’s own needs.
2. *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).
3. *Inducibility*: The readiness for getting influenced by others or for influencing other group members.

The features of cooperating learning groups described by Johnson and Johnson (1999) are - accomplishment of shared goals by working together; all the students benefit from the outcomes; discussions, helping one another, encouraging each other and higher performance of all the students than what they would have accomplished individually.

It is also important to note that like any other learning strategy, cooperative learning also has its challenges. Some common obstacles identified by Le et al. (2018) are:

1. Lack of cooperative skills: Students may not accept opposing opinions or ask for help when it is needed; there may be a lack of trust; students may neither give elaborate explanations nor feedback.
2. Free-riding: Some of the group members do not make efforts to contribute to the task.
3. Competence status: The influential members of the group may underestimate the suggestions of low-status members and hence ignore their views.
4. Friendship: Feeling of friendship may inhibit the members from being critical and constructing serious arguments.

All these challenges may be overcome by giving orientation to the learners about the desired outcomes and the required cooperative skills before initiating a cooperative task in a class.

Sharma and Chunawala (2015), in a published part of this research, report contexts of cooperative learning through diagrams and models which were successful in evoking higher-order questions from students. It suggests that cooperative-inclusive settings are effective for SVIs to draw and learn through diagrams. In another publication, Sharma and Chunawala (2016) report that cooperation among students with different perceptual abilities, facilitated by their awareness of the difference in the styles of perceptions provides an advantage to students in inclusive settings. Also, Kizilaslan et al. (2020a) in their study with SVIs, in a special school, report that the peer learning opportunities in a science classroom are helpful in effective learning.

2.3.2 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 et al., 2000). According to Vavra et al. (2011), visualization can be differentiated into -

- *Visualization objects:* physical objects of representation like models, pictures, diagrams, geometrical illustrations, animations, videos.
- *Introspective visualizations:* mental pictures made by the mind (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.

Studies by, Gilbert (2005), Jones and Broadwell (2008) and Ramadas (2009) consider science to be a subject in which visualization is indispensable for enhanced learning and understanding. Emphasizing visualizing experiences in science, the dual coding theory (Clark & Paivio, 1991) refers to 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 while Vavra et al. (2011) report that the imagination of extremely abstract concepts, like that of subatomic particles, can be successfully facilitated by scientific visualizations.

2.3.2.1 Visualization and visual impairment

It has often been contested whether visualization occurs among persons with visual impairments. Research has indicated that parts of the visual cortex in persons with congenital visual impairments get activated while doing activities that involve inputs through the tactile form of perception (Sadato et al., 1996) and even during Braille reading by persons with no vision (Zangaladze et al., 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 et al. (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 and 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 SVIs which is reflected in the less rigorous mathematics and science curriculum that is offered to SVIs at the secondary level (Taraporevala, et. al, 2013).

2.3.2.2 Disadvantages faced by SVIs due to emphasis on the visual mode of science teaching

Generally, SVIs are often at a disadvantage while learning science and technology as the visual mode is given a lot of importance during teaching (Kumar et al., 2001; Fraser & Maguvhe, 2008; Jones et al., 2006). Diagrams that can be a useful resource in teaching-learning often become problematic as their use lacks any reference to the considerations of cognition, history and philosophy (Ramadas, 2009). Also, such excessive reliance on a single mode of perception occurs 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 SVIs to reduce the so-called 'cognitive load' on them. Thus, SVIs find it difficult to pursue subjects of their interest and their aspirations to get into careers of science are limited (published part of this research in Sharma & Chunawala, 2013a).

2.3.3 Multimodal communication

The popularly held views of science learning consider it to be an acquisitive process mediated by the teacher, textbooks, worksheets where learners acquire facts. In contrast to the above views, Kress et al. (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. This view emphasizes 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.

The multimodal approach stems from the social semiotic theory which focuses on linguistic modes and extends its principles of communication to different modes that are used by people to produce meaning. According to this theory, the list of semiotic resources through which people communicate extends from language alone to gestures, visual images and other resources as well. Kress et al. (2001) give a detailed analysis of the learning procedure that takes place in a multimodal science classroom where a teacher used different modes to develop the concept of 'blood circulation'. In this classroom, the teacher used 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 the session reached was a representation of human blood circulation as an image in the textbook.

Jewitt et al. (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 classroom, such a process of meaning-making becomes much more useful because of its inherent scope of multi-sensory engagement. Through the use of multiple modes, students get a better chances of meaningful learning through their preferred senses. D'Amico and Gallaway (2010) suggest using a multi-sensory approach through multiple modes for giving the best learning opportunities to the SVIs in inclusive classrooms. Carpio et al. (2017), in their study with 7 SVIs (congenital) and 21 students with sight, conducted in Spain, report that the SVIs could acquire the content and aesthetics of images through verbal descriptions, sounds and tactile representation of three paintings.

The study also reported no significant differences between the acquisition among SVIs and sighted students. This gives some evidence regarding the effectiveness of multimodal and multi-sensory communication for students with and without vision.

2.3.4 Multiple representations

A closely linked, sometimes integrated and yet different concept from to multimodal communication is the concept of multiple representations. The difference is that multimodal communication is concerned with the meaning-making of learners by integrating the different components of the representation (Tang et al., 2014) whereas, multiple representations refer to multiple ways to symbolize or refer to some physical entity.

Representations whether verbal or non-verbal; are manipulable and lead to the transformation of experience. They help us understand, reason with and communicate science concepts. Learning happens through experiences that can include a variety of internal and external representations of entities and phenomena. The study of representations in the learning process has a long history both in educational research and practice. Representations of some physical object, idea or phenomenon may be-

(1) *internal*, defined by Tversky (2004, p. 210) as the 'internal translations of external stimuli; as such they not only eliminate information from the external world, they also add to it and distort it in the service of interpretation or behavior or

(2) *external*, through a variety of display modes, gestures, or kinesthetic experiences. The external representations may or may not result in internal representation (Gilbert, 2008). Tsui (2003) describes four types of external representations as-

- *verbal-textual* (metaphors, words or linguistic symbols)
- *symbolic-mathematical* (formulas, equations, symbols)
- *visual-graphical* (graphs, diagrams, tables, pictures, videos and animations) and
- *actional-operational* (demonstrations, gestures, physical models and manipulatives).

The use of multiple representations in teaching and assessing has been strongly recommended by various researchers. External representation through drawings and physical models is common in teaching and learning of science. Justi and Gilbert (2002) and Gilbert (2008) underline the importance of the use of models in chemistry along with verbal descriptions to facilitate visualization of processes and entities. In our study, 3D models were used to teach the structure of an atom, and how the concept of atom has evolved. Diagrams, which are visual-graphical representations, symbolize the elements of the real world and the spatial relations between these elements to facilitate learning. According to Jones and Broadwell (2008), the representation of knowledge through drawings and diagrams is important in learning science because of their role in motivation and cognition. They help in attracting attention, creating learning contexts, enhancing understanding, retaining information and enabling learners to handle complex information (Vinisha & Ramadas, 2013).

2.3.5 Students' drawings

According to Mathai and Ramadas (2009), textbooks have 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 et al. (2011) suggest that students should be asked to draw when learning complex science concepts, as drawing is both motivating and helps to make students' understanding explicit. Besides, drawings as external representations can help in assessing learning (Pittman, 1999; Rapp & Kurby, 2008).

Drawing is one of the strategies that has 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 SVIs but also for students with vision. There is often merely a focus on the reproduction of bookish diagrams without the expectation of any creativity. Glynn (1997) describes students' drawings to be “inherently constructive and motivating for students” (p. 30) when used as a tool to represent the mental models developed after learning. The possibility of integration of a diagram centered pedagogy is supported by Padalkar and Ramadas (2011). Effective utilization of drawings and diagrams for science learning would require the promotion of students' drawings to express their observations, conceptual understanding, feelings and perceptions while grappling with complex concepts (Hope, 2008).

Students' drawings are also important communication tools because these can help to overcome linguistic barriers, and are helpful in making comparisons among students with different abilities and languages; apart from being an expression of their internal representations (Barraza, 1999). However, in education, one must also focus on the limitations of using drawings when children differ in their drawing abilities. How do SVIs 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 SVIs when dealing with a situation that requires them to draw or to deal with diagrams.

2.3.5.1 Drawings and SVIs

The National Curriculum Framework, 2005 (National Council of Educational Research and Training, 2007) 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 SVIs at a disadvantage when learning science (Kumar et al., 2001; Fraser & Maguvhe 2008).

Another problem that plagues SVIs 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). While innovations and techniques like thermal printers, embossed raised line printers and 3D printers provide access to raised diagrams, maps and models, these are not easily and widely accessible in Indian schools. However, even if there is access to embossing sheets and 3D pens, there is still a need to find contexts in which SVIs would need to draw. Thus the experience of SVIs with drawings and diagrams in the context of science tends to be limited.

There is an urgent need to make not only drawings and diagrams accessible to SVIs but also to promote the experimental and theoretical aspects of science by making adaptations in methods of representations, in scientific equipment and the social environment of classrooms (Kumar et al., 2001). Why do we want SVIs to draw? We think that drawing would have benefits for SVIs just as it benefits the sighted and there is a need to focus on this aspect. This thought is in line with Meijer (2010) according to whom all students benefit from the adaptations that are made to facilitate learning among SWDs.

Studies on the use of diagrams for SVIs in the learning of science have reported their effectiveness (Stoffers, 2011). Hill (1995) in a study reports how raised line diagrams can be used for SVIs to give nearly full access to diagrammatic aspects of science and raise the quality of science education. The haptic perception through raised lines and visual perception through the use of colors encourages visualization in students with or without vision. Jubran (2012) reports the use of adapted diagrams for learners with sensory disabilities. These studies suggest that learning of science by SVIs can be facilitated through the use of diagrams. It is important to note that while drawing, in general, has a skill component, sketches and schematic diagrams do not require superior drawing skills.

Kennedy (1993) reports similarity in the stages of development of drawings in students with and without vision. He also reports that the ability to draw may grow even without direct tuition whether a child has vision or not and claims that 'drawing is universal... it only needs tapping to make itself evident' (p. 179). He highlights a very important aspect of 'willingness to draw', which precedes the ability to draw. Further, he suggests that in the absence of proper tools, the visually impaired cannot draw spontaneously, have no or limited exposure to drawings made by others and cannot enjoy making marks by banging or even scratching with a pen or similar object on a smooth surface.

These different studies and our belief in the need for multiple and diverse ways of representations have motivated the present work.

2.3.6 Inquiry-based learning

This approach has been reported to be effective for the inclusion of students with cognitive and behavioral disabilities in science classes in terms of retention of learning; no hindrance to the learners without disabilities (Bay et al., 1992); academic achievement (McCarthy, 2005) and cognitive performance during the processing of information (Brigham et al., 2011). In a design experimental study conducted by Palincsar et al. (2001), the authors reported a significant improvement in the achievement level among students with cognitive disabilities in inclusive settings. This improvement was observed when the teachers clubbed the guided inquiry-based science instruction with- cooperative learning; monitoring and facilitation of student thinking and; supporting the ability of learners to comprehend and create the texts, The study was conducted in the USA, with 111 upper-grade elementary students in inclusive settings for two years.

Not all studies have found positive effects of inquiry-based science learning in inclusive settings. For example, Abels (2015) found that the strategy was not an effective inclusive approach for giving Chemistry learning experiences to students with cognitive disabilities.

2.3.7 Some other strategies

Some other strategies have been reported by researchers to be effective in inclusive science classes. A literature review by McComas (2013), reported that science teachers, aiming for effective inclusion of students with diverse learning needs in science education, made the science lessons relevant to students; made adaptations in assignments, texts, and assessment to make them accessible to SWDs; used analogies to make the difficult concepts of science more understandable; created opportunities in the classroom for the sharing and discussion on the topics of science and used the examples of scientists that have abilities or disabilities equivalent to the students in the classroom.

Use of mnemonics in instruction has been reported to be effective in an inclusive classes with students that face cognitive disabilities. Mnemonics were helpful in promoting the easy recall of information and thereby making the learning of scientific concepts easier (Mastropieri et al., 2000; Scruggs & Mastropieri, 2000; Scruggs et al., 2008 and; Therrien et al., 2011). Similarly, a collaboration with the special education teacher and concept mapping has also been reported to be effective in inclusive classes (Haskell, 2000). A literature review by Brigham et al. (2011) suggests some science learning strategies for students with learning disabilities, namely- verbal learning of sentences that state facts (declarative sentences); experiential learning through activities; opportunities of scientific reasoning and; tailoring of instruction as per the individual needs of learners (differentiated instruction).

A literature review by Abels (2015) indicated some other effective strategies in inclusive classrooms, such as, - use of graphic organizers; peer-tutoring; targeted questioning; task analytic instruction and; use of differentiated learning material.

2.3.8 Gaps in existing literature

As said earlier, the above literature review has formed the basis of this study, and to add to this statement, not only the reviewed literature but also the gaps that were found in the literature have formed a basis. Following are the gaps in literature that have been identified:

- There was literature on the attitudes of educational stakeholders regarding inclusive education for SWDs, but little work was able to identify the reasons for specific attitudes.
- No literature was found regarding aspirations of the SWDs in science.
- There is literature regarding strategies for effective science learning, but no research studies could be found in the Indian context that weave these strategies into an effective science learning pedagogy for inclusive classrooms with SWDs (especially SVIs).

- Also no comparative studies regarding science learning for SVIs in inclusive settings and special education settings in the Indian context were located.

The present study tries to address some of the gaps in the existing body of research and the literature with respect to inclusive education of SWDs, especially in the Indian context.

Chapter 3

Research Methodology

With a broader vision of an inclusive society, it is pertinent that efforts be made for developing a system of education that endeavors towards the inclusion of students from all the marginalized/deprived groups. The National Curriculum Framework for Teacher Education (NCFTE) (National Council for Teacher Education, 2010) identifies that these marginalized groups comprise of students with disabilities (SWDs); children from scheduled castes, scheduled tribes, and minority communities; girls and; children with diverse learning needs. In addition, UNESCO also identifies marginalized children based on remote location, poverty, gender discrimination, language, and traditional or cultural deprivation in society (UNESCO, 2010). But since the scope of all-inclusive education is too large to be addressed through one single research, the present study has focused on the inclusion of the largest group of marginalized people, that is, the group of persons with disabilities. As informed by the reviewed literature, even within this group, those with visual impairments find science education extremely challenging. Therefore, this research, in its later stage narrows down its focus on developing such strategies that are helpful in giving positive learning experiences to students with visual impairments (SVIs) when learning science. It is hoped that this research would contribute to filling the gap in the educational endeavors in India and would lay a foundation for other relevant researches in this area.

3.1 About the study

Research on inclusive education is a complex area. This is because there are a number of groups whose inclusion can and should be focused upon. In fact using the term inclusive education only with regards to persons with disability would be a disservice to those groups who are socioeconomically marginalized in education. However, as mentioned above, this research has focused on students with disabilities, as the scope would be too wide if all excluded groups were to be focused on. Therefore, this study has made an effort to understand the status of SWDs in education in general, and in science education particularly, in the Indian context. It scrutinizes the need for inclusive science education for SWDs through literature review and field surveys. The literature review helped identify gaps in the existing literature which the research questions attempt to answer.

A survey has been done to compare the aspirations of SWDs in science with the actual/existing state of science education for them. Another survey was aimed at highlighting the views of teachers, parents and peers regarding inclusion in education through interviews and administration of an attitude scale. The last phase of the study narrows its focus to science education for SVIs. Based on the learning from literature review and field surveys, some strategies for science teaching were developed and tested with SVIs and sighted students in special and inclusive settings. These survey reports and experiences from the science teaching strategies have formed the basis of research findings and the contributions of the study.

3.2 Research objectives and questions

In order to contribute to the body of knowledge in science education, this research endeavors to study-

- the status of inclusion in science education through secondary data and classroom observations.
- the aspirations of students with disabilities (SWDs) in science.
- the views of teachers, parents and students regarding the inclusion of SWDs in education.
- and develop strategies for teaching science to students with visual impairments (SVIs).

Research Questions

1. What aspirations do students 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?

3.3 Methodology

3.3.1 Research design

Looking at the complexity of the research questions, a need for combining quantitative and qualitative approaches in the study was felt. Therefore, this study followed a '**mixed-methods**' research design. Creswell (2003) describes mixed-methods research as 'pluralistic, inclusive and complementary' because of the inherent legitimacy it gives to researchers for using multiple approaches while answering research questions. Researchers have creative choice in regards to integration of qualitative as well as quantitative data in a single or multiple studies. This quality of the mixed-method design makes it an expansive form of research rather than a limiting form, as it suggests researchers take an eclectic approach for maintaining a 'sustained program of inquiry'.

The research design used in this study may also be called '**emergent mixed-methods**' because the issues that led to the use of different methods, developed while conducting the research. The emergent mixed-methods design occurs after some part of the research is already done (Creswell & Clark, 2011). A need of adding qualitative interviews occurred to the researcher while surveying the views of educational stakeholders towards inclusion of SWDs in education. After quantitatively surveying the attitudes through a scale, a need of qualitative survey was also felt. Thus, the responses of stakeholders were also elicited through detailed interviews to triangulate the data and to make the study more comprehensive.

3.3.2 Stages of research

In the initial stage of the research, surveys have been conducted to understand the need and status of inclusive education. The first survey which is regarding the aspirations of SWDs has been conducted through a questionnaire and interview. This explores 6 sub-research questions regarding the perceptions, learning expectations, difficulties, suggested changes, attitude towards science, and preferred careers of SWDs in science. The participating 30 SWDs were selected through purposive sampling from 6 different schools, and the responses were thematically analyzed to address the research question (RQ) 1.

Regarding RQ 2, a survey of attitudes of teachers, parents, and students has been done through an attitude scale and semi-structured interviews. The scale has been adapted from Wilczenski's (1992) Attitude Towards Inclusive Education Scale (ATIES). It carries 22 statements that need responses on 5 points Likert scale. For administering the scale, convenience sampling of teachers, parents, and students from 10 different schools in Delhi was done. The collected data was analyzed by calculating mean responses to survey statements and performing t-tests to determine (any) differences of means among different demographic variables. For conducting the interviews, a snow-ball sampling of 6 teachers, 5 students and 4 parents was done. The audio-recorded interviews were thematically coded, analyzed, and results are reported in chapter 5. The qualitative and quantitative findings through a Likert scale and interviews have helped to make the results more elaborate and complementary.

As informed earlier, the later stage of the study focuses on a crucial aspect of education in India, which is science education for SVIs. This stage began with visits and observation of classes in 5 different schools in Delhi and Mumbai that have enrolled SVIs. These observations, guided by the reviewed literature, give a basic understanding regarding the science learning strategies that are being used in different schools for SVIs. These observations also form a basis for three exploratory studies. The first strategy was regarding the use of raised lined diagrams in an inclusive class setting (with SVIs) for teaching science. This strategy was implemented in the first part of the study to learn the process that is involved during such a learning situation. The qualitative analysis of this part of the study formed the basis of development of yet another strategy that involved using more than one form of raised lined diagrams and also gave opportunities to learners (including SVIs) to express via drawing. This strategy was implemented in the second part of the study, again done in inclusive settings. The analysis of these two studies formed the basis of development of yet another strategy that involved the use of descriptions, discussions, models, and objects to represent a difficult concept of science, followed by drawings by learners to represent the learning. This formed the basis for the third part of the study which has been in an inclusive setting as well as a special school for SVIs.

In this way, these 3 activities, that have been done at different stages with different students as three exploratory studies, have helped to develop some science teaching strategies for SVIs and sighted students. The sampling for all these activities is purposive and the qualitative analysis has been done through written responses and drawings of students; their performance on different tasks and; the video recordings of activities. Methods used for each research question have been tabulated in Table 3.1.

Table 3.1: Methodologies used for different research questions (RQ)

RQ	Methodology		Nature of sample	Method of analysis
1	Survey through questionnaire and interviews		Purposive sampling of 30 SWDs from 6 different schools	Thematic analysis of responses
2	Survey through 5 points Likert scale on attitudes		Convenience sampling of 97 teachers, 166 parents and 521 students from 10 different schools	Mean responses; t-test 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	Exploratory study of cooperative learning among students (facilitation is done by the researcher).	Part 1	Purposive sampling of 20 students from 1 inclusive school	Analysis of written responses of students and record of their performances on tasks
		Part 2	Purposive sampling of 18 students from 1 inclusive school	Analysis of written responses of students and record of their performances on tasks
		Part 3	Purposive sampling of 5 students from inclusive settings and 5 students from a special school for SVIs	Analysis of video-recorded activities and drawings made by students

3.4 Ethical considerations

Research ethics have been considered to be ‘norms of conduct’ that helps researcher make decisions which are acceptable both in moral as-well-as legal terms. Bickman et al. (2009) consider ethics pivotal for the entire research, as these need to be taken care of at each level of the research for maintaining its rigor. The British Educational Research Association (2018) provides five guidelines which must be ensured by research in education. These guidelines are: respect for (1) the person (2) knowledge (3) democratic values (4) the quality of educational research (5) academic freedom. All these guidelines have been followed by the researcher in this study. Parveen and Showkat (2017) compiled the ethical issues that are faced by researchers in India. In accordance with these issues, the ethical considerations that have been strictly followed in this research during each and every stage of the research have been presented in next sub-sections.

3.4.1 Ethical ethos

Ethical ethos lays responsibility upon the researcher to safeguard the physical and mental well-being, and rights of the participants. This would require the researcher to consider the research project from the viewpoint of participants also. To fulfill the ethos, following steps were ensured.

3.4.1.1 Researchers' obligations

- All the data collected during the research has been analyzed and reported sincerely, truthfully and objectively.

- Permission was obtained from the heads of institutions where the study/studies were conducted and the teachers, during whose classes the study was conducted. In fact, these heads extended their support for the study by giving instructions to the concerned school personnel to lead the researcher and introduce to sample and the study venue. Similarly the teachers provided all the background information about the sample as and when required.

- Care was taken to use the spoken language of the participants during each study respect was given to the personality and dignity of participants.

- The security and safety of participants was given importance and it was ensured that no activity would potentially harm any participant in any way.

3.4.1.2 Participants' rights

- During the study, participants always had a choice of not disclosing personal information and also not responding to the procedure as and when they felt so. No participant was pressurized in any ways for the same.

- Utmost care was taken not to disclose the identity of the participants at any stage in any form. To maintain confidentiality, pseudonyms have been used in the thesis and publications and only such photographs have been used that do not give clues regarding the participants.

3.4.2 Research ethics

3.4.2.1 Researcher-participant ethics

- Clear instructions were given to the participants regarding the requirements of the study. They were informed about the purpose and procedure, prior to studies and were also provided opportunities to discuss the survey questions and interview structure as needed.

- This research work has been carefully planned in such a way that it leads to the enrichment of body of knowledge and a betterment of the present education status of inclusive education in India.

- The photographs, audio and video recordings were done for gathering data only after getting prior permission from school heads and students. No such data was gathered without such consent.

- The questionnaires and scales were developed in the languages which were most convenient for the participants. The three languages were Hindi, Marathi and English.

3.4.3 General ethics

- No conclusion of this research is expected to have harmful effect on the participants, field of education and the human society.

- The support and help of every person for this study has been carefully acknowledged and the references of reviewed literature has been cited in the text as-well-as in the ‘bibliography’ section.

- The objectivity of research has been maintained by developing and using valid and reliable tools and also getting help from experts regarding this. The pilot testing of tools was done to find the reliability of research tools.

- The analysis of all the data has been done critically without any pre-judgments.

- The researchers have tried to report all the data and findings truthfully and any form of fabrication or distortion in them has been avoided.

- All the raw data of this research has been retained for referencing and review, but the approach of anyone to this data would be guided by the ethical consideration of confidentiality.

- It has been tried that the language used for reporting the findings and conclusions remain discernible and comprehensible so as to avoid any ambiguities.

- The affiliation of this research to Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, Mumbai has been clearly declared on the very first page of this thesis.

Chapter 4

The Aspirations of Students with Disabilities in Science

India has traditionally been known as a center of knowledge. Stories of the existence of centers of excellence in education are known from the time of Nalanda to the present Indian Institutes of Technology. As a place that had a rich and flourishing culture of science and education from ancient periods, the culture of science education may be considered to be present in Indian society. Viewing the scenario of inclusion in education we find that the benefits of inclusive education have been accepted through a large body of research in countries all over the world, India being no exception to it. But as we scrutinize deeper, we find studies that have reported the presence of few students with disabilities (SWDs) in any form of higher education in India, and in science-related courses, numbers are even lower. What can be the reason for this sorry status of science education for such a large section of the population? Does the present state of science education not fit into the aspirations of students with disabilities, or does it provide unequal 'conditions for success'?

Basing this work on the literature reporting the importance of aspirations in science and the factors that affect them, an attempt was made to explore the aspirations of SWDs in science. This work aimed to learn what is needed for bringing an inclusive transformation to meet the aspirations of SWDs about science.

4.1 Objectives of the survey

This section explores the aspirations of SWDs with reference to their perceptions of science; science education and inclusion in science education. To achieve this objective, a survey was conducted to arrive at answers to following sub-research questions:

1. How do students with disabilities (SWDs) perceive science?

2. Do SWDs career aspirations involve science careers? and what science careers do SWDs prefer?

3. What do SWDs expect to learn in science?

4. What difficulties do SWDs face in learning science?

5. What changes would SWDs suggest in science education?

6. What are the attitudes of SWDs towards inclusion in science?

4.2 Methodology

The method used in this section of the study is a survey. Surveys have been described by Groves et al. (2011) to be one of the most commonly used tool of social scientific studies and are considered to be ‘crucial building block’ in the present day where information is power. Surveys use sampling to systematically gather and describe information about specific attributes of a population. In the field of education, Lodh (2014) has classified surveys into different categories as:

1. Descriptive surveys, that uses- academic/psychological tests; questionnaires or interviews.

2. Analytical surveys, that collect data through- observations; rating scales; factor analysis; documentary frequency or critical incident.

Among these categories, this section of the study explores 6 sub-questions regarding aspirations of students in science, using a descriptive survey and a structured interview. The characteristics of the descriptive survey (Groves et, al., 2011), that have been considered in this study are:

- Only a small subset of whole population is approached for data collection.
- Information is collected either through interviews or recording of answers by people on questionnaires.

The process of development of the questionnaire and its administration has been described in the next sub-section.

4.2.1 Development of the tool (questionnaire)

A questionnaire was developed on the basis of 6 research sub-questions (mentioned in 4.1) to explore the aspirations of students with disabilities about science. The pilot study of this questionnaire was done with 6 students, of whom 1 student had multiple disabilities (orthopedic and learning disabilities in reading and writing); 2 students had an orthopedic disability; 1 student had visual impairment (low vision); and 2 students had visual impairments (no vision).

Modifications to pilot questions were made following students' feedback. For example, -

- The question about whether the family of the student has a 'Below Poverty Line card' was changed to the 'monthly income of the family'.
- The question about the 'abilities that you have' was changed to- 'what do you think are your strong points in school?'.
- The question about 'how does science help you become better?' was changed to 'how does science affect your life?'.
- Another question regarding 'what qualities are required to achieve a good understanding of science?' was elaborated with some options that students had to choose as a response. These options were: good memory, repeated drill and practice, categorization, analysis, experimentation, observation, truthfulness, discipline, patience, good knowledge of English, and a good understanding of content.
- Lastly, the question- 'how can science learning be made easier? was changed to, 'how can science learning in school be made more effective?'

The content validation of the modified questionnaire was done by three subject experts and one language expert who found it suitable for administering. The final questionnaire is available in Appendix 1 of this thesis and the procedure of its administration has been described in 4.2.3.

4.2.2 Sample

Thirty SWDs from 6 schools were selected through purposive sampling to participate in the study. The government schools in the study had enrolled SWDs but these did not fulfil the criteria of being inclusive. For example, no teacher of the school, except the special educator had training regarding education of students with special needs. Also, the infrastructure of the schools lacked the features required for inclusiveness. Moreover, no adaptations in the school curriculum, learning aids and pedagogy were observed in these schools that could have been helpful for including SWDs in the learning process. On the other hand the inclusive school in this study has been quoted as an example in the document of UNESCO (United Nations Children's Fund, Nepal, & United Nations International Children's Emergency Fund, 2003) due to its inclusive adaptations in infrastructure and curriculum.

Table 4.1: The sample information for aspiration questionnaire

Type of school	**Gender**	**No. of students in class & Age**	**Types of disabilities**
Government senior secondary school for girls	3 Girls	(3) Class 6, (11, 12 & 14 yrs)	1 Visual disability 1 Orthopedic disability 1 Learning disability
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
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
Special schools for SVIs (2 schools)	4 Boys	(3) Class 6, 15 to 17 yrs (1) Class 10, 16 yrs	4 Visual disability

This is also to disclose that none of the sample students had responded to the questionnaire during the pilot study. The characteristics of the sample have been tabulated in Table 4.1.

4.2.3 Tool administration

The modified questionnaire was administered to the 30 SWDs in their schools' premises. For the students with other than visual impairments, the questionnaire was administered in groups. At times, some students in the class (with no disabilities) were trained to write the responses provided by SWDs. Students who could interpret sign language were requested to assist students with hearing and speech impairments in responding to the survey questions.

Some notional instructions about the survey were provided to students before its administration. These instruction were, “children I want to know what you think and feel about science, and what changes you would suggest in it. To know this I will distribute some questionnaires and read out the questions one by one. You can write your responses on the blank space after each question according to your own beliefs. This is not a test so try to write your own views. Your responses will remain confidential.” The researcher then read out, and also clarified the questions one-by-one and gave ample time to students to respond to each question before moving to the next one.

For the students with visual impairments (SVIs), the questionnaire was administered in the form of structured interviews. Each SVI was interviewed separately and the responses were written as well as audio recorded by the researcher.

4.3 Results and analysis

The analysis of questionnaire responses and interviews was done by focusing on the answers of 6 research sub-questions related to perceptions of SWDs regarding science, science education and inclusion in science education. Looking at the difference in the nature of the questions (open or closed-ended) and also the nature of responses given by participants, different strategies were used to analyze the responses. For the analysis of most of the questions, information of number of participants with a particular response was important. For the open ended question regarding the perception of science, the responses were thematically analyzed on the basis of existing definitions of science in different sources (Siddiqui & Siddiqui, 2005; Nuangchalerm, 2009; Sharma & Chunawala, 2011). The number of responses in a particular theme gave an idea of the popularity of a particular perception of science among students.

All the participants responded to the bilingual questionnaire in Hindi language which was also their mother tongue. For reporting purpose, the responses have been translated into English by the researcher. The students' responses to the questionnaire have been summarized in subsections 4.3.1- 4.3.9.

4.3.1 What is science?

To elicit students' perceptions regarding science the open-ended question ***"According to you what is science?"*** was posed. The responses were categorized and summarized. Some of the perceptions of students regarding science are quite unique, but such responses often came from just one or two individuals.

The responses of 57% students (17/30) could be grouped under the category of science as an *accumulated and systematized body of knowledge*. This is often a common view of science held by teachers too (Sharma & Chunawala, 2011). Another common lay view of science reported by about 20% of students (6/30) was that *science is a creator of technological products*, whereas 10% of students (3) said that *science is a method of investigation*. For the student with dwarfism, science was a *transcendental experience,* while a student with orthopedic disability felt that science is something *entertaining.* According to a student with multiple disabilities who was in an inclusive school, science was *magic,* another student with a learning disability, wrote that science is a *very good thing*, while another student with a learning disability from the same school equated science with a *textbook.*

The categories of students' responses regarding science being an *accumulated and systematized body of knowledge* and science as *a scientific method of investigation* are in accordance with the definition of science by the Columbia Encyclopedia (1963) and cited by Siddiqui and Siddiqui (2005), which states that science is a systematic learning about nature which leads towards a body of knowledge comprising of facts and emergence of methodology and attitudes that are specific to science. In relation to the 'science as a creator of technological products' perception, we can relate it to the popular culture of electronic devices (for example, Mobile phones, TV, search engines, etc) in our day to day life, where we tend to connect developments in science with technological products that we use.

4.3.2 Science as a school subject

Students' perceptions regarding science as a school subject were learned through a closed-ended question. Of the given options (very important, important, somewhat important, unimportant, and absolutely unimportant), 93% of the students (28/30) stated that science was "very important" or "important". Thus, SWDs are like other students in India who have a very positive image of science. (Chunawala and Ladage, 1998). Only 2 students 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.

Regarding the views of science as an interesting subject, 93% of the students (28/30) felt that science is "very interesting" or "interesting", while only one student from a government school who had a cognitive disability found science "boring" and another student with visual disability from a special school stated that science was "somewhat interesting". Regarding the utility of science, 87% students (26/30) reported that science is "very useful" or "useful". Only 2 students from an inclusive school (students with multiple disabilities and hearing and speech disabilities) reported it to be "somewhat useful"; while a student from government school who had cognitive disability said science is "useless" and;

a student from an inclusive school who had orthopedic disability reported science to be "absolutely useless". Regarding students' perception of the difficulty of science, 53% of the students (16/30) reported that science is "very easy" or "easy", 16% students (5/30) found science to be "somewhat easy", while 30% students (9/30) found science as a subject to be "difficult" or "very difficult".

From the responses of the participant, it can be said that regardless of the level of ease of science in students' minds, SWDs find science as important, useful and interesting on many fronts.

4.3.3 Effect of science on students' lives

Regarding the effect of science on their lives, again a majority of students mentioned a positive role for science. Of these, 43% of the students (13/30) said that *science makes life easier*, 23% (7) 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 student mentioned that science helps to *develop healthy eating habits.* Regarding a negative role of science, one student from a special school for the visually impaired felt that science *pollutes the environment* whereas another student with a hearing impairment remarked that science has no effect on our lives and two students did not respond to this question. Thus, overall students viewed the effects of science on our lives as positive.

4.3.4 Success in school science

To assess how students can achieve success in science as a school subject, they were asked the question, "how can you get good marks in science?", The comments of SWDs can be summarized as: by *reading, understanding and writing science, working hard, learning question-answers, revising, writing answers correctly, and through "mental power"*. A large number, 73% of the students (22/30) affirmed that getting good marks in science means knowing science well, while only 16% (5/30) students said that getting good marks in science does not necessarily mean that one knows science better. It appears that a majority of students equated performance on tests to cognitive understanding. It is a great challenge upon the education system to ensure a match between the learning of students in cognitive terms, national priorities and the evaluation process (National Council of Educational Research and Training, 2006). Of the 30 students, three students had given unrelated responses.

In response to the closed-ended question, ‘what qualities are required to achieve a good understanding of science’, most of the students’ agreed that *experimentation, good memory and truthfulness/honesty* are necessary for getting a good understanding of science (the last quality is especially related to the ethics of science (Charlton, 2009). The responses of students are presented in Table 4.2.

Table 4.2: Qualities needed for a good understanding of science according to students

Qualities selected by students	**Number and % of students selecting the option**	
Experimentation	27	90%
Good memory	26	87%
Truthfulness /Honesty	26	87%
Discipline	22	73%
Good understanding of content	21	70%
Analysis	20	67%
Patience	18	60%
Good command of English	18	60%
Repeated practice	15	50%
Categorization	12	40%

Table 4.2 highlights that performing experiments is considered important in understanding science by most SWDs. This suggests that students are aware of the crucial role of experimentation in learning science and in achieving success in science. Thus it is paramount that schools providing opportunities for all students including SWDs to engage in these activities.

4.3.5 Preferred career/job/profession

To the question regarding what course of higher education would the students opt for, 53% of the students (16/30) stated that they would prefer to pursue science, 33% (10/30) wished to pursue humanities (which is generally referred as ‘Arts’ in the Indian context). Commerce and Computer science were preferred by 2 students each, while a course of designing was preferred by 1 student. An interesting observation is that all the 4 SVIs from special schools preferred to pursue languages for their higher studies (2 preferred Hindi and 2 students preferred English). One SVI among these students wished to pursue English, Political science, History and Science courses together, which is not common in Indian context of higher education.

The job most preferred by SWDs was that of a 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), 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 they would 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 individual students and these were, army personnel, policeman or doctor, work in a mobile shop, government job and musician.

The large number of preferences of SWDs for learning science in their higher studies and for jobs that require a good understanding of science shows the popularity of science among them. Since in this study, the academic performance has not been correlated to their choices, one can say that the job preferences and courses of study are similar to that which would be made by any student. Similar findings have been reported by Shukla (2005), according to which, 60% of general students in India from classes VI to VIII wished to pursue science related courses and 40% among them preferred the jobs of doctors or engineers.

In our study, a special mention needs to be made regarding the students from special schools, whose responses show that jobs related to science are not their aspiration. This might be an outcome of the low expectations that they face from the stakeholders regarding science, which leads to no opportunity of learning science in most of the special schools for SVIs.

4.3.6 Learning expectations from science

The question, “what would you like to learn in science?”was asked directly to know about the learning expectations that SWDs have regarding science education. As a response to this question, 27% of the students' (8/30) learning expectations were related to the ***knowledge domain of science education.*** For example the knowledge about-

- making of machines
- nutrition
- technological things
- solar system
- discoveries and discoverers
- questions and answers to science

Some of the areas which the largest number of students (57%) wished to learn were related to the ***process domain of science***. These were regarding-

- making drawings and pictures
- doing projects
- scientific procedures
- assistants of scientists.
- doing experiments and science-related activities
- inventing and discovering things
- doing practicals in a laboratory

The learning expectations of 3 students from science were related to some ***general areas of education*** like-

• spellings	• reading
• sensibility	• writing

One student each expected to attain through science, the qualifications that are needed to become a doctor and becoming good human being. It is important to note that 57% of the participating students (17/30) mentioned that they expect to learn areas of science that lay in the process domain, suggesting the importance of the same for them. Thus constructivism in various ways is being suggested by SWDs and the approach must be utilized by implementors to bring a match in between the science curriculum and the expectations of SWDs.

4.3.7 Suggestions for science education

Some suggestions were given by students to make science education interesting. The gravity of these suggestions is high because these have been elicited from that group of students that has been marginalized the most in science education. It is important that these suggestions be considered seriously as these may play an important role in improving the accessibility of science education. According to the SWDs, science education can be made interesting by-

• making the content interesting • making science understandable • studying with concentration • making jokes • reading and writing correctly • through happiness	• making the study of science like a game • understanding and obeying science • making use of technology of science and miracles of science • through enjoyment and concentration • paying attention to the teacher's words

• reading • experiments • activities • writing and sitting silently • diagrams	• supplementing theory with practicals • by understanding what is science and by doing experiments • stories along with serious subject matter • knowledge about the changing world • through understandable tasks

The suggestions of SWDs can be helpful in the development of strategies to be used by teachers in science classrooms for transacting the curriculum. Some of the suggestions made by SWDs are already acknowledged as principles in science curriculum. This is reflected in the position paper of the National Council of Education and Training (2006) which, along with the development of speaking, reading and writing skills through science, emphasizes on ‘nurturing’ curious minds of children through joyful and learning-by-doing activities. This would help learners to explore the environment and harmonize with it. This study also directs engaging the science learners with design tasks, surveys and experiments for learning scientific concepts.

An important suggestion was put forward by three SWDs in relation to learning of drawings and diagrams in science to make learning science more interesting and effective. In fact, drawings and diagrams are an important tool in science for focused observation, understanding and visualization not only for SWDs but for all students. In another study regarding teaching science to SVIs, Carney et al. (2003) have suggested using diagrams with raised lines, thus raising the importance of drawings for inclusive science education even more.

4.3.8 Attitude towards teaching science to SWDs

A large number, 87% of the students (26/30) had a positive attitude towards the inclusion of SWDs in science learning. Some of the reasons given were as follows:

> *Science has a specialty... science is made for disabled students* (student with dwarfism from government school)

> *If God has snatched the vision then... we can do so much... even... if not a scientist... we can do something in the future.* (student with visual disability from a special school)

However, four students from a 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:

> *No, because they do not study science properly and are unable to understand alphabets written in a science textbook.* (student with visual disability from a government school)

> *No, because all children are not similar, some are not able to speak and some are deaf. Because of the differences, they find it (science) difficult.* (student with orthopedic disability from a government school)

4.3.9 Difficulties faced in Science

The students were asked what difficulties they themselves experienced in learning science; the difficulties of all students while learning science and those specifically of SWDs. Table 4.3 shows that SWDs have a different view on the difficulties faced in learning science when asked about their own difficulties, as compared to the difficulties of all students and specific difficulties faced by SWDs 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 responses that the spectrum of difficulties faced by SWDs is large. As reported by the sample of SWDs, the difficulties arise due to a failure in understanding science, sensory disabilities and the lack of reading/writing skills that hinder a large number of SWDs. It is notable that only one student (from class X) reported a difficulty while doing science practicals. This may be related to the later observation of the researcher regarding a lack exposure of larger number of participants (27/30 students from middle classes) of this study to science practicals. The reason being a lack of culture of performing science practicals in middle classes of the sample schools. This is also to note that among the 3 students of secondary class (who perform science practicals), 1 SVI from special school had an exemption from studying science. Therefore it may be said that actually only 2 students had a chance of performing science practicals and among whom 1 student reported a difficulty.

Table 4.3: Number of SWDs reporting difficulties in learning science (Number of students)

	What difficulties do **you** face while learning science?	What difficulties do **all** students face while learning science?	What specific difficulties are faced by **SWDs** 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 the 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 knowledge of English	1		
Difficult words		4	
Irrelevant curriculum & lack of textbooks		1	
Disturbance due to treatment			1
Doing activities that need locomotion or sitting			4
Responding through speech			3
Do not face any difficulty	10	2	3
Unrelated response	1	2	3

4.4 Findings

This section reports the perceptions and aspirations of 30 SWDs from classes VI and X of six different schools with respect to science and suggests possible ways to make science education more inclusive. An important finding is that a majority of SWDs have positive attitudes towards science, perceive science as important, interesting and useful and commonly held views by SWDs about nature of science is that “science is an accumulated and systematized body of knowledge” and “science is a creator of technological products”.

While it is seen that the SWDs in the present study found science difficult and the reasons for the same may be drawn from the India Science Report (Shukla, 2005), which states that 40% of general students who did not opt for science at senior secondary level did so because the large sized classes created hindrance in their learning. Some students in the present study reported that difficult words and inability to read and write also caused difficulty in learning science.

From Table 4.3, it can be seen that there are some specific difficulties that SWDs feel are faced only by SWDs such as, sensory and cognitive difficulties, drawing and visualizing diagrams, disturbance due to medical treatment, doing activities that need locomotion or prolonged sitting, responding verbally and reading and writing (stated by those facing specific learning disabilities). It is interesting that the sample SWDs also reported that all students face difficulties in understanding science, answering the questions of science, lack of concentration, difficult words and irrelevant curriculum, and lack of text-books.

While the comparison is not absolutely correct, if one does compare the general students of +2 level in the India Science Report (Shukla, 2005), where a third said that science was not their preferred subject for higher education because nothing in science could motivate them to study it further, it was found that the SWDs are generally motivated to study science. But, it is due to the difficulties that they mentioned in this study that they are unable to opt for science at higher levels. It is also important to note that 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 SWDs there.

In the present study, the SWDs suggest that in order to get good marks in science they need to:

- read the content of science
- learn question-answers
- do writing practice in science
- do hard work
- understand the scientific concepts
- do revision of learned topics
- write the answers correctly

This is to note that all these suggestions for improving performance in science are similar to the difficulties that SWDs report they face in science. These suggestions may lead to additional work for SWDs and despite the work, SWDs may get lower grades in science examinations, thus causing problems in their opting for science at higher levels.

SWDs showed interest in a vast spectrum of areas of science that they wish to explore and learn. It is interesting that the number of students who wish to learn the processes of science is almost double to those students wanting to learn different areas of knowledge in science. This is also important in light of the emphasis laid by National Council of Educational Research and Training (NCERT, 2006), on the process approach of science, while framing the science curriculum.

> *It should stress not only the content of science but, more importantly, the process skills of science, that is, the methods and techniques of learning science. This is necessary since the process skills are more enduring and enable the learner to cope with the ever-changing and expanding field of science and technology.* (NCERT, 2006 p.11-12)

Also, the suggestions given by students for improving science teaching are very important as they come from the very target group which is the focus of various experiments, seminars, and workshops and for whom various policies of inclusion are being put forth. Another important point is that the implementation of these suggestions such as focusing on activities, experiments, practicals, projects and drawings and diagrams would make science more interesting, useful and effective not only for SWDs but also for all students with diverse learning needs and diverse backgrounds.

A positive finding in the context of the inclusion of SWDs is that science is the most preferred subject for 53% of SWD’s (16/30) for higher education. This is comparable to the 60% of general students at class six to eight levels in the India Science Report (Shukla, 2005), who wanted to pursue some science courses at a higher level of education. A high value for science is demonstrated by SWDs through their preference of science-related jobs like doctors, engineers and scientists. The findings are in accordance with Bevins et al. (2005), study that reports a contrast between a small number of students from industrialized societies having aspirations to become scientists or technologists and the high value of careers in science and technology for school students from developing countries. But sadly in India, only a few SWDs get enrolled in courses having a science background (Shukla, 2005), and they are almost invisible in science-related jobs.

Another important finding is the preference shown by SWDs for the profession of teaching. Being a teacher is their choice in both instances- their first choice and also in case of their being good in science. Scientists, doctors and engineers were the second, third and fourth most popular professions respectively. This finding does have similarity to the choices made by general students of classes VI to XII, as reported in the India Science Report, where the professions of teaching, doctor and engineering were preferred the most by the students (Shukla, 2005).

4.5 Implications and limitations

This study presents a contrasting picture of the low expectations of the stakeholders of education regarding science education for SWDs (Sacks et al., 1992) and the high aspirations of SWDs in science. It discloses how SWDs perceive science, their positive attitude towards science as well as the difficulties faced by them in learning science. The students themselves have reported their areas of interest and suggested ways to make science more interesting, useful and effective. It is important that to make science education inclusive, developers of the science curriculum must take these suggestions into cognizance and incorporate them accordingly.

The findings also indicate a gap between the high aspirations of SWDs in science and the meager presence of SWDs in science courses for higher education and in turn in jobs requiring science backgrounds. In this study, more students from inclusive settings reported that they do not face difficulties in science, which 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. By incorporating the diversity among the abilities and experiences of students progress in science education can be ensured.

The scope of this study is limited to the SWDs as it could not gather and analyze the data regarding responses of general students from inclusive and non-inclusive settings. Therefore, a comparison between responses of general students and SWDs could not be done. Also the comparison of responses from SWDs of general schools, special school and inclusive schools and that from students with different disabilities could not be done because of the small sample size.

Chapter 5

The Attitudes of Teachers, Students and Parents Towards Inclusion

It is evident from the present study that students with disabilities (SWDs) do have high aspirations in science. The larger and immediate question is, do stakeholders accept the inclusion of SWDs and clear the path for SWDs to achieve what they are longing for from science in their lives? While one may argue that often acceptance is committed only verbally and not demonstrated in behavior, we were interested in learning what is said by the stakeholders of education, specifically, teachers, parents, and students themselves. Under the framework of the 'Theory of Planned Behavior' (Ajzen, 1991), the statements of attitude scale fall under the 'affective' dimension- related closely with actual behaviors or a person’s intentions to behave in a certain way (Favazza et al., 2000 and Eagly & Chaiken, 2007). Attitudes of stakeholders affect the process of inclusion and are an important factor that regulates the success of inclusion in education. A careful analysis of attitudes may also determine the strengths and weaknesses of the education system that are most required for the successful inclusion of students.

In the Indian context, attitudes of teachers towards inclusive education have been well documented through a number of quantitative studies, but a need for a greater understanding of this field is still emphasized (Bhatnagar and Das, 2014b; Sharma et al., 2017). Since many prior studies explored the attitudes of teachers of private schools (Parasuram, 2006; Chowdhury, 2015; Bhatnagar & Das, 2013; 2014a; 2014b), our study expanded the scope by surveying teachers from both government and non-government (private) schools. In addition, our study aims to capture multi-stakeholder perspectives and thus explores the attitudes of two other stakeholders of education- students and parents. To make the responses more expressive and elaborate, the study examines the field both qualitatively and quantitatively. Such an extended understanding of attitudes of stakeholders of education and their role in the inclusion of SWDs would be helpful in making the process of inclusion in education successful by guiding the concerned agencies.

5.1 Objectives

The study explores the attitudes of multiple stakeholders about inclusion in education. Similarly, the study also analyzes the traces of weaknesses and strengths of the education system through analysis of the attitudes, which together suggest needful measures for a successful inclusion of SWDs. Keeping these objectives in view, following sub-research questions were formulated:

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

5.2 Methodology

To address research sub-questions regarding views of teachers, students and parents on inclusive education, both analytical and descriptive survey methods were applied in this study. The analytical survey has been conducted through a Likert scale that was adapted from a pre-existing scale (‘Attitude Towards Inclusive Education Scale’ (ATIES) developed by Wilczenski, 1992). A Likert scale has a definite number of sentences accompanied by a ‘scaled set of answers’. For each statement, the participant selects particular rating on the scale which according to him/her is most appropriate. As a research tool, the Likert scale has been appreciated by Groves et al. (2011) as each question has the ability to uncover information that would be possible through paired comparison.

The Likert scale used in this study is ‘Attitude Towards Inclusive Education in India Scale’ (ATIEIS). The development and administration of ATIEIS has been discussed in the next sections. The ATIEIS scale responses were further triangulated with a descriptive survey (conducted through semi-structured interviews) and its interpretive analysis led to an understanding of the roots of particular responses on the scale. We also believe that the responses (or attitudes) of stakeholders of education arise from their experiences or perceptions, which can only be accessed through direct interactions. Such insightful interviews in the Indian context are few, therefore this triangulation with empirical studies becomes still more important for providing additional insights regarding perceptions of educational stakeholders.

5.3 Analytical survey

5.3.1 Development of 'Attitude Towards Inclusive Education in India Scale' (ATIEIS)

The development of ATIEIS involved tailoring of 'Attitude Towards Inclusive Education Scale' (ATIES) developed by Wilczenski (1992) to fit appropriately in Indian school education context. The ATIES has 16 statements, each to be ranked on a Likert scale of 1 to 5 (1 -strongly disagree to 5 -strongly agree). Of the 16 statements in ATIES, we dropped 2, used 4 as framed originally, adapted 5 with minor changes, made major changes in 5 and added 8 new statements. The changes (major and minor) in 10 statements were made to adapt them to the Indian context. For example, original ATIES scale statements- "students who need an individual functional academic program in everyday reading and math skills should be in regular classes" was changed to "students who need separate special classes in everyday reading and math skills should be in regular classes". In this changed statement, it was anticipated that 'special classes' for mathematics and language skills become central idea for the statement and participants then can rank the statement on the ATIEIS attitude scale.

Among the (10) changed statements, 4 statements were worded negatively to reduce the tendency of default agreeing to the given statements. Among the 8 new statements: one aimed to learn attitudes towards inclusion of students with severe disabilities (statement 7); one focused on situations when support systems are provided for implementation of inclusion (statement 15); and the other six were aimed at learning the stakeholders perceptions regarding consequences of inclusion in classrooms (statements 17 to 22). 4 statements focused on different types of disability and opinions of above-mentioned stakeholders of education regarding the inclusion of students with these disabilities in classes. We termed this altered version as Attitude Towards Inclusive Education in India Scale (ATIEIS, Appendix 2).

This modified scale was validated by 3 education experts and one special educator. It was developed in English and translated to Hindi. The translated version was validated by 2 language experts. We piloted the survey scale with 10 teachers, 10 students and 2 parents and received their feedback, which led to a revision of the scale. The updated version was re-tested with a different sample of 5 teachers, 5 students and 2 parents. The test-retest reliability calculated through Pearson's correlation coefficient, and is 0.70. This was conducted with 14 students, 10 parents and 6 teachers after a gap of 21 days.

The final statements of ATIEIS can be classified into the 3 macro-categories that have been listed below.

Attitude towards inclusion of students with general non-acceptable behavior (statements 1, 3, 4, 6, 9, 12, 13, 14, 16): This category refers to the statements regarding the inclusion of students with such behaviors that may or not be directly related to disabilities and are general in nature. The causes of such behavior may range from physical health, social, psychological, or some issues arising from some disability. The following statements come under this category:

1. ___Students who frequently fail in exams should be in regular classes.
3. ___Students who are shy and withdrawn should not be in regular classes.
4. ___Students whose speech is difficult to understand should be in regular classes.
6. ___Students who are verbally aggressive toward their peers should not be in regular classes.
9. ___Students who cannot control their behavior and disrupt the classroom activities should be in regular classes.
12. ___Students who do not follow school rules of conduct should not be in regular classes.

13. ___Students who are frequently absent from school should be in regular classes.

14. ___Students who are inattentive in class should be in regular classes.

16. ___Students who physically harm other students in school should not be in regular classes.

Attitude towards inclusion of SWDs in classroom (statements 2, 5, 7, 8, 10, 11, 15): In this category, all the statements are clearly related to the inclusion of students with particular disabilities. The statements are as follows:

2. ___Students who cannot move without help from others should be in regular classes.

5. ___Students who cannot read printed words and need to use Braille should be in regular classes.

7. ___Students who are dependent on others for daily life activities should be in regular classes.

8. ___Students who cannot speak and use sign language should be in regular classes.

10. ___Students who need separate special classes in everyday reading and math skills should be in regular classes.

11. ___Students who cannot hear conversational speech should be in regular classes.

15. ___With appropriate support all students with disabilities should be in regular classes.

Perceived effects of inclusion of SWDs in the classroom (statements 17 to 22): Under this category, the statements are related to the perceptions of educational stakeholders regarding situations that may arise in classrooms due to the inclusion of SWDs.

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.
19. ___In a regular class with students with disabilities, other students may not get proper attention.
20. ___Students with disabilities may not be accepted by other classmates.
21. ___Teachers may not be able to handle students with physical disabilities in a regular class.
22. ___Teachers may not be able to handle students with sensory disabilities in a regular class.

5.3.2 Sample

The ATIEIS was administered to 97 teachers, 166 parents and 521 students from different kinds of schools (6 Government, 2 special, 1 aided and 1 private school) located in Delhi, India. The convenience sampling helped us to achieve a mix of teachers, students and parents from government schools, private schools, special schools and non-government aided schools from Delhi, India. Tables 5.1 and 5.2 present more details of the survey sample. During the final administration of scale, most of the sample preferred the Hindi version and only 5 teachers responded to the English version of ATIEIS, whereas all other teachers (92), students (521) and parents (166) responded to the Hindi version. The sample was also categorized in terms of gender, the experience of teaching SWDs, and exposure to disability (self, family, or acquaintance). This is to note that responses of parents of students from special schools could not be obtained. The reason behind this is the location of residences of students at far away places from their residential schools. Moreover, the Principals of schools also expressed their inability to contact the parents regarding the study.

Table 5.1: 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 5.2: Particulars of sample for ATIEIS

Teachers			
Gender	35 females	62 males	
Experience of teaching SWDs	32 with experience	65 with no experience	
Teachers with disability or having exposure to a disabled person in family or friend circle	30 with disability or exposure	67 without disability and exposure	
Parents			
Gender (Out of 166 parents 14 did not inform about the gender)	50 females	102 males	
Parents with disability or having exposure to a disabled person within their family or friend circle or both	29 with disability or exposure	132 without disability and exposure	
Students			
Gender	206 girls	315 boys	
Type of school	39 from special schools	30 from inclusive school	452 from general schools
Disabilities	67 with disabilities	454 without disabilities	

5.3.3 Quantitative results

For analysis, the mean scores for each ATIEIS statement (Table 5.3) was calculated. 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 and also across their demographic variables. The critical t-values (2 tailed) against which the t-test scores were compared among different demographic variables are:

Table 5.3: Critical t-values (2 tailed) against which the t-test scores were compared

<table>
<tr><th colspan="2">Teachers- Students</th><th colspan="2">Teachers- Parents</th><th colspan="2">Students- Parents</th></tr>
<tr><td colspan="2">1.98</td><td colspan="2">1.96</td><td colspan="2">1.96</td></tr>
<tr><th colspan="6">Teacher- teacher</th></tr>
<tr><td colspan="2">Gender</td><td colspan="2">Experience of teaching SWDs</td><td colspan="2">Exposure to disability</td></tr>
<tr><td colspan="2">1.98</td><td colspan="2">1.98</td><td colspan="2">1.98</td></tr>
<tr><th colspan="6">Student- Student</th></tr>
<tr><td>Gender</td><td>Disability in self or not</td><td>Special Vs General school</td><td>Special Vs Inclusive school</td><td colspan="2">Inclusive Vs General</td></tr>
<tr><td>1.96</td><td>1.96</td><td>1.96</td><td>1.99</td><td colspan="2">1.96</td></tr>
<tr><th colspan="6">Parents- Parents</th></tr>
<tr><td colspan="3">Disability and/or exposure</td><td colspan="3">Gender</td></tr>
<tr><td colspan="3">1.97</td><td colspan="3">1.97</td></tr>
</table>

T-test results indicated significant differences in the attitude of students and parents on 7 statements of ATIEIS. Parents were more positive towards students who are verbally aggressive (t=3.01), who do not follow school rules (t=3.14), who are inattentive in class (t=3.30), who physically harm others (t=3.21) and were less negative towards students who display uncontrolled behavior (t=6.22) as compared to the students. For the students who fail in exams (t=3.82) students were more positive than the parents, whereas, for students with speech disabilities (t=2.92), students were positive, but parents were negative.

Significant differences were also found in the attitude of students and teachers on 12 statements. On 11 of 12 statements i.e. students who fail in exams (t=2.36), who are shy and withdrawn (t=6.60), who are verbally aggressive (t=4.68), display uncontrolled behavior (t=16.26), do not follow school rules (t=5.14), are frequently absent (t=4.94), are inattentive in class (t=9.00), who physically harm others (t=5.67), the effect of inclusion on academic achievement of peers (t=2.77), no diversion of attention of teacher from peers (t=2.35) and ability of teachers to handle the students with orthopedic disabilities (t=2.52), the attitude of teachers was more positive as compared to that of students. Regarding the inclusion of students with speech disabilities, the students were positive as compared to the teachers who were negative (t=2.76).

On comparing the mean attitudes of parents and teachers through t-test, the teachers were found to be significantly more positive on 10 statements of ATIEIS as compared to parents i.e. for the inclusion of those students who fail in exams (t=4.91), who have orthopedic disabilities (t=2.30), who are shy and withdrawn (t=6.25), who are verbally aggressive (t=2.18), who display uncontrolled behavior (t=8.20), who do not follow school rules (t=2.50), are frequently absent (t=3.58), are inattentive in class (t=5.78), the inclusion of all students with proper support (t=2.40) and inclusion of those who physically harm others (t=2.91).

The mean responses of students, parents, and teachers to ATIEIS survey are summarized in Table 5.4. Analysis of means (depicted in brackets) indicated that parents, teachers and students were positive to the inclusion of students who displayed *general non-acceptable behaviors* such as failing in exams (means, 3.12, 4.04 and 3.64 respectively), expressing shyness (3.47, 4.41 and 3.46 respectively) having language disabilities (3.24, 3.23 and 3.20), but students were more negative in their attitudes towards other students who displayed verbal and physical aggression, who did not follow school rules (2.73, 2.71, 2.69) as compared to their parents (3,20, 3.14 and 3.13) and teachers (3.54, 3.65 and 3.58). For the inclusion of those students who were frequently absent and inattentive in class, both parents (2.79 and 2.91) and students were more negative (2.59 and 2.50) than teachers (3.40 and 3.86).

Table 5.4: 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 SWDs in the 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 SWDs 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 SWDs (orthopedic)	3.14 +	3.30 +	2.97 -
Teachers can handle SWDs (sensory + speech)	2.91 -	3.18 +	2.91 -

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

Regarding the *inclusion of SWDs in classrooms*, attitudes of parents, teachers, and students varied largely, depending upon types of disability. All three were positive towards the inclusion of students having orthopedic disabilities (3.30, 3.66 and 3.38 respectively), dependent on others for daily life activities (3.30, 3.50 and 3.30) and having learning disabilities (3.55, 3.39 and 3.42). On the contrary, they were negative to the inclusion of students with visual (2.80, 2.77 and 2.91) and hearing (2.82, 2.63 and 2.64) disabilities. This negativity was offset by an extremely positive response to the statement, 'With appropriate support, all students should be in regular classes' (4.08, 4.39 and 4.22 respectively for parents, teachers and students). Comparing the above contrasts, it is evident that the attitudes of stakeholders varied based on the type of disability. But, they believed that 'additional support' can make inclusion successful for all SWDs.

For speech-related disabilities, students differed from their parents and teachers (3.27, 2.90 and 2.80 respectively) and were more positive towards them as compared to parents and teachers. Again, both the parents (2.40) and students (1.76) were negative towards students with behavioral disabilities and differed with the teachers (3.76) who were positive towards them (2.40, 1.76, and 3.76 respectively).

Regarding the effects of inclusion of SWDs in classrooms, all the three stakeholders were positive that inclusion would not result in teaching/learning becoming stressful (3.52, 3.56 and 3.41 respectively), would not affect the academic achievement of other students in a class (3.60, 3.77 and 3.35 respectively) and would not divert teachers' attention from other students (3.26, 3.39 and 3.08 respectively). They were also positive that SWDs would be accepted by their peers (3.15, 3.32 and 3.16 respectively).

The last two statements in ATIEIS scale were about teachers' abilities to handle SWDs in the class, and the SWDs categories were a) orthopedic and b) sensory and speech. In the analysis, it was observed that teachers were also sure about their own ability to handle SWDs in class (3.30 and 3.18) but their students may not be on the same page in regards to such capabilities of their teachers (2.97 and 2.91). Parents too had doubts on the teachers' capability regarding the handling of students with sensory disabilities (3.14 and 2.91).

5.3.3.1 Demographic differences among teachers

Differences on the basis of experiences with SWDs: T-tests indicated a significant difference in the attitude of teachers with experience of teaching SWDs as compared to teachers without such experience on 12 of the 22 statements.

The experienced teachers had significantly more positive attitudes than inexperienced teachers regarding the inclusion of students with orthopedic disabilities (t=2.94), learning disabilities (t=2.27), verbally aggressive students (t=2.34), students who do not follow school rules (t=2.27) and are dependent on others for daily activities(t=3.94). They also were more positive regarding the inclusion of all students with appropriate support (t=3.00) and that the inclusion of SWDs in a classroom does not increase stress (t=2.18), does not have a negative effect on academic achievement of peers (3.73) and does not divert the attention of teachers from peers (t=3.72).

Significant differences were also found regarding the inclusion of students with visual disabilities (t=3.08), speech disabilities (t=2.87) and hearing disabilities (t=4.07). The experienced teachers had more positive attitudes for the inclusion of these students as compared to inexperienced teachers. These differences suggest that teachers without the experience of teaching SWDs would face a greater transition effect when regular classrooms transform into inclusive classrooms.

Differences on the basis of exposure to disability: Regarding teachers who were exposed to disability whether in self or in their family/friend circle as compared to teachers who had no such exposure, the only significant difference found was regarding no diversion of their attention due to inclusion of SWDs in a classroom (t=2.58). The teachers exposed to disabilities were more positive than their counterparts.

Differences on the basis of gender: T-tests indicated only two significant gender differences among attitudes of teachers. Male teachers had significantly more positive attitudes to the inclusion of students who were dependent on others for their daily life activities and were also more positive about the effect of inclusion on the academic achievement of other children as compared to female teachers (t=3.11 and 2.00).

Table 5.5: Mean scores of teachers (total and on demographic variables) on ATIEIS

Statements in ATIEIS	Gender		Experience of teaching SWDs		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 SWDs in the 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 SWDs 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 SWDs (orthopedic)	3.20+	3.35+	3.62+	3.14+	3.47+	3.24+	3.23
Teachers can handle SWDs (sensory+speech)	3.03+	3.26+	3.50+	3.01+	3.23+	3.18+	3.18

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

5.3.3.2 Demographic differences among students

Differences on the basis of disability in self: The t-tests for students with disabilities as compared to students without disabilities regarding inclusion indicate that there were significant differences in 16 responses. SWDs had significantly more positive attitudes for those who fail in exams (t=4.17), had orthopedic disabilities (t=3.46), language disabilities (t=2.38), speech disabilities (t=2.63) and learning disabilities (t=4.11). They were also significantly more positive towards the inclusion of all students with proper support (t=2.71), the effect on academic achievement of peers (t=3.11), no diversion of teachers' attention from peers due to SWDs in class (t=3.52) and acceptance of SWDs by peers (t= 2.71).

Regarding the inclusion of students with visual disabilities (t=5.71), hearing disabilities (t=5.52), those who do not follow school rules (t=2.97) and who are frequently absent (t=4.19), the SWDs had positive attitudes, whereas their counterparts had negative attitudes. Similarly, the SWDs were positive regarding the ability of their teachers to handle students with orthopedic and sensory+speech disabilities (t= 2.63 and 2.82 respectively).

Regarding the inclusion of those students who display uncontrolled behavior (t=4.72), SWDs had significantly less negative attitudes as compared to their counterparts.

Differences on the basis of gender: On t-test, significant differences in 6 statements were found. Girls were significantly more positive towards those students who were dependent on others for daily activities (t=2.92), had speech disabilities (t= 3.73) and were positive to the inclusion of all students with proper support (t= 2.70) whereas they were more negative to those students who do not follow school rules (t=2.04). Boys were significantly more positive towards students who fail in exams (t=2.38) and have learning disabilities (t=2.22). Regarding the attitude towards acceptance of SWDs by peers, girls were negative whereas boys were positive (t=3.09).

Differences on the basis of the type of school: Significant differences were found in responses of students from *inclusive schools* as compared to students from *general schools* with students from inclusive schools more positive to the inclusion of students on 15 variables. While both students were generally positive to the following kinds of students, the sample from inclusive schools was more positive. These statements referred to students who fail in exams (t=2.04) are dependent on others for daily activities (t=4.49), have speech disabilities (t=2.56), learning disabilities (t=3.43) and regarding the inclusion of all students with proper support (t=2.51). Students from the inclusive school were also more positive that the SWDs would not effect the academic achievement of peers (t=3.44) and will be accepted by peers (t=4.86).

Table 5.6: 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)	SWDs (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 SWDs in the 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 SWDs 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 SWDs (orthopedic)	2.97 -	2.92-	2.98-	3.29+*	2.90-*	3.59+	3.32+	2.88+
Teachers can handle SWDs (sensory + speech)	2.91 -	2.98-	2.83-	3.39+*	2.82-*	3.72+	3.31+	2.79+

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

In other cases too the attitudes of students from inclusive schools were positive as compared to students from general schools who were quite negative like, towards those students who are verbally aggressive (t=2.43), who do not follow school rules (t=2.08), are frequently absent (t=4.28), are inattentive in class (t=3.99), have visual disabilities (t=3.94) and hearing disabilities (t=6.53). Students from the inclusive school were also positive that SWDs may not divert teachers' attention from peers as compared to their counterparts who were negative (t=4.86). The attitude of students from inclusive schools as well as from general schools was negative for those who show uncontrolled behavior, but still, the students from the inclusive schools were significantly less negative than their counterparts (t=4.20).

Significant differences were also found on 17 responses of students from *special schools* and *general schools.* The students from special schools were more positive towards the inclusion of students with orthopedic disabilities (t=2.87), language disabilities (t=2.05), speech disabilities (t=2.61), learning disabilities (t=2.91), for those who are dependent on others for daily activities (t=4.18), and for including all students with proper support (t=3.26). Students from special schools were also more positive regarding the SWDs not making the learning stressful (t=2.12), do not effect academic achievement of peers negatively ((t=3.88), will be accepted by peers (t=2.96) and that teachers can handle students with physical (t=3.39) and sensory disabilities (t=4.10).

Regarding the inclusion of students with visual disabilities (t=6.39), hearing disabilities (t=5.45), those who are frequently absent (t=3.21) and that the SWDs may not divert teachers' attention from peers (t=5.22), the students from *special schools* have positive attitudes whereas students from *general schools* have negative attitudes with significant differences.

Even in the cases where students from *special schools* and *general schools* had negative attitudes, the students from special schools had significantly less negative attitudes as compared to their counterparts for statements referring to the inclusion of students with uncontrolled behavior (t=5.74) and who are inattentive in class (t =2.56).

Interestingly the only significant differences that were found in responses of students from *special* and *inclusive schools* were regarding the inclusion of students with orthopedic disabilities (t=2.43) for whom the students from the special school were more positive and regarding the acceptance of SWDs by peers where the students from the inclusive school were more positive (t=2.06). This is also to note that the students from all the groups had a negative attitude for the students who were verbally aggressive and showed uncontrolled behavior.

5.3.3.3 Demographic differences among parents

Differences on the basis of gender: The only significant differences that were observed in the attitudes of male and female parents were regarding the inclusion of students with speech and hearing disabilities. Mothers had a negative attitude towards such inclusion whereas fathers were positive (t=2.57 and 3.57 respectively).

Differences on the basis of disability in self or exposure to disability: While 50 parents had such exposure as compared to 102 parents who did not have such exposure, we found only one significant difference between these two groups on a statement regarding the inclusion of students who are shy and withdrawn (t=2.78). Parents with disabilities or exposure to disabilities had a negative attitude towards such students whereas those without disabilities had a positive attitude.

Such a finding is in contrast with the findings made by de Boer et al. (2010) in their review of 10 studies on attitudes of parents towards inclusive education. The study reported a less positive attitude of parents of children with disabilities as compared to the parents of children without disabilities. While nothing can concretely justify these differences, some possibilities of explanation can arise in difference in the location and time of studies. De Boer et al reviewed the studies mostly from developed European countries, as well time range of the earlier studies that were conducted in between 1998 to 2007 is broad, some differences in the attitudes of parents may have occurred due to the results of inclusion being evident.

Table 5.7: Mean scores of parents (total and on demographic variables) on ATIEIS

Statements in ATIEIS	Total Parents (166)	Disability and/or exposure: With disability or exposure (29)	Disability and/or exposure: No disability & no exposure (132)	Gender: Female parents (50)	Gender: 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 SWDs in the 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 SWDs 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 SWDs (orthopedic)	3.14+	2.96-	3.16+	3.23+	3.02+
Teachers can handle SWDs (sensory+speech)	2.91-	2.69-	2.90-	3.00-	2.69-

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

5.4 Descriptive survey

5.4.1 Tool used (Semi-structured interviews)

In order to gain a broader understanding of attitudinal data collected through ATIEIS, we coupled our inquiry with an additional dimension of interviewees' verbal perspectives on inclusion in classrooms. To attain this purpose, the tool of the semi-structured interviews was developed. This helped to collect selective and detailed accounts of experiences of 6 teachers, 4 parents and 5 students regarding inclusive education. Although the sample was small, it was purposeful. Through the interviews, the interviewees shared their educational backgrounds, knowledge about inclusion and experiences with SWDs. Teachers were especially encouraged to describe and reflect on their instructional practices in classrooms. Probing questions were asked along with the ATIEIS scale to ensure that the discourse was rich with personal stories and reflections and in turn could help to explore some underlying reasons for the overall attitude ranking of statements. Interviews were conducted in regional languages (Hindi/Marathi), translated and transcribed later. All the interviews were audio-recorded and their duration ranged from about 60 to 90 minutes. The interview analysis was based on thematic coding done by two interviewers independently (The methodology, results and findings of this study have already been published in Sharma et al., 2017).

5.4.2 Sample for interviews

As informed earlier, the interview sample although small, was purposeful. Two of the interviewed teachers were from special schools in Mumbai and 4 were from Delhi working in regular schools.

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 convenience sampling was followed. The exposure of interviewees to the type of disability varied.

Table 5.8: Interview sample (students, parents and teachers) summary

Codes	Gender	Teaching experience	Type of school	Exposure to disability
Teachers				
A1	Female	4 years	Aided school for SVIs (classes I to VII)	Yes
A2	Female	13 years	Govt. General	Yes
S1	Female	30 years	Inclusive school	Yes
G	Male	22 years	Govt. General	Has locomotor disability
S2	Male	25 years	Govt. General	No
H	Male	8 years	Govt. General	Yes
Students				
1	Girl	NA	General	Yes
2	Boy		General	No
3	Boy		General	Yes
4	Boy		General	Has cerebral palsy
5	Boy		General	Yes
Parents				
P1	Female	NA	General	Yes
P2	Female		General	Yes
P3	Male		General	Yes
P4	Female		General	Yes

5.4.3 Qualitative results

The analysis of interviews involved deriving primary and secondary themes from the transcripts through iterative listening of audio-recorded interviews. Primary themes were close to teachers' dialogues. Secondary themes were derived interpretatively by grouping primary themes expressed in a similar context. The exercise of grouping primary themes was performed separately by the two interviewers to consider multiple perspectives. Overlapping secondary themes were described as broad themes. Iterative analysis of the data over a significant length of time was responsible for refining secondary themes.

5.4.3.1 Results of teachers' interviews

Semi-structured interviews of teachers gave a closer view of teachers' perceptions and attitudes about inclusion by engaging with their lived stories. Also, the triangulation with

ATIEIS provided a lens for the exploration of attitudes that have led to the emergence of 3 broad themes that are being discussed here.

1. Variation with the type of disability: To understand the reasons shaping differing attitudes with respect to the type of disability (observed in the ATIEIS analysis), we parsed the instructional practices of teachers. A teacher (H) with exposure to disability, but having no experience of teaching SWDs, held the notion that physical disability only limits students' movement inside the classroom; however, these students still actively participate in discussions on academic topics, so a class involving students having a physical disability does not need any additional instructional changes. Similar views were expressed by teachers having experience of teaching students with physical disabilities. All teachers expressed some concerns about access to school, or to the play areas in school, yet it didn't alter their positivity about the inclusion of physically disabled students. In fact, one teacher mentioned that she had established a norm in her classroom regarding helping the physically disabled student in moving within the school campus.

> *In my class, I have recommended them (peers) that they should help (physically disabled students) by taking her to the play area during sports activities every day.* (Teacher A1)

Another teacher reflected on peers' supportive behavior towards SWDs mentioning,

> *Those physically disabled students having calipers (or leg braces) require to take extra care while getting up or sitting down. I have seen peers often help such students, maybe on humanitarian grounds.* (Teacher A2)

We also noticed reflections suggesting the severity of physical disability could alter positivity (or negativity) of attitudes to some extent. A teacher having experience with SWDs expressed that "access to classrooms" becomes a greater concern in such cases.

> *I have orthopedically challenged students but I can take assistance from parents and school staff to help them to bring the students to my class on the third floor. However, it becomes difficult in case of those students whose body is partially paralyzed. For a cerebral palsy case, access becomes even more difficult. We don't enroll such students.* (Teacher S1)

The Teacher G, who had orthopedic disability was very much concerned about this issue of infrastructure in his school. Therefore, looking at the indifference of the head of school even after a SWD had fallen while climbing stairs to his classroom, the teacher himself took the initiative to install ramps at all the places that needed climbing of stairs.

> *A child with disability had fallen from a height while climbing stairs. When we (teachers of school) asked the Principal regarding making of ramps in school, he did not respond to this. Then I myself took the initiative and called masons to make ramps. I had spent Rs. 20000 for this, but the Principal never returned them back.* (Teacher G)

In a developing country like India, infrastructural changes may not necessarily be the top priority for accepting the philosophy of inclusion, and hence the above quotes encapsulate the complexity of inducting SWDs in the school system. Nevertheless, teachers not only had positive attitudes about students with physical disabilities, they were further taking initiatives themselves and encouraging their peer communities and parents to step in for support when access/infrastructure becomes a hurdle for SWDs. The first, second and fourth extracts in some sense display the behaviors associated with such positive attitudes.

However, as compared to an orthopedic disability, teachers having no experience with SWDs have 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 some behavioral techniques. I do not feel that he/she will be able to learn more than this.* (Teacher H)

> *I would feel problem in handling such students (students with visual, hearing and speech impairments) in my class because the visually challenged child would not be able to see the blackboard writing, the child would only be able to listen. And the child who is deaf and dumb, will be able to just see what is written on blackboard… the things shared verbally, would not be heard by the child.* (Teacher S2)

Non-experienced teachers associated type of disability with the diverse learning needs of SWDs and felt that the inability to see, hear or speak limits the extent to which they can learn curricular subjects. Teachers had reservations about the instructional methods required as indicated in the quote above. However, teachers having experience with SWDs had confidence in using and switching between technological devices as needed to facilitate instruction, we discuss this in detail in the following section.

2. Technology in the inclusive classroom: Teachers having experience teaching SWDs felt that they could teach the same curricula to all students, including all types of SWDs students, by simple instructional alterations achieved through technological support. According to these teachers, the curricula could be homogeneous, but the instructional model could involve flexibility in inclusive classrooms. One teacher expressed,

> *...sometimes I used audiotapes, sometimes I used Braille* (Teacher A2)

Another teacher with experience of teaching SWDs insisted on making the devices readily available to all SWDs in the classroom. Experienced teachers additionally relied upon peer support in making the inclusive class more successful, and emphasized educating all peers about different tools that SWDs might use in their classroom.

> *Whenever I had students with hearing disabilities in my class, I made sure to provide the information about hearing aids to SWDs as well as to other students. I have also suggested other children experience the tool so that they are mentally prepared about what kind of help they can offer to SWDs, so it naturally takes away the stigma associated with such aids/devices.* (Teacher S1)

> *...if we bring these tools into the classroom then SWD students will learn more* (Teacher G)

> *I have a particular system called the induction loop in my class. When it is installed in any class, the teacher can practically roam around anywhere in the class, and students can hear us clearly. These setups are provided by the government to resource teachers, but it requires additional training.* (Teacher S1)

Experienced teachers portrayed how teachers could select appropriate teaching tools to assist their instruction. For instance, a visual aid including a picture, chart, or book could be replaced with audiobooks or other advanced technological tools with sound effects and some 3D gimmicks. Overall, inclusive classes are considered more equipped with a technology-assisted environment, yet adaptations are made by anticipating support from teachers, peers, and SWDs themselves. A few studies on inclusion have reported the effectiveness of audiobooks and multimedia presentations in an inclusive class

(Taraporevala et al., 2013 and; Israel et al., 2014). Importantly, gateways for interactions between teachers having experience of teaching SWDs with other teachers can be formed to get them acquainted with the resources being currently used. Extrapolating this idea further, the familiarity of only SWDs and teachers with resources (SWDs specific) is not sufficient, because this might limit the peer support in inclusion. Therefore, such knowledge must be considered to be made accessible to all.

3. Concerns about the adequacy of inclusive education training: Appropriate training is considered an important factor for the success of inclusion by all the teachers who have experience of teaching SWDs (Loreman et al., 2013; Kakkar, 2014; Bhatnagar & Das, 2014b; Kuhl et al., 2015). 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. We include two exemplar excerpts where teachers having experience with SWDs, or exposure to a disability, share their caution.

> *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 A2)

> *How can a general teacher teach (in a class that includes a student with hearing impairment) when he does not have a familiarity with sign language? In this 5-day seminar, only minor things are covered. It may change mindsets regarding SWD children, but will not help in actually teaching them.* (Teacher S2)

The excerpts suggest that existing training (described as “limited” in terms of both content, and time) might keep the under-preparedness feelings among novice teachers unchanged even after undertaking some provisional training in inclusive education. As a result, irrespective of teachers’ willingness to adapt to inclusion, experienced teachers had also voiced their concerns regarding how current training does not prepare all teachers for the practical task of teaching in an inclusive setting and needs.

5.4.3.2 Results of students' interviews

A similar analysis of semi-structured interviews of students has led to the following 3 broad themes:

1. Inclusion is beneficial for all*:* The highly positive attitude of young students regarding the inclusion of all the students is corroborated by the disclosure of their perceptions during the interview. It is interesting to note that the reason for such a positive attitude differs from student-to-student. Student 4, who is a SWD articulates how he constantly receives support from his peers in school. This support from peers is acknowledged as quiet 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 support inclusion are varied, some range from happiness gained by helping someone; or possibility of learning new scripts and languages used by SWDs, to even getting benefits by being a close friend of SWD.

> *It would be beneficial as we will be able to help him (SWD). We will get a 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)

> *Like, if he cannot walk then… like if we are compelled to go somewhere but we do not feel like going, then he would ask us to stay with him. And when the teacher comes and asks why we were staying in class, then he would tell that he had asked us to remain with him.* (Student 3)

It is interesting to note that students are not only considering helping SWDs in their educational activities as the only way to express positive attitude about inclusion. Students expressed aspects of mutual care, and benefits which reduces the power hierarchies often assumed for able bodied students otherwise in a mixed students' group.

Students are also in support of social inclusion due to the perceived benefit of getting first-hand experiences in social aspects of life.

> *Yes, they must study together because they get information about other religions and they can also inform others about their religion… if my parents allow so then I shall definitely*

> *like to visit (their home). I shall find a new atmosphere… I shall feel good experience.* (Student 2)

The excerpt provides some glimpse of how student 2 is not limiting interactions only to curricular subjects but shows some interest in understanding each other's cultural background. This excerpt may lean towards a particular experience, but it also puts forth a possibility of how inclusion of SWDs is not viewed only in context of learning academic subjects in class by students.

2. Variation with the type of disability: Similar to the teachers, the students are also negative towards the inclusion of students with sensory and speech disabilities despite being positive for inclusion in general. Responses of students in the interview revealed that the reasons behind such conditional attitude are the lack of knowledge of the abilities of SWDs and also disbelief on the ability of their teachers to handle them in classrooms.

> *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 (SWDs) will not be able to explain the answer. Also, they would not be able to note the work written on the blackboard.* (Student 2)

> *Teachers would not be able to handle them (students with sensory disabilities). They will feel difficulty.* (Student 4)

This is to note that the above perceptions have been expressed by students from general schools. Now going back to the findings from quantitative data regarding the students from inclusive and special schools being significantly more positive towards (a) inclusion of students with sensory and speech disabilities and (b) abilities of teachers to handle SWDs, it may be said that the lack of knowledge and the disbelief on teachers' abilities may arise from the lack of experience of learning with SWDs and lack of exposure to the abilities of SWDs which may be overcome through inclusive intent of every school.

3. Delinquency is a big issue for students: The quantitative finding regarding the negative attitude of students towards those who show delinquent behavior is again corroborated through the interviews of students. The interviews also added to the comprehensiveness of the finding by revealing the reasons for such a negative attitude of students. The interviews reveal that the habit of delinquents of not being good in studies themselves and then bothering others through physical or verbal means, results in others wishing to avoid them.

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

> *There are some students who are weak in studies, have somewhat bad language and who also abuse sometimes, I do not feel good with them.* (Student 1)

5.4.3.3 Results of parents' interviews

As predicted earlier, the interviews with parents helped us to gain insights for the responses that they gave on the ATIEIS scale and this also highlighted the concerns that parents have regarding the inclusion of SWDs in regular classrooms. The responses could be again grouped into 3 broad themes that have been discussed as under.

1. Concerns due to delinquent students: Although the quantitative data suggests an overall positive attitude of parents towards the inclusion of delinquent students, the interviews disclosed parents' concerns regarding the well-being of their children that may arise due to delinquent students, which they try to overcome by suggesting their wards to avoid them.

> *There are some children who 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 there are some children who misbehave like that, then we tell them to avoid such students.* (Parent 1)

> *We shall not like things like bad behavior, dirty talks and abusive language of children.* (Parent 2)

2. Variation with the type of disability: As revealed through both quantitative and qualitative data, parents are in support of inclusion. But similar to teachers and students, they also have concerns regarding the problems that may arise due to the inclusion of students with severe or sensory disabilities. Their main concerns are regarding the well-being of students with severe or sensory disabilities during the inclusive transformation of schools, that may require the development of an extra support system. The lack of such a support system may affect the learning among such students. The other reasons that make the attitude of parents negative towards students with severe disabilities are the development of inferiority complex among SWDs that may arise due to comparison with other students of the class in terms of academic achievement and the disturbance in class that may arise due to the presence of a child with the 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 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)

> *It depends upon the type of disability, if suppose the child has an intellectual disability then he would lag behind and the complexes regarding weakness in reading abilities or failures would increase.* (Parent 3)

3. Abilities of teachers and school administration determine the success of inclusion: The responses of parents on the interview regarding the role of teachers in the process of inclusion express their belief that the success of the process of inclusion depends upon the abilities of teachers to manage the class. This disclosure when referred to with the negativity among parents towards belief in the ability of teachers to handle students with sensory and speech disabilities on the ATIEIS scale, gives a very strong reason for the variation of attitudes with the type of disability.

> *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)

> *So, it depends on teachers how much they help the child with disabilities, after this, there is nothing wrong with including… everybody can learn.* (Parent 3)

Parents are seen relying on individual teacher’s abilities to manage their class. In their perceptions, a good work on the front of managing class could lead to a successful inclusion. Such responses indicate that for ensuring support of parents for inclusive education, the school system, along with the enhancement of skills of teachers must also develop ways to assure the parents about the teachers being skillful in handling the inclusive classes.

A parent whose child is SWD (orthopedic) enrolled in general school made some important suggestions such as peer grouping and the use of individualized techniques in classes that suit to the learning abilities of SWDs.

> *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)

The excerpt shows the faith parent expresses in the capacity of school systems and teachers to provide an inclusive environment for all.

5.5 Discussion of findings of three stakeholder groups

5.5.1 Teachers

This study brings a deeper understanding of teachers' attitudes, and particularly, how an influential factor of (the severity and type of disability) is shaping these attitudes among Indian middle school teachers. The study finds significant differences in teachers' attitudes towards inclusion depending on the type and severity of the disability, and among teachers with and without the experience of teaching SWDs. Similar results have been reported by de Boer et al. (2011) in the context of primary school teachers, although conducted in a different parts of the world. No gender bias was found in teachers' attitudes regarding inclusive education. This result resonates with findings reported by Parasuram (2006), and Reusen et al. (2001). Despite the variety of different contexts, there are commonalities in teachers' attitudes about the inclusion of specific types of disabilities worldwide. Anecdotal pieces of evidence are reported by Das et al. (2013) in their studies conducted using a similar geographical context in India, although the type of disability is not explored to its fullest in the study. Our results show such parsing in terms of the type of disabilities is important to understand teachers' attitudes in greater depth.

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. The teachers with experience of teaching SWDs were more positive towards the inclusion of all SWDs (including students with severe sensory and speech disabilities) in regular classes as compared to teachers who lacked such experience. Similar results have been reported by Sharma et al. (2006) and Prakash (2012).

The interviews with experienced teachers (those who had experience of teaching 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. It was insisted by teachers that not only the availability of technological devices to SWDs must be ensured, but also the functional knowledge of these must be provided to all the students. The reason being the benefits that occur through elimination of anxiety among students regarding the devices and a larger number of cooperative learning opportunities among the peers. Also, the technological aid helps teachers to maintain homogeneity in curricula in the inclusive classroom such that all students essentially learn the same topics, and SWDs have greater ease in engaging with the curricula and classroom learning environment. It also connects to the parents' expectation about teachers managing the classes smoothly where teacher in fact rather than being a solo proprietor of knowledge can share some responsibilities with students. As everyone is similarly equipped with knowledge of specialized technological devices, new ideas can quickly spread among all students through mutual support. 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 by teachers having experiences with 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. Their observations regarding a lack of exposure to inclusion during pre-service training, and even unsatisfactory in-service training in some cases could explain reservations of inexperienced teachers about inclusion.

For more effective teacher training, we recommend that teachers with prior experience of inclusive settings must be involved in pre-service or in-service teacher training programs so that their attitudes towards all types of disabilities and rich experiences with SWDs and inclusive setting can be shared with novices. Opportunities of witnessing actual inclusive classrooms must also be provided to teachers (both pre-service and in-service) so that the best inclusive practices may be highlighted and the case studies of successful implementation may become an integral part of teachers' training program. This recommendation gets support from the study by Avramidis et al. (2000) which reported that the teachers who have implemented inclusive programs and therefore had an active experience of inclusion, possessed a more positive attitude towards inclusion. A similar result was reported by Reusen et. al (2001) who found that there was a relation between positive attitudes for including SWDs in classrooms and the amount of training and experience for working with SWDs possessed by the teachers.

Suggestions made by experienced teachers, including technology-equipped classrooms described in this study, have evidences to support successful inclusion of students with all types of disabilities in schools. Therefore, this information will be helpful for novice teachers in planning educational practices with inclusive intent. Despite the limitations of a smaller sample of interview participants, this message depicting the experienced teachers' unique aspects of instruction and philosophy is important for novice teachers, curriculum planners and teacher educators in India.

5.5.2 Students

An important finding of this study is regarding the puzzling attitude of stakeholders about their being positive towards the inclusion of students in general, but negative for some specific categories. Particularly the students were negative towards the inclusion of those who indulge in delinquent or uncontrolled behavior, are irregular and inattentive in class and those with vision and hearing-related disabilities. The analysis indicated that students from the inclusive school were more positive in their attitude towards inclusion as compared to students from special as well as general schools. This is an important finding reflecting from the experiences of students and is in accord with Olaleye et al. (2012) which also found that the attitudes of students towards their peers in inclusive settings were generally positive. Also, the positivity of SWDs towards inclusion as compared to the students with no exposure to disabilities points at their intentions and preference for inclusion. As evident from the responses of SWDs during the interview that the support that they 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 to handle students with physical and sensory disabilities in the classroom. Such a concern may arise from the experiences of the students during day-to-day interactions with the teacher and when matched with the similar concerns of teachers, it gives a stronger reason to empower teachers through in-service and pre-service training and exposure to inclusive education.

The study also indicates the sincere concerns of students regarding delinquent behavior. Such behavior, although not a larger concern for teachers and parents, is a matter of deep concern for students from all the demographic variables. This concern should be viewed in the light of the fact that generally the delinquent behavior of children is revealed only in the absence of adults which are obviously the teachers or the heads of the school. It is the children who suffer the most due to the delinquent behavior of their peers, which could go to the extent of harassment, abuse and threats if reported to adults. This is an indicator for the curriculum framers that the problem that is highlighted here may just be the tip of an ice-berg, which if remains unaddressed at the initial stages of childhood and schooling may escalate at tertiary education levels. It is therefore suggested that the curriculum framers should consider keeping such elements in the curriculum that either channelizes the energy of students towards a positive direction or inculcate the social feelings of empathy, peace and affection towards all.

In addition to the above findings, as obtained through the responses of students during the interview, the positive attitude of students toward mingling with students of a different religion, caste or social status seems to be a good reason for satisfaction regarding communal harmony among young learners. It appears that in young minds, inclusion is viewed more holistically and goes far beyond learning academic subjects together in a class.

5.5.3 Parents

This section, similar to that for teachers and students, demystifies the cause of variations in attitudes of parents with the nature of inclusion. Parents are another important stakeholder in the process of education. Their attitudes become very important in the process of education because they are the primary educators of children regarding social behavior. Their role is still more important due to the influence that parents have on the attitudes of their children and the important role that parents of SWDs have played in the disability rights movement and getting the inclusive education implemented (de Boer et al., 2010). Parents, like teachers and students too, are generally positive for inclusion, but their concerns for the well-being of their children, whether they be with or without disabilities, make them negative towards the inclusion of those with severe and/or sensory disabilities. Parents have shown their awareness that there must be some minimum support system that needs to be developed for implementing inclusion effectively. Often, this support is expected from the school systems and from teachers, in fact, parents endorse teachers' skills of managing the class as an important factor for successful inclusion. The parents of SWDs have gone a little further in suggesting the measures that may help in the inclusion of children with disabilities. Therefore, to address the concerns of parents, the school must develop such support systems and also inform parents regarding the measures that they have taken, to implement the process of inclusion. A failure in informing parents about how school and teachers are being trained for inclusion could limit schools' opportunities of accessing parents support for inclusion efforts.

We did not find any significant differences among the attitudes of parents due to gender or due to the exposure to disabilities. Parents seem to identify the abilities of teachers to be the most important factor for the success of inclusion and their uncertainty about the ability of teachers to handle SWDs in classrooms makes them negative towards the inclusion of students with severe disabilities. This concern in the light of similar concerns raised by teachers themselves and the students must be addressed on a priority basis. The concerns of parents towards the well-being of their children may be threatened due to the presence of delinquents in class, but the positive attitude towards children who show delinquency shows the goodwill of parents towards all the children. Looking at the problem again from the perspective of parents, the curriculum developers and teacher trainers must take important steps to address the issue of teacher training as mentioned earlier.

5.6 Summary

This chapter describes the concerns that teachers, students and parents have regarding the effects of inclusion of SWDs in education. It also informs that the otherwise reported negative attitudes of stakeholders towards SWDs with severe or sensory disabilities actually arise from the concerns regarding well-being of SWDs themselves. The contribution of this study lies in the strategies that have been suggested by stakeholders themselves to address the problems that may barricade the process of inclusion in education. All three stakeholders demonstrated a lack of faith in the abilities of teachers to handle SWDs in their classes, and the need for special attention to methods of upgrading the skills (and training programs) of teachers and these are important findings. In the already existing structure of pre-service and in-service training of teachers, addition of opportunities to observe inclusive classes and workshops of in-experienced teachers by experienced teachers may bring a smooth transformation in teachers practices and thereby in the current education system in terms of its inclusiveness. Also, strategies like inclusive infrastructure, peer group learning, use of technology and appropriate learning aids and development of minimum support system for SWDs within school premises and some other simple and doable strategies must be researched to establish their applicability, so that become helpful not only for SWDs but also for other learners. Lastly and equally importantly, the issue of delinquency in schools, which is of less concern for teachers and parents but an issue of high risk for students, needs to addressed by policymakers with priority.

Chapter 6

Using Diagrams and Drawings for Inclusion of Students with Visual Impairments (SVIs)

Through earlier chapters, it has been asserted that SWDs have high aspirations in science and that the general attitude of stakeholders is also positive towards the inclusive education. Next there is the main concern that needs to be addressed regarding the development of appropriate strategies for teaching SVIs in inclusive classrooms. According to Sharma and Chunawala (2013b), the study and development of effective pedagogy for inclusive science education are needed during this transitional stage towards educational inclusion. Teke and Sozbilir (2019) in their study regarding the learning needs of a SVI in inclusive setting concludes that through the use of appropriate learning aids and pedagogy SVI can learn science with a better understanding. Again, Kizilaslan et al. (2019), while designing science activity for SVIs suggest that science can be made accessible to SVIs through (I) peer group learning and (ii) by making adaptations in classrooms and laboratory to suit the preferred mode of perception of students.

It is in the context of such studies that this chapter focuses on appropriate pedagogy to teach SVIs in inclusive settings. It presents the teaching strategies used by the researcher 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 SVIs 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.
- Informal cooperative group learning.

- Representation of learning by students through verbal discussions and drawings (raised line drawings by SVIs).

Regarding the use of drawing as a tool of representation for SVIs a question may arise, ‘why do we want SVIs to draw?’ To answer this question we should think about the use of drawings as an aid to thinking for persons with sight (Anning, 1997 and Tversky, 2002). If we deprive SVIs from a tool easily available to others, a secondary disability occurs that Bodrova and Leong (2006) explain as affecting the ‘primary lower mental functions’ of a 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 SWDs, full access to the available cultural tools for learning that include drawing must be facilitated. Secondly, it has been observed that a large number of SVIs do not have visual impairments congenitally. Children might lose their sight after experiencing some period of regular schooling, in which drawing is a common joyful form of learning. The availability of a drawing tool would be useful for such students, so that they may continue the use of drawing as a learning and representation tool.

This study was done in three successive 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 use of such interactive peer support strategies to create learning situations has been successful for the inclusion of SWDs in general education (Bond & Castagnera, 2006). The basic elements of the cooperative learning approach (Davidson & Major, 2014) 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 & accountability.
- Mutually helpful behavior among learners.

6.1 Research sub questions

The following sub-questions were addressed in this part of the study:

1. What pedagogical strategies are helpful for SWDs and SVIs for learning science at school?
2. What do students with/without vision observe in diagrams in inclusive cooperative learning situations?
3. What questions are raised by students with/without vision while observing diagrams?
4. What drawings are made by SVIs while learning about atoms?

6.2 Methodology

This stage of research is **exploratory** in nature and tries to investigate the process of learning with the use of planned strategies and activities in a science class with SVIs. This is an area in which few empirical studies were found during the process of literature review. The main objective was to identify the factors that lead to effective science learning among the students with /without vision in informal cooperative learning situations.

Stebbins (2001) describes exploratory research as a systematic quest that has been undertaken to understand and describe a less investigated area of research and designed to discover purposive generalizations that range broadly. The main characteristic of the methodology in exploratory research is an extensive dependence on personal standpoint of the exploring researcher.

An approach of ‘concatenated exploration’ has been used in this study to derive inferences based upon three different parts of an exploratory study that have been conducted to collect qualitative data during the development of some science teaching strategies for SVIs and sighted students. The concatenated exploration refers to a process of research that has a chain of field studies that are linked together and each linked study examines some social processes in related groups. (Stebbins, 2001). Such exploration has helped this study to increase the ‘detail, breadth and validity’ of the qualitative study. A substantial part of this study has been presented and published in Sharma and Chunawala, (2016).

6.2.1 Venue

Parts one and two of the study were conducted in the same inclusive school in Delhi, but with different students from two different classes. Part three was conducted in two different settings: one of them was a centre of National Association for the Blind (NAB) in Mumbai, where the siblings of the visually impaired students along with other sighted children also attended; whereas the other was a special school for SVIs in Delhi.

6.2.2 Sampling

The sampling for all parts of the study has been purposive. The number of students participating in part 1 of the study was 20, while 18 participated in part 2 and 10 students (5 from inclusive settings and 5 from special school) participated in part 3 of the study. The details of the sample have been given in Table 6.1 and sub-subsections 6.3.1.1, 6.3.2.1 and 6.3.3.1.

6.2.3 Tools of analysis

The qualitative analysis was done through written responses of the groups, individual drawings made by students, records of students’ performance on different tasks and the video recordings of activities.

Table 6.1: Methodology for the study

Part of the study	Method	Nature of sample	Tools of analysis
1	Exploratory study of cooperative learning among students (facilitation was done by the researcher).	Purposive sampling of 20 students from 1 inclusive school in Delhi.	Analysis of written responses of students and record of their performances on tasks
2		Purposive sampling of 18 students from 1 inclusive school in Delhi.	Analysis of written responses of students and record of their performances on tasks
3		Purposive sampling of 5 students from inclusive settings in Mumbai and 5 students from a special school for SVIs in Delhi.	Analysis of video-recorded activities and drawings made by students

6.3 Three parts of the study

6.3.1 Part 1 of the study

Part 1 was conducted for 2 days using raised-line diagrams of micro-organisms in an unguided, cooperative learning situation with school students. This was done to explore whether, in an inclusive setting, SVIs are able to gather information from raised-line colored diagrams that are accessible to students with vision. The study involved the facilitation of science activities by the researcher with students in a cooperative learning inclusive setting. The venue was the classroom of the students in which the students were having their regular classes. The analysis of this qualitative study used the written responses of students and the records of students performance on the tasks. During the study, all the basic elements of cooperative learning were ensured through the following plan:

- The group learning activity involved an unguided observation of raised lined, colored and labeled diagrams (**not in Braille**) of microorganisms.

- Interactions were facilitated among students in groups of 4.

- Group observations were noted down by one of the group members on an observation sheet; with only one diagram presented at a time. In this way, interdependence among group members was ensured.

- Students were individually asked the next day to recognize the diagrams and recall their names from 8 unlabeled, miniaturized, colorless, raised lined, mirror image representations of the earlier shown diagrams in the observation task.

6.3.1.1 Sample

The sample consisted of 20 students (Grade 8, age-range 13-18) from an inclusive school selected through purposive sampling. 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 disability.
- Group 4: 4 girls, 2 with hearing disabilities, 1 with hearing & speech disability, 1 with no disability.
- Group 5: 4 boys, 2 had orthopedic disabilities, 2 had no disability.

6.3.1.2 Tools and administration

Students performed two tasks:

A) Unguided cooperative observation of 8 large, raised-line, colored and labeled diagrams of micro-organisms.

B) Individually recognizing these diagrams from 8 colorless, mirror-imaged and differently raised-line diagrams and recalling the names of the micro-organisms on the next day.

6.3.1.2.1 Development of diagrams for observation

Eight raised lined, colored diagrams of microorganisms on A3 sized ivory (thick white paper) sheets were prepared by the researcher. The topic of micro-organisms was selected because generally, students at the elementary level do not get the opportunity to observe these under microscopes. In the absence of diagrams, the information about the shapes of microorganisms remains almost inaccessible to the students.

The diagrams were sketched and colored and then thick, colored threads were pasted on the outlines. The diagrams had no other labels except the name of the microorganism in the Hindi language, which was also the medium of instruction for the class. The diagrams were chosen from the National Council for Educational Research and Training (NCERT), class VIII science textbook from the topic 'microorganisms'. This is a regular instructional topic for class VIII in schools and the book was already being used by the teacher and students for classroom learning.

The thick thread was used to make the lines raised in all diagrams except the Bacillus, which was made of long, hollow, brown colored, medicinal capsules. The diagrams of Spiral bacteria, Rod-shaped bacteria, Rhizopus, Amoeba & Virus were comparatively simpler than that of Aspergillus, Paramecium & Chlamydomonas in terms of complexity in lines, colors and details in diagrams. The photos of the diagrams have been presented in Figure 6.1.

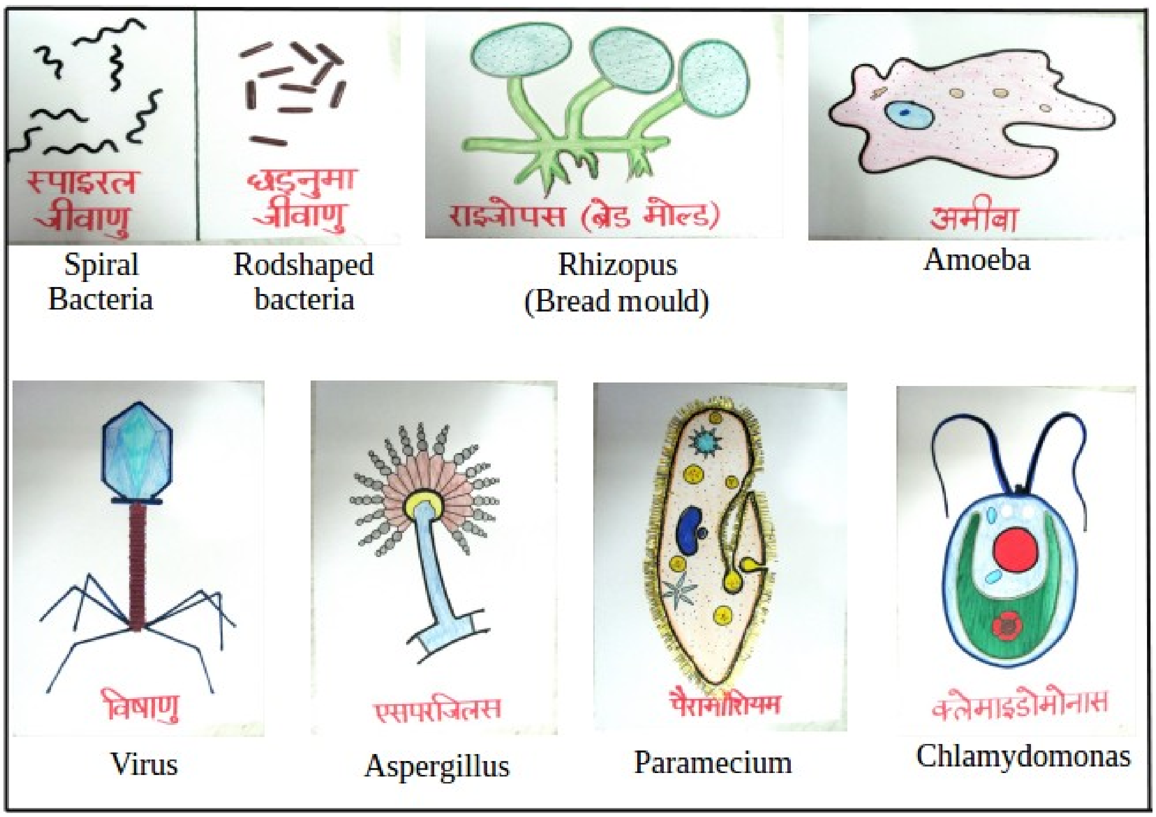
6.3.1.2.2 Test diagrams

The test diagrams were also developed by the researcher to represent the same eight micro-organisms. The difference being their miniaturized form as compared to those used by groups for observation. Moreover, these test diagrams had no labels, no color, only raised lined, mirror-imaged representations of micro-organisms on a single A3 sheet. These were developed by drawing on the ivory sheet, kept on a rubber mat. The drawing was done with an empty ballpoint refill by pressing on one side of the ivory sheet, due to which the shapes of micro-organisms got embossed on the other side of the sheet. These test diagrams were used for task B) of the study on the second day.

6.3.1.2.3 Observation sheet

An observation sheet was prepared on which the groups recorded their own particulars, such as name and class, as well as their observations of diagrams and the questions that came up during the observation.

Figure 6.1: Diagrams of microorganisms used for part 1 of the study



6.3.1.2.4 Administration of tools

For task A, after the formation of groups, the following instructions were given to students: “Dear students, today we shall be doing learning activities regarding some of the micro-organisms that are present around us. This would require doing some tasks in groups like observation, discussion and writing. To accomplish the tasks, some material in the form of diagrams and observation sheets will be distributed among your groups from time to time.

In case of any confusion or need, feel free to ask for help either from your group members or from me. I hope you would cooperate and enjoy this learning session".

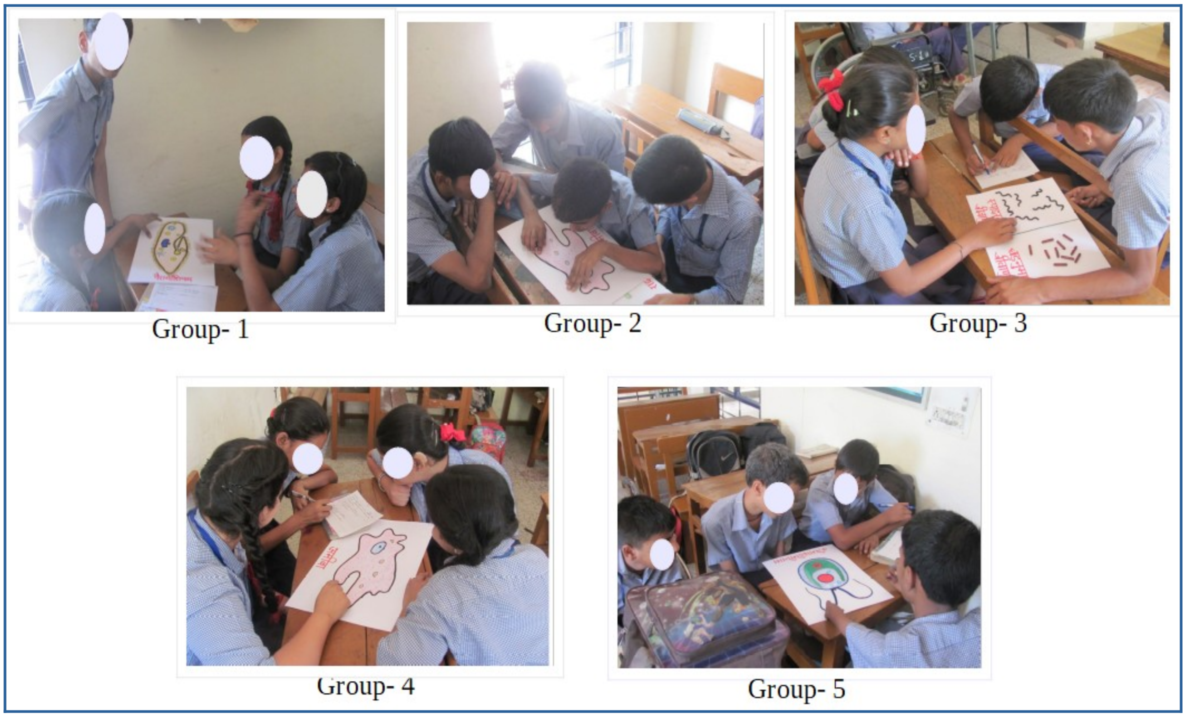
6.3.1.2.5 Pedagogic process

The researcher observed the science classes of the sample class for three consecutive days, prior to initiating the study, to learn the procedures followed by the science teacher in this class. The topic was discussed with this science teacher who reported that the learning experiences related to the chapter of micro-organisms had already been covered in the class. This became evident when three days before the study, the students could collectively name some of the classes and names of microorganisms like protozoa, algae, fungi, bacteria, viruses, etc. during interaction with the researcher. All the students except the SVI were expected to have already noticed the diagrams in their textbook. According to the science teacher, the SVI could not get access to the diagram due to the lack of any embossed diagrams in the Braille books. The teacher had been using self-made raised lined diagrams to give learning experience to the SVI, but no such diagrams regarding the shapes of micro-organisms had been used.

On the day of the study, the instructions regarding the activity were given and the diagrams and observation sheets were distributed among the groups. Group members cooperated with each other to observe the diagrams and wrote the observations and the questions (that occurred to them while observing the diagrams) on the observation sheets. Any one member of the group did the writing. During the observations, discussions and writing of responses, the groups could take as much time as required. Since the classroom sessions lasted only for 40 minutes and the diagrams were given to the groups one-by-one, all the groups observed a different number of diagrams.

On the second day, the students were called one-by-one in a separate room and asked to recognize the diagrams, which they had observed on the previous day. Students were also asked to recall the names of the observed diagrams at the same time.

Figure 6.2: Groups of students in part 1 of the study



6.3.1.3 Observations of the activity

6.3.1.3.1 Questions and observations of students

Group-1 observed 6 diagrams (Spiral bacteria, Bacillus bacteria, Virus, Paramecium, Aspergillus and Chlamydomonas) within the 40 minutes duration. In the observation sheet, the group simply noted the name of the micro-organism that was represented in the diagram.

Group-2 observed 3 diagrams (Rhizopus, Amoeba and Virus). This group was focused upon, as two members of the group were SVIs.

Group 3 observed 4 diagrams (Paramecium, Spiral bacteria, Bacillus bacteria, Rhizopus) in the prescribed duration, however it only recorded Paramecium and Rhizopus.

Group 4 observed 4 diagrams (Amoeba, Virus, Spiral bacteria, Bacillus bacteria).

Group 5 observed two diagrams (Chlamydomonas and Paramecium) during the 40 minutes duration, thereby taking the longest time for recording their observations and questions per diagram. Also, the group did not record any questions regarding the diagram of Paramecium. The responses of all the groups have been tabulated in Table 6.2.

Table 6.2: Responses of groups to the observed diagrams

Group 1	
Spiral bacteria	**Question:** · *Why are the spiral bacteria black in color?* (The spiral bacteria diagram was made from a material that was black in color)
Bacillus bacteria	**Questions:** · *Why are they named Rod-shaped?* • *Why do Rod-shaped bacteria look as capsules?* (the Bacillus diagram was actually made by hollow, single-colored, medicinal capsules)
Virus	**Questions:** · *Why does the virus look like a robot?* • *Why has it been named as virus?* • *What work does the virus do?*
Paramecium	**Questions:** · *In which animals or humans are they found?* • *What are their uses?*
Aspergillus	**Questions:** · *Why are they shaped like a tree?* • *Where are they found?* • *What is their use?*
Chlamydomonas	**Questions:** · *Why does it look like a cockroach?* • *Where are they found?* • *Why has it been named so?*
Group 2	
Rhizopus	**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) bamboo-like wood.* (Stolon) **Questions:** · *Where are they found?* • *What are the harms and uses due to this?* • *What causes the spreading of these?* • *What diseases can be caused by them?*
Amoeba	**Observations:** · *There are four round structures in it.* (Nucleus and ………vacuoles) • *Amoeba is also a protozoan.* • *Its shape does not remain stable.* • *There are many bacteria like dots in it.* (Cytoplasm) **Questions:** · *What is Amoeba and where are they found?* • *With which instrument can they be seen?* • *Does it cause disease or not? If yes, then how?* • *What is the color of Amoeba?*
Virus	**Observations:** · *It looks like an alien or robot.* • *Legs are visible in it.* **Questions:** · *What disease is caused by it?* • *What is its color?* • *Where are they found?*
Group 3	
Paramecium	**Observations:** · *What are these blue* (Mega and micro nuclei), *yellow (food vacuoles) and sky blue (contractile vacuoles)* structures? **Question:** · *What is the meaning of (word) Paramecium?*
Spiral bacteria	**Question:** · *Where are the Spiral bacteria found?*
Bacillus bacteria	**Question:** · *What is the meaning of the term Bacillus?*
Rhizopus	**Observation:** · *Why is their shape grape-like?* **Questions:** · *Where is Rhizopus found?* • *What material has been used in this (diagram)?*
Group 4	
Amoeba	**Observations:** · *It is peculiar as if a child has made a rough thing.*

	• *It has so many pits. (Nucleus and food vacuoles)* • *It looks very dirty.* **Questions:** · *Why does Amoeba have no (fixed) shape?* • *Why does it have pits?* • *Why is Amoeba called a strange name, Protozoa?* • *It has a strange shape and dirty color (why)?*
Virus	**Observations:** · *Virus enters our cells and by increasing its number it destroys the cell.* • *It is a pathogen.* • *These look like a robot.* • *To escape from it we keep our hands and surroundings clean.* • *When Viruses enter our body, we fall ill, so doctors inject penicillin into us.* **Questions:** · *These live in dirt and make us ill. Why is it so?* • *How do they enter our bodies?* • *Where are these found?*
Spiral bacteria	**Observation:** · *These ones look like long ropes.* **Questions:** · *Where would they be found?* • *When would they do movements: during the day or at night?*
Bacillus bacteria	**Observation:** · *These just look like capsules.*
Group 5	
Chlamydomonas	**Observations:** · *It is looking like an insect.* • *It has black colored long-long mustaches.* • *These are found in water.* • *These two circles of white color look like their eyes.* • *These are found in decaying materials.* **Questions:** · *Where are these found?* • *Why is it named so?* • *What diseases do they cause?* • *Is it harmful to us or not?* • *Why is it round-shaped?*

Paramecium	**Observations:** · *It is a kind of Protozoa.* • *It looks like mud.* • *It (the diagram) has been made very beautifully.* • *The yellow dots in it look like laddus* (round sweet dish). (Food vacuoles)

6.3.1.3.2 Performance on the recall task

Every student of each group recognized all the observed diagrams correctly from the 8 test diagrams. In group 1; one student could recall only the name of Paramecium; 1 student could partially recall the names of Spiral bacteria, Bacillus and Aspergillus; 1 student could not recall any name; while 1 student could partially recall the names of Paramecium and Chlamydomonas.

In group 2; two students could recall all the three names correctly, the SVI could recall two names correctly as Amoeba and Virus and 1 student could recall the names Amoeba and Virus correctly, but the name Rhizopus incorrectly.

In group 3; one student could recall the names Paramecium, Spiral bacteria and Bacillus correctly, but the name Rhizopus partially, 1 student could recall Paramecium correctly, but Bacillus and Rhizopus partially, whereas 2 students could not recall any names.

In group 4; three students recalled all the four names correctly, whereas 1 student recalled the 3 names correctly and the name of Spiral bacteria partially correct.

In group 5; one student could not recall any name, 1 student could recall both the names partially, 1 student could recall only the name of Paramecium partially and 1 student could recall the name of Chlamydomonas partially.

6.3.1.4 Analysis

The cooperative observations of students resulted in analogies, such as, “looks like an alien or robot”. Analogies are made by students from familiar to unfamiliar objects and are considered to be important while developing and understanding new ideas (Brown & Salter, 2010). The questions raised by the students on the basis of these diagrams were non-trivial and were related to the material used in the diagram as well as the micro-organism that was being represented through the diagram. On 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. This is to note that the diagrams for recognition were colorless, mirror-imaged and differently raised lined diagrams which are generally used only by SVI. 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 finding is in accord with Zimler and Keenan (1983) who in their study found that the performance of SVIs on three different tasks, that involve visual imagery, was similar to the sighted students. From this observation, it may also be inferred that the raised lined diagrams without colors are recognizable by other students as well, although the mode of perception was still vision and not haptic.

It was found that all the students (8/8 students of two groups) who had observed the diagram of Amoeba, could recall its name correctly during the recall task, whereas the names of 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 learned and recalled by the SVI 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 SVIs. This cooperative observation and the transfer of information can be related to the peer interaction.

A comparison of the performance of students at recognition and recall tasks gives a clue that the shapes are more easily remembered by students as compared to the words. The study suggests a need for using strategies with students for remembering new scientific terms in classrooms.

6.3.2 Part 2 of the study

Part 2 of the study was guided to a large extent by part 1 of the study. In this part, 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 gathered information from the raised-line colorless diagrams (which are generally used by teachers for SVIs) but also represented it through drawings. The topic was selected because teeth are an important organ of our digestive system. Although they are directly visible in the mouth, their complete structure is inaccessible to students because of the visible part being only the crown of teeth while the root part is embedded inside the gums. Moreover, the difference between the structures of different types of teeth is important to appreciate their differentiated roles in food mastication.

Similar to part 1 of the study, in part 2 also, the facilitation of cooperative science learning activities was done by the researcher in the classroom of students of an inclusive school. The qualitative analysis of this exploratory has been done through the written responses of students, drawings made by them and their records of performance on the tasks. The basic elements of cooperative learning have been ensured in this part also through following ways:

- All the tasks that were performed by students during the activity were done through cooperative group learning. The tasks involved:
    a) Naming and drawing of diagrams of different types of teeth individually through earlier knowledge.
    b) Cooperating with the group (of 4-5 members) for observing and discussing 4 different types of raised lined diagrams of human teeth.
    c) Naming and drawing diagrams individually through memory after observation.

d) Recognizing the observed diagrams individually from differently colored 9 diagrams.

- Interactions among group members was facilitated.
- The group members were interdependent in using the observation material as one diagram was provided at a time and was replaced only after the group had completed observing it.
- Students were accountable individually for naming; drawing diagrams and; recognizing the observed diagrams from differently colored 9 diagrams through memory after the observation tasks.

6.3.2.1 Sample

18 students of class VII, from the same inclusive school (as in part 1) were selected again through purposive sampling. The age of students ranged from 12-16 years. For the purpose of the activity, the students formed 4 groups of their own choice. The particulars of group members 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.

6.3.2.2 Tools and administration

6.3.2.2.1 Diagrams for observation

The diagrams of teeth were developed by the researcher on Braille sheets of 15 x11cm size, after referring to the NCERT textbook. Each type of teeth diagram (for example, incisors) was different from another type (canine, molar, or pre-molar) in terms of color, type of raised outline and raised or smooth inner space. All the diagrams were validated by one subject expert and two special educators who are experts in the education of SVIs. The diagrams were labeled with their Hindi names at the lower end in Devanagari as well as Braille scripts. Each diagram of teeth that was used by groups of students for observation during part 2 of the study may be described as:

- **Incisor**- Raised continuous lines were developed on the Braille sheet, after keeping it on a rubber mat. The embossed impression of lines were made by drawing (hard pressing) on one side of the ivory sheet with an empty ball-pen refill. In this way, the shape of the Incisor got embossed on the other side of the sheet. No color was filled in this diagram. The differentiating features were: square crown, incomplete junction line between the crown and root parts and, triangular one side tilted root.

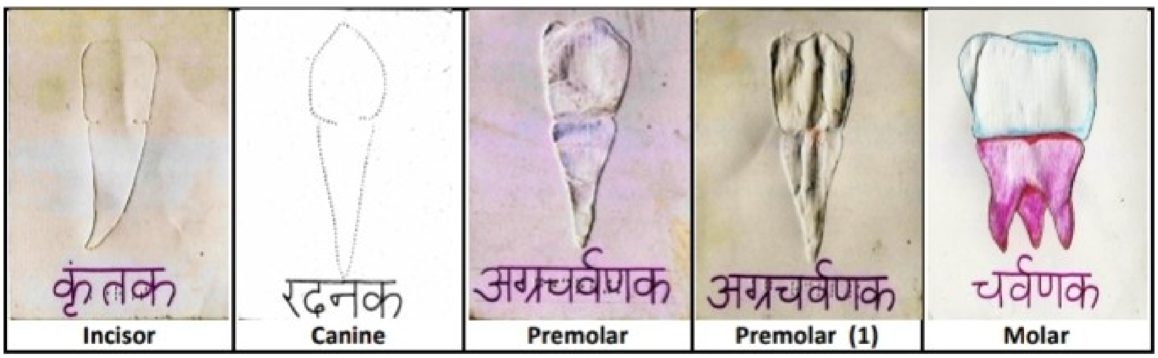
- **Canine**- This diagram consisted of raised dotted lines and had no colors. The method of development was similar to that of the earlier diagram with a difference that the lines were kept dotted instead of making them continuous. The differentiating features were: pear-shaped crown, incomplete junction line between crown and root and, triangular shape of the root.

- **Premolar-** The development of raised continuous lines of this diagram was similar to that of the Incisor diagram with an addition of the inner space being raised. The inner space was raised by hard-pressing lines all over the inner area of the diagram. Again this diagram had no colors. The differentiating features were: two cusps in the upper line of the crown, complete junction line between crown and root and the triangular shape of the root.

- **Premolar (1)**- A second diagram was developed similar to the earlier with a difference of an extra upper lining to show the back portion of the crown top.

- **Molar**- The raised continuous lines and the raised inner space of this diagram was developed in a similar way as that of premolar. In addition to the other features, this diagram had multicolored outlines as well as inner space (as shown in Figure 6.3). The differentiating features of this diagram were: double, irregular upper lining of the crown, complete junction line between crown and root, trilobed root and the occlusion of the middle lobe of the root.

Figure 6.3: Diagrams of teeth used for observation in part 2 of the study



6.3.2.2.2 Observation and response sheets

The groups recorded their own particulars, observations of diagrams and the questions that they had after observing the diagrams on the sheets provided to them. On the first response sheet, the students drew diagrams from earlier knowledge before the observation of diagrams and on the next response sheet they drew diagrams after the observations. Two such sheets were Brailled to be used by the SVI before and after the observation of diagrams.

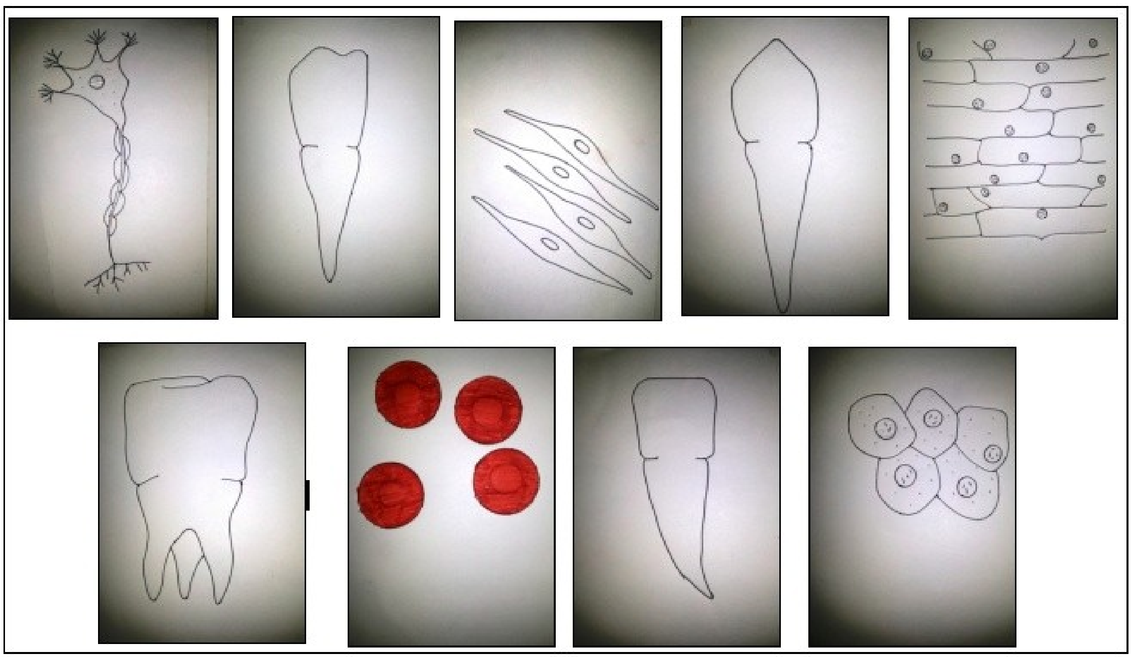
6.3.2.2.3 Video

A video of the digestive system was used during the study. The duration of the video was around 8 minutes and this was played on a laptop and the external speakers were used to enhance the sound. The criteria of selection of video was the descriptive commentary associated with the video which could make it understandable for students with and without vision. The language used in the video was Hindi which was also the language of learning for the students.

6.3.2.2.4 Test diagrams

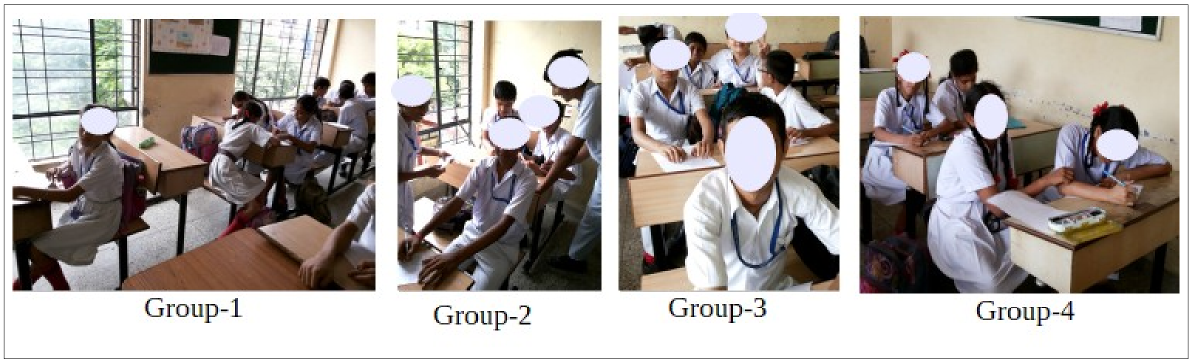
These consisted of 9 unlabeled raised line test diagrams with black outlines on separate sheets. (i) Five such diagrams represented human cheek cells, unstriated muscle cells, onion peel cells, nerve cell and red blood cells and (ii) the four other diagrams represented the types of teeth that were shown earlier.

Figure 6.4: Test diagrams used for the recognition task in part 2 of the study



None of the diagrams had any label on them. The red-blood cells diagram had raised and colored inner space also. The size of the sheets and diagrams were closer to the observed diagrams. From these diagrams, students had to recognize those diagrams of teeth which they had observed earlier.

Figure 6.5: Groups of students in part 2 of the study



6.3.2.2.5 Administration of tools

The details of the students were collected from the class teacher prior to the study and the planning of the topic was done after discussion with the science teacher of the class. It was informed by the science teacher that the students had previous knowledge about the names and shapes of the four types of teeth through their classroom learning and the science textbook. It was also informed that the SVI had no exposure to the diagrams of teeth as the Braille textbook did not have such diagrams, but they had experienced some other embossed diagrams earlier, related to some other topics. During the discussion, this came to be known that the idea of SVI drawing a diagram was new to the teacher due to non-availability of tools for this. Even the class teacher was very curious and interested to observe how the SVI of her class would be dealing with this new task. This teacher was present in the class as a silent observer during the study.

On the day of study, the students and the researcher had met for the first time. After the groups were formed, the instructions were given to students in Hindi language (medium of instruction in class) regarding the activities. The peers of students with hearing impairments were asked to translate the instructions into sign language for their fellows. The instructions that were given were, “Dear students, today we shall be doing some activities regarding different shapes of our teeth. This would require doing some tasks like drawing, writing, observing, discussing, etc. Some of these tasks must be done in groups, whereas others would require individual working. Some learning material in the form of diagrams and sheets will be distributed among your groups from time to time which would be helpful to accomplish the tasks. In case of any confusion or need, you must feel free to ask for help either from your group members or from me. I hope you would cooperate and enjoy this learning session".

The instructions were followed by the distribution of response sheets among all the students on which they were asked to write the names of different types of teeth and draw their diagrams through previous knowledge. The SVI was given instructions on a Braille sheet. As the SVI had a lack of exposure to raised lined diagrams of teeth, no response was recorded by the student on this response sheet.

After the collection of first response sheets, each group of students was given diagrams of four different teeth one by one for observation. The groups recorded their unguided cooperative observations and questions related to the diagrams on the observation sheets. This is to note that all the groups observed all the four diagrams. This was followed by a screening of the video of the digestive system to give some time interval between the filling of the observation sheet and the second response sheet. After the screening of video, the students recorded their names on the sheet and drew the four types of teeth that they had observed, based on recall. It was a pleasure to notice that this time the SVI drew diagrams of two types of teeth by recalling her observations (although with some difficulty and some help from peers). The drawings of SVI have been presented in Figure 6.6. Next, the 9 unlabeled raised line test diagrams were presented to the students, wherein they had to recognize the diagrams of teeth which they had observed earlier.

6.3.2.3 Observations

6.3.2.3.1 Questions and observations of students

On the task that tested the previous knowledge of students, only 2/18 students could draw the teeth-diagrams (partially correct) while 9 students could name all the types of teeth correctly. For deciding the correctness of the diagrams drawn by students, the presence of the differentiating features of the tooth, such as (i) the proportion of crown to root (ii) outline of the teeth and (iii) inner contours were compared with the observed diagrams. Responses of all the groups have been presented in Table 6.3.

Table 6.3: Observations and questions of groups on the diagrams of teeth

Incisor	**Observations:** · *This seems to us to be like the shape of a carrot.* • *Its upper part looks like a square box.* • *On looking at it we remember carrot.* • *Some part of this tooth is embedded inside the gum.* • *Teeth are different in shape.* **Questions:** · *How is its lower part (root) formed?* • *Why don't these teeth prick in our mouth?* • *How long is this tooth and why?*
Canine	**Observations:** · *This seems to us like an ice-cream cone.* • *This tooth is exactly like a cone.* • *Its crown part looks like a gram (chickpea).* • *This is a pointed tooth.* • *This tooth looks like a cone of ice-cream or as a fire torch.* **Questions:** · *Why is it shaped so?* • *Why does it look like this?*
Premolar	**Observations:** · *The upper part looks like teeth itself, but the root looks like a chili.* • *It looks like a radish.* • *This tooth is very useful.* **Questions:** · *What similarities does it have with other teeth?* • *Why does it look so?*
Molar	**Observations:** · *This looks like a World cup trophy.* • *It looks to us like an Octopus.* • *This is molar.* • *It helps in grinding the food.* • *This is the largest (tooth) among all.* • *The lower part of this tooth looks somewhat similar to (legs of) an elephant.* • *Some part of the tooth is embedded inside the gum.* • *This tooth looks like a hand.* • *Its shape is totally different from others.*

	Questions: · *Why do they all look so?* • *Why is it tilted?* • *Why are they present (in mouth)?*

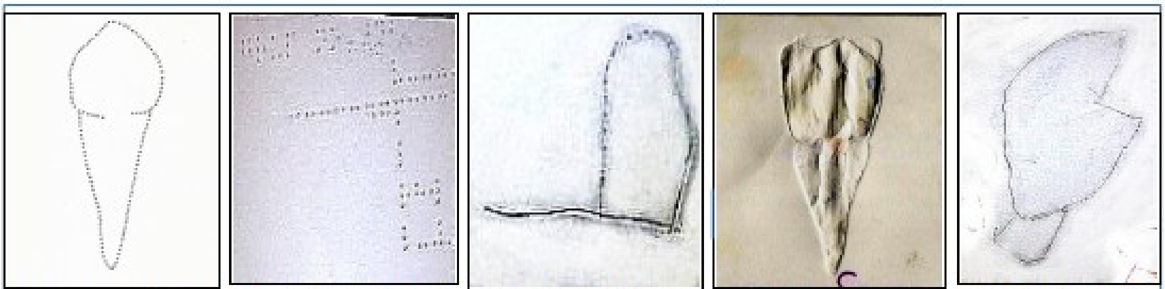
6.3.2.3.2 Performance on recall task

When asked to draw the teeth diagrams individually from memory 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. The SVI tried to draw diagrams of canine and premolar, but only the premolar diagram is correct. The details have been presented in the next sub-section. The performance of students 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. This is also to note that the SVI had not written any names on the response sheets although being well versed with reading and writing Braille (as informed by the teacher). The reason behind no written response in Braille by the SVI could not be found. On 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.

6.3.2.3.3 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 Figure 6.6, where she attempted to draw a canine tooth. It is to be noted that she herself was not satisfied with her efforts. 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, after making some more attempts which were again not satisfactory to her, she drew a premolar with a blank refill ball-pen on a Braille sheet, showing both the root and crown (although not in the same proportion as the observed diagram). It can be said that the use of a better tool of drawing and a practice of drawing has led to better diagrams. The SVI was helped by group members in making efforts, without such help the drawing would have been much more difficult for her.

Figure 6.6: Drawings of teeth by SVI



Canine figure observed (A) | Canine drawn by SVI: Stylus & slate (B) | Canine drawn by SVI: Blank refill ballpen (C) | Premolar figure observed (D) | Premolar drawn by SVI: Blank refill ballpen

6.3.2.4 Analysis

This is interesting to note that due to lack of earlier exposure to the shapes of teeth, the SVI, as expected, did not draw the diagram of teeth on the previous knowledge task, but surprisingly, even in the case of sighted students, only 2/17 students could draw partially correct diagrams. This may indicate that during the process of learning in lack of focus on visualization or the drawing through observation, the shapes of objects do not register effectively for students (with or without sight). Similar to part 1 of the study, the cooperative observations of students focused on the analogies (resemblance of the diagram with some known object) but unlike in part 1, the observations and questions asked by students were not related to the material used for representing the teeth. These were mostly related to the shapes, functions and effects of actual teeth. This may point at lesser distraction among students while observing embossed diagrams as compared to the diagrams that had threads pasted on the outlines or made up of some 3-D material (like, medicinal capsules).

Regarding the fact that all the students recognized the observed diagrams from the other diagrams a fewer number of students correctly recalled the names of observed diagrams and; a lesser number of students drew the shapes correctly, these may be an indicator of the difficulty levels of the task as faced by students. It indicates that recognition is the easiest and drawing from memory is the toughest among these three tasks. This finding also adds one more step to the finding from part 1 regarding 'the remembering of shapes being easier than remembering of names'. Now it may be said that 'the remembering of shapes is easier than remembering of names and representation of a remembered shape through drawing'. Under such a situation if a SVI could represent some aspects of the observed diagram through drawing, then this indicates some effectiveness of co-operative learning. This also indicates that all the types of diagrams used in this part of the study (continuous raised line, dotted raised line, raised line and raised inner space and raised lie with colored and raised inner space) were recognizable to students with and without vision. This finding, like part 1, again reiterates the inferences drawn by Zimler and Keenan (1983) regarding similarity of performance of SVIs and sighted students on the tasks that involve visual imagery.

That more students drew the molar correctly after their observations, may be because this shape was remembered as it was the last observed diagram; or that the colored, raised lined and raised inner space diagrams are more effective aids for learning; or both.

6.3.3 Part 3 of the study

Part 3 of the study explored the use of 3-dimensional models, their descriptions and cooperative discourse among students to understand an abstract scientific topic regarding the structure of atoms and the representation of this understanding by students through drawings. The topic of atoms was selected for this study as it was suggested by two students from the inclusive setting who during informal talks reported it to be difficult. Both students were also a part of the sample of the study. This topic is a basic requirement to learn several other concepts of physics and chemistry (Sarikaya, 2007) but is a difficult topic as reported by the SVI. Regarding learning the structures of atoms, Harrison and Treagust (2000) suggest that analogical models of atoms are not always interpreted by students in the way they are intended and multiple models are not always easy to understand.

The concept of atoms has roots in ancient philosophical debates on the nature of matter (Tsaparlis, 1997) and this concept forms the foundation of modern physics and chemistry. The 'particulate model of matter' (atomic model) is an abstract topic that is generally introduced in chemistry and physics syllabi at the secondary stage of schooling. According to Adadan et al. (2009), without classroom interactions, students either have no knowledge about this model of matter or are unable to use the particle ideas to explain phenomena.

Gilbert and Treagust (2009) report that most students have problems while relating the concept of atoms to the observable natural world; to the sub-microscopic level and; to the symbolic level, resulting in several alternative conceptions, that make the learning of atomic structure difficult. For a better understanding of the concept of atoms, Harrison and Treagust (2000) recommend social negotiations among students and the use of multiple models of atoms. Ainsworth (2008) also suggests carefully designed multiple representations for an effective understanding of such complex scientific concepts.

This part of the study explored the prior conceptions of the students regarding atoms and the kind of drawings made by SVIs while learning about atoms. This work focused on understanding the conceptions of SVIs through their verbal reports and drawings. Various activities were performed by the researcher on four different days (around one hour each day) with two different groups of students in inclusive and special (SVIs) education in two settings. Video and audio records, classroom observations and field notes formed the various tools of data collection. As mentioned earlier, in the Indian context, SVIs in special schools simply opt-out of science courses at the secondary stage. This circumstance has forced us to emphasize an exploration of the challenges faced by SVIs rather than making a comparison of the two settings.

Science activities related to understanding the structure of atoms were conducted with two different groups of students in inclusive and special (SVIs) educational settings. The 'historical approach' to teaching and learning the structure of atoms was followed, which was also found in the text-books of the sample students. This approach introduces the learner to the developments that have undergone with time in the understanding of a particular concept and also how perceptions of scientists changed regarding the concept. The approach helps the learners to obtain a basic understanding of the concept and also to cope with misconceptions (Mamlok et al., 2005).

Similar to the earlier two parts of the study, the elements of cooperative learning among students were ensured during this part also.

- The group learning activity was a discussion on the different scientific theories about the structure of atoms as given by four different scientists and the observation of real objects or physical models to represent the theorized structures.
- The interactions were facilitated among students in groups of 3-5.
- Every time, a single representative object or model was provided for observation to ensure interdependence among members of the group.
- Students were accountable individually for representing their understanding of the theorized structure of the atom by drawing on separate sheets.

6.3.3.1 Sample

The sample and settings were selected via purposive sampling, which depended upon getting permission from school authorities. The principals of the schools and students were met to collect data about the sample. The number of students differed on different days and the details of the sample are provided in Table 6.4.

As the number of students was less, the students formed a single group of 5 students in each setting. This is also to note that on different days, the total number of students in groups also differed. This happened due to other activities of the school, in which the participation of students was considered more important by the school authorities.

Table 6.4: Details of the sample for part 3 of the study

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)	Yes	18	Boy	10
	J	No vision (lost after age of 2 years)	No	18	Boy	10

6.3.3.1.1 Inclusive setting

The activities with this group were done in a study center of the National Association for the Blind (NAB), in Mumbai. In this center, teaching is done by some volunteers and three teachers with experience in special education, including teachers with a science background. Here all the school subjects are taught. SVIs at the center are also enrolled in local schools, or open schools, which they visit only to appear for their examinations. Along with the SVIs, sometimes their (sighted) relatives or friends or other students also attend the center and participate in the learning activities.

In this setting we observed that the teachers read aloud from the textbook and explained the meaning of what was read. There was also some questioning by students as well as the teachers during the classes. Students asked questions mainly for clarification while teachers asked questions to steer the dialogue towards the topic of discussion. Teachers gave illustrations from daily life to help students relate to the topic better. Recreational and co-curricular activities were also conducted. The syllabus and textbooks are based on the guidelines provided by the State (Maharashtra) where the concept of atoms is introduced in class VII, and further elaborated in class VIII to include the atomic models of Dalton, Thomson and Rutherford, as well as, the concepts of electrons, neutrons and protons; atomic number, atomic mass number, isotopes and valency.

It is important to note that the SVIs did not have Braille textbooks for science and were dependent on verbal descriptions by teachers and peers. All the students in the center who took part in the study had already been exposed to these topics earlier. One student (B) who was in class X had opted for the subject 'home science' instead of 'science and technology' because she considered the latter tough. Students here reported prior experiences of tactile maps and geometrical figures that were made by their teachers in other subjects, but not science. Only one student (F, with no vision congenitally) in this group did not have any experience of drawing prior to the study, whereas all the other students had some experience.

6.3.3.1.2 Special education setting (SVIs)

Activities were conducted in a special residential school for SVIs, in Delhi, where the sample students were enrolled. This school run by a charitable trust for the blind had special educators, none of whom was specialized in science. While no science classes could be observed as these were not held during our observation period, general classroom observation of language classes indicated that the 'read aloud' method mentioned earlier was used. However, a difference was that students read from their Braille books and explanations were provided by teachers.

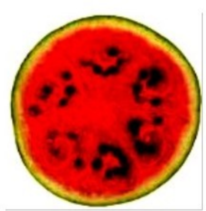
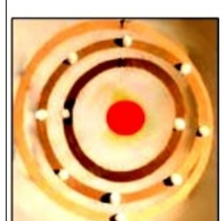
None of the sample students in this setting had any exposure to the topic of atoms, despite three of them being in class X, while the topic is introduced in class IX in the NCERT books. The students themselves mentioned that they had the option of not appearing for abstract topics in evaluation. While all the students used Braille textbooks, there were no tactile illustrations in these books. Only one student (K) had some prior experience of drawing before losing his vision.

6.3.3.2 Tools and administration

6.3.3.2.1 Models used for representations

Some objects and models were used in this part of the study to introduce and illustrate the different structures of atoms as conceptualized by different scientists. To understand Dalton's concept of the atom, 8 balls of different sizes were used; a watermelon (whole fruit later cut to pieces) was used to represent Thomson's concept of the atom; a ball surrounded by a beaded ring was used to represent Rutherford's concept of the 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.

Figure 6.7: Models used for representation in part 3 of the study

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

6.3.3.2.2 Pedagogic process

The activities in both settings were conducted by the researcher over a period of 4 days and all activity plans and representations used were validated by two science education experts. On the day prior to the actual study, the data of students was collected through informal talks with students and the Principals. Some cooperative games of interpreting and making drawings through the use of drawing tools for SVIs were also played with the students. These activities helped in creating a rapport with the students and acquainting the students with the cooperative learning situations and also with the drawing tools for SVIs.

On day 1, students' ideas about atoms were elicited. They were asked to describe atoms and give examples of things around them that have atoms. Students were specifically asked whether things such as water, carrot, door, wall, clothes and air have atoms. Lastly, students were asked to draw how they thought atoms looked like. For drawing, the SVIs used tools that are described later. In the next 3 days, learning activities concerning the structure of atoms were conducted through verbal descriptions by the researcher and real objects & 3D models was also made and discussed with the students. Finally, drawings were made by the learners to represent their understanding of atoms, which the students were asked to explain.

All activity plans and models used were developed keeping in mind the syllabus and its presentation in the Maharashtra State textbook of class VIII general science. This textbook was used to keep the learning material the same in both the settings mainly, as in the Delhi school the topic of atoms was not being taught at all.

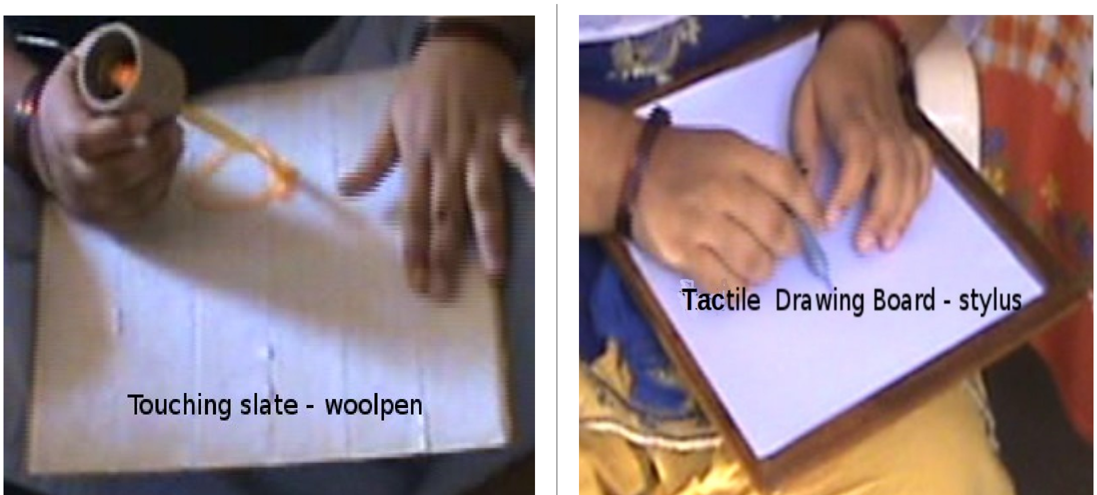
On day 2, students were introduced to the ancient debates on continuity/discontinuity of matter. This was followed by information on Dalton's experiments with gases and his inferences about the properties of atoms. Representation of Dalton's theory of atomic structure was done with the help of 8 balls of different sizes that the students handled in groups talked and had discussions, and then made drawings individually to represent the resulting structure. This was followed by information about the discovery of cathode rays, the nature of negatively charged particles and the charge neutrality of atoms. Students discussed the changes expected in Dalton's model due to this discovery. Another theory on the structure of the atom as proposed by J. Thomson was introduced through a watermelon which was first observed from outside and then from inside by cutting it into two halves. The students after group discussions about this model of the atom represented the structure through drawings.

On day 3, the gold foil experiment was described through a 3D model. Students handled the model and discussed the discrepancies that would arise in Thomson's model due to these experimental findings. The students then represented the gold foil experimental set up through drawings from memory.

On day 4, the nuclear model of the atom as theorized by Rutherford was described and presented. Students later represented it by drawing from memory. This was followed by information on later discoveries that culminated with Bohr's theory about the structure of atoms. This too was represented by a model. The topic ended with a note about how discrepancies in earlier theories lead to new theories on the structure of atoms.

On all four days, students were encouraged to draw without worrying about the correctness of the drawings. After completion of the drawing, they were asked to explain it and say if their drawing could represent the concept. Some of the students made multiple attempts at drawing. The students with vision and low vision used paper-pencil to draw whereas 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). The limitation of wool-pen is that the wool needs to be cut in order to begin drawing from a fresh point. The limitation of the tactile drawing board is that SVIs needs to turn the sheet to feel the embossed material on the opposite side. At the outset, all the SVIs were given time to become familiar with the new drawing tools.

Figure 6.8: Drawing tools used by SVIs during part 3 of the study



6.3.3.2.3 Data and tool for analysis

In the Mumbai setting which was an inclusive setting, groups, students spoke in Marathi or Hindi. The video recordings of the activities carried out with students on all four days were transcribed and translated from Marathi and Hindi to English. The students' responses were analyzed to identify themes in their conception of atoms, and interesting quotes and instances in each of the themes are presented. Students' drawings of atoms were categorized and in order to increase the credibility of our categorization we sought the help of a design expert. All the students were asked what they were trying to depict and the categories are based on the resemblance of the drawings to the description. Regarding the stages of development of drawing in children, 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 the 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.

Next the transcripts and videos were also analyzed iteratively to find in the discussions, instances and evidence of visualization by SVIs. To decide whether something was an instance of visualization, the dual coding theory (DCT) was used. DCT is a theory of cognition according to which, the verbal and non-verbal (imagery) representations are modality-specific and their associative processes explain human behavior and experience. The assumptions of DCT suggest that “mental images are also amenable to dynamic spatial transformations that are not possible with verbal representations” (Clark & Paivio, 1991, p 152). The theory has been developed in the context of education, hence its use for the analysis becomes more relevant.

With the above theory in view, the responses that represented transformations in mental images were selected and on the basis of the nature of the visualized image, they were categorized into-

(1) Visualization objects

(2) Introspective visualizations

(3) Interpretive visualizations

6.3.3.3 Observations

6.3.3.3.1 Students' conceptions of atoms before the intervention

The responses of nine students (four students from the inclusive setting – F and R with no vision, and P1, P2 with vision; and five students N, S, J, K and D in the special education setting with no vision) collected on the first day before initiating the various learning activities are presented below. These responses indicate their earlier knowledge about atoms. In inclusive settings, these responses may have been a result of exposure to teaching in some cases (older students).

(I) Inclusive setting

<u>The shape of atom</u>: The question regarding the shape of atoms is non-trivial and has a history in ancient philosophy and modern science. A study by Cokelez (2012) on students' ideas about the shape of atom reported that at lower levels (grade VI) of schooling when the concept of the atom is introduced, a large number of students do not respond to the question about the shape because of the difficulty in having a mental model of atoms.

The drawings made by students in the study reveal that students in the lower classes had a particulate conception of atom mostly depicted by balls or spheres. In our study, students F, R and P2 considered atoms to be spherical in shape. For instance, F said,

> *It would be like a ball….* (Student F)

However, R began with the example of water and said

> *...it seems to me that the atoms in water do not have any shape... like water, which does not have any shape and takes shape of whatsoever (vessel) we put it in.* (Student R)

However, subsequently she said that overall atoms of other substances may be round. Such a consensus among students points at specific knowledge framework among them regarding the spherical/round shape of atoms (although scientifically inaccurate). This can be speculated that such a conception develops through the analogical description of different states of matter in science textbooks of lower classes, through differently spaced balls kept inside boxes to depict solid, liquid and gas.

One student, P1 had a conception that the shape of atoms is irregular, which was also depicted in the drawing made by her. Later on it was found that the student was confusing atoms with fungi, hence the description was different from other students.

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. Some interesting responses were given by F. He considered that all atoms are of similar sizes.

> *I feel that all atoms must be similar, of the same size, only things that are small have less and those which are bigger would have a larger number of them.* (Student F)

This is an interesting conception additionally, he mentioned that there must be some visual aids by which atoms that cannot be seen by unaided eyes become visible, however, he used the term telescope when perhaps he meant microscope. Similar results have been reported by Harrison and Treagust (1996) that students have this conception that atoms may be visible with microscopes.

Analogies for atom: Analogies are important when learning unfamiliar concepts (Thagard, 1992), because they help science learners to accommodate the new knowledge into their existing knowledge structure, thereby making it more understandable (McComas, 2013). In our study, we looked for analogies that students used when talking about atoms. Student F as mentioned earlier 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 following analogy,

> *They are similar to the thin capsules of cotton... If touched, they get pressed and get attached to our hand. They are in the middle part of the bread*. (Student P1)

Thus P1 was confusing atoms with fungi. According to student P2,

> *Atom is like material inside chalk when we write then its particles fall down and they have even smaller particles in them*. (Student P1)

In order to explain invisibility of atoms, student F said,

> *It is just like a (light) ray which is not visible to anyone.* (Student F)

Referring to two earlier parts of the study we again find that students used analogical references to communicate their ideas about the concepts under consideration (atoms in this case). Such a repeated and spontaneous use of analogy by students to learn and communicate scientific concept indicate that this is a tool of learning that is easily available to students. Glynn and Takahashi (1998) in their study regarding the use of analogy-enhanced text for learning science report that the strategy resulted in better conceptual understanding among students and their better performance on recall and recognition tests as compared to the control sample. In fact analogy has been identified as a tool of mediation between the knowledge that the learners already have and the new knowledge. This occurs through the use of already existing schema for assimilating the new concept thereby making it more understandable and even more easily retrievable (Glynn & Takahashi, 1998).

<u>Location of atoms:</u> Students were asked to state where atoms are found. Three students from the inclusive setting gave a response that can be exemplified by student F's response,

> *Atoms are present in every matter... it seems to me that atoms are present in everything.* (Student F)

But again the response of student P1 was different form the others. According to her, atoms are located on bread, chapattis, (unleavened flatbread), water and on the back of animals.

> *They are small and irregular, I have seen in my book. If touched they get pressed and attach to our hand. They are in the middle part of bread. They might be like this (showing the drawing which has been depicted in Figure 6.9). Atoms must also be present in water, on the back of animals and in chapatis They are of black, white and blue color and they are similar to thin capsules of cotton.* (Student P1)

It is to be noted that the student P1 had normal sight and her responses can be attributed to the confusion of terms atoms with rhizopus, which she had learned from her science classes (this is clear from her drawings). Later the student informed that the topic of micro-organisms including the description of rhizopus had been covered in her class a few days back, whereas the topic of atoms was covered earlier. Through this disclosure, it may be said that the strategy of questioning and drawing by students can be effective in revealing the confusion among students regarding the scientific concepts, therefore must become a part of classroom learning.

(II) Special education setting

However, in the special education setting different responses emerged. When asked about atoms the responses from most of the students (N, in grade VIII and students S, J, K who were studying in grades X) indicated that their knowledge of atoms was connected to having heard about atom bombs in their history classes. This topic of atoms which is introduced in grade IX science had been exempted from their science curriculum. One student D (grade VI) reported that he had never heard the term atom before. That students after numerous years of schooling had no prior knowledge about the term atoms in a science context suggests the lowered importance given to the teaching-learning of science. Being in a residential school, these students had less opportunity of hearing any related terms from other sources like family members, neighborhood, or media.

6.3.3.3.2 Drawings made by students

(I) Inclusive setting

<u>Structure of a single atom through prior knowledge</u>: On day 1, before the start of the learning activities, students were asked to draw a single atom. This task in itself was quite unconventional for SVIs. Of the 5 students in this setting, one student was not available to participate in this activity. Students, F (who can only perceive light and dark) and R (who has no vision) had made a dot to represent a single atom and said that the atom is a *"small solid ball"*. This was similar to the small dot made by P2 (with vision). On being asked to depict a larger view of the atom, all the three students drew circles. When both F and R were asked to draw atoms connected to each other, they drew filled circles connected to each other. Their drawings had some resemblance to the object that they had in mind (based on their verbal descriptions). One student, P1 (with vision) made a drawing that resembled the growth of fungi on bread. This drawing matched her description and represented her misunderstanding of the term 'atom'.

Structure of atom according to Dalton's atomic theory: On day 2, the students had the opportunity to represent atoms as theorized by John Dalton after handling solid balls of different shapes that were used as a model to represent the theorized structure of the atom. Figure 6.9 presents the drawings of the students over the course of the different activities. Four of the 5 students drew circles to depict atoms, only F struggled in his attempts to make a circle. His drawing indicates difficulty in closing the circle. Three of the students, R, P1, and P2, made perfect circles and this was possible with the help of a bangle. Interestingly, the idea of using a bangle as a drawing tool was suggested by R (with no vision) and was quickly appropriated by two students who both could see. Student B (low vision) labeled his drawing with the words 'atom' and 'Dalton' written in the Marathi language.

Structure of atom according to Thomson's atomic theory: The students were introduced to Thomson's model of an atom, with the help of a watermelon (whole, cut and consumed). This was followed as usual by an opportunity to represent the theorized structure by drawing. Students R, P1, P2 and B made drawings that resembled the cut surface of a watermelon. Regarding the drawings of atoms as per theories of Dalton and Thomson, Student R said,

> *The big circle alone represents Dalton's atom but Thomson's model has a big circle with smaller circles in it.* (Student R)

The drawing made by F again highlighted his struggles while attempting to close a circle and his inability to place dots inside the circle. Student B's (with low vision) drawing depicted an alternative conception of Thomson's atom. The electron (labeled) was placed in the center of a circle and was depicted as a dark circular mass; the space in between the electron and the outer circle was labeled as a positive charge in the Marathi language.

Drawings of Rutherford’s gold foil experiment: On day 3, the gold foil experiment was described with the help of a 3 D model that students could explore and then students represented this set-up through drawing. Student F drew two schematic drawings on the same page in which the two slits were not depicted. He had some questions regarding the experimental set-up such as,

> *But alpha particles could have traveled above or below, why in a straight line? … Is the gold plate circular? I thought this as the shape of atoms is round.* (Student F)

Student B asked,

> *Why do they (alpha particles) not break when they fall on the gold foil?* (Student B)

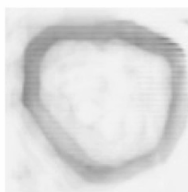
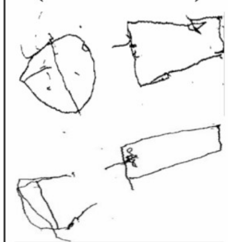
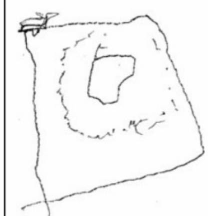
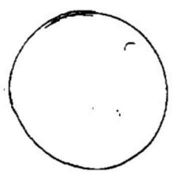
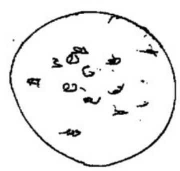
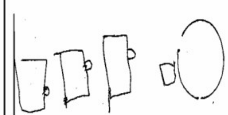
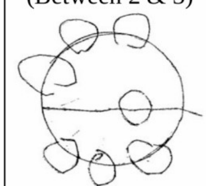
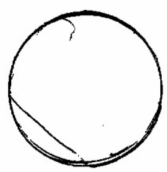
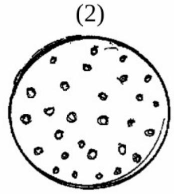
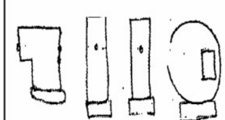
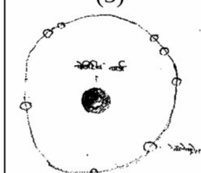
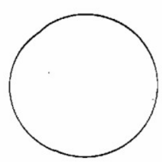
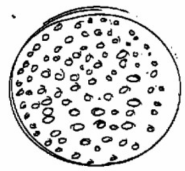
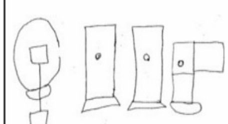
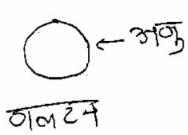
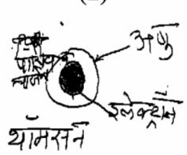
Student R was able to draw the alpha source, two slits and the ring, but could not draw the gold foil inside the ring. The drawings made by P1 and P2 were more realistic and placed the gold foil inside the ring.

<u>Structure of atom according to Rutherford's atomic theory</u>: After exposure to a model that had a ball surrounded by a beaded ring to help understand Rutherford's concept of the atom, students were asked to draw a representation of this concept of the atom. A simple representation would be a positively charged nucleus in the center of a larger circular path of electrons. Two students, B (low vision) and P2 with vision did not draw, while F made a schematic drawing and reported difficulty while drawing a circle in the center of the drawing.

Student R used the bangle and her drawing was quite a realistic drawing of the model which depicted even the thread that was used in the model to hold the central sphere in middle, although it was informed during the observation of model that the thread was not a part of the represented object. P1 drew and also labeled (in the Marathi language) a model with a central dark circle labeled as depicting positive charge and the dots on the outer circles labeled as electrons. F had a question while exploring the model,

> *Why are these electrons unevenly distributed and why do they not collide with each other while revolving? Or else they behave like a merry-go-round.* (Student F)

Figure 6.9: **Drawings made by students in an inclusive setting in part 3 of the study**

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

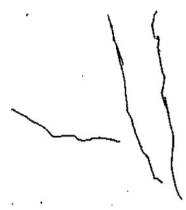
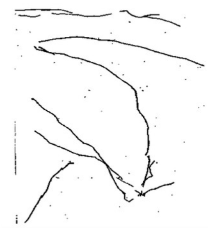
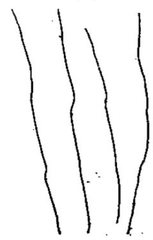
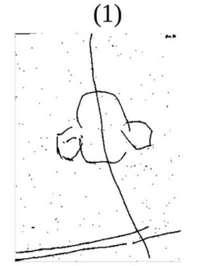
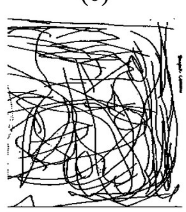
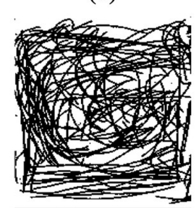
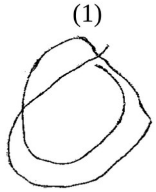
(II) Special education setting

On day 1 when students were asked to draw before any exposure to the learning activities and models and external representations, only one student (K) managed to draw a circle-like figure and reported that he had some earlier exposure to drawings. However, student N drew a line to represent an atom and J drew a series of small scribbles. Both of them said that they connected atoms to bombs and heard about these in history classes. When asked what they had drawn, they said they wished to represent circles. Student S drew a vertical line and was attempting to draw a circle and eventually asked the researcher for help in drawing, which the researcher provided.

One student, D, however, did not draw and said he had never heard the term before. On day 2, in both the tasks, only 3 students N, S and D attempted to draw but drew vertical lines or scribbles and were unable to draw a circle and their drawings were unrepresentative. Regarding the gold-foil experimental set-up, none of the students attempted to draw as they considered this particular depiction difficult.

However for depicting the structure of the atom according to Rutherford's model, S made a schematic drawing of the central circular nucleus, the thread that was used in the model and the pins that joined the thread to the inner ball (nucleus), but the outer circular path of the electrons was missing. The drawings by the other two students (N and D) were unrepresentative of the observed model as well as of their verbal description. Two students J and K did not participate on this day.

Figure 6.10: Drawings made by students in a special education setting in part 3 of the study

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

(III) Comparison of the two settings

A comparison in between the drawings made by those students who did not have prior experience of drawing would be interesting. Students F (inclusive setting), N, S, D and J (special education setting) had no vision congenitally and had reported no earlier experiences of making drawings. Yet on all the four days, F could represent his ideas about atoms through his drawings which were schematic at times. There was considerable complexity in the drawings made by F and they had some elements that were representative of the visualized concepts or the object. In contrast to this, the drawings made by N, S, D and J were unrepresentative of the visualized object. Only the drawing made by student S for Rutherford's atomic model was schematic, whereas all other drawings made by N, D, J and even S had merely vertical lines or scribbles.

Here a special mention of the drawings made by R from inclusive setting needs to be made, who had lost her vision after the age of 9 years and had a good experience of drawing prior to losing her sight. According to her, she liked to draw very much and this liking still persists. The drawings made by R in this study were in between list drawings and realistic depiction of the observed models. Her drawings also resembled those made by two other sighted students because of the borrowing of her idea of using tools for drawing by the other students as well. Such instance of drawing skill was nowhere visible among the students of special school.

Some possible reasons for the differences in the drawings of SVIs in the two settings may be the fact that the inclusive group was more heterogeneous regarding visual abilities and this helped the students. The students in this setting were found to be aware of the difference in the styles of perceptions of their differently abled peers and this knowledge was used by them while cooperating for learning. Such student-to-student cooperation was spontaneously visible in the inclusive setting in discussions and even while drawing. As mentioned earlier, with reference to the bangle incident, the tool was used by the sighted children to draw perfect circles, based on the suggestion given by a SVI and the SVI suggested ways to a sighted student to represent a sphere through drawing. Such instances give evidences that the difference in abilities in the inclusive setting allowed more opportunities of cooperative scaffolding among students. On the other hand, the lack of vision among all students in the special education setting possibly did not allow the students to benefit from cooperation among them, a point that appears in the work of Mäkinen and Mäkinen (2011) also. During discussions in the special education setting, academic interactions were limited to student-researcher despite the researcher encouraging peer-to-peer interactions. These observations suggested that the inclusive setting provided a more conducive educational environment for SVIs.

6.3.3.3.3 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, the following dialogues took place among the students.

> F*: (Holding a full watermelon in one hand and cut watermelon in the other) Look this is Dalton's and this is Thomson's model. Dalton feels that an atom cannot be divided and this is Thomson's model.*
>
> B*: He looked by opening it and found that electrons were embedded inside the positive charge.*
>
> R*: Did you eat a positive charge or the electron?*
>
> B*: Did you eat seeds or the pulp?*
>
> F*: I ate two electrons. (laughs)*

These dialogues 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. This clearly is an example of the representation being related to the concept and hence an instance of the students visualizing the object.

Introspective visualization

After the introduction of the concrete model of Rutherford's atom, student F tried to compare that with Thomson's model of atom which was represented and discussed before this model.

> *Sir, I want to ask that the electrons that are present, they only... hmmm... I mean you told me that all positive charge is present in the center, then, are there no electrons inside this positive charge? Like if consider watermelon then this is not so inside it. This* (positive charge) *is present in the center but there even seeds are present. So I wanted to ask that if we look through this point, then electrons should also be present in the center (in the atom).* (Student F)

In the above statement, the student was using the earlier learned model of the atom to compare with the new, hence this is an instance of the introspective visualization taking place. 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 (I in the dialogues is for the researcher) about why some of the alpha particles bounced back after hitting the gold foil, the students kept Thomson's atomic model in mind which had been introduced on the previous day.

> F: *What could have made it bounce? Did it bounce by hitting the electron or the positive charge?*
>
> R: *Maybe they did not get space to pass through the foil,* or *maybe something was present there, in the gold foil, which opposed the alpha particles.*
>
> F: *But if it had opposed then even those would not have passed which actually did.*
>
> R: *I mean that those could pass through, hmmm, consider that a gold foil is present. Then if we hit alpha particles on it, then the particles which passed through, they would have been that much strong, I mean this much stronger than gold foil that they would have passed through it. I mean they would have found space to pass in accordance with their size.*
>
> I: O*k*

R: *Is this possible?*

I: *Yes*.

F: *But sir, it should be the case... are the sizes of alpha particles smaller and bigger (do they have different sizes)?*

I: *No all the particles have equal size.*

F: *Ok why I asked this is because as R has said that those which were smaller would have passed and those are larger in size would not have passed.*

I: *Can you think anything else?... Hmmm, P what do you think?*

B: *Sir, they bounced back after hitting, why did not they break away?*

F: *They might be having this much strength that they would not break. Like sir, we have marbles, so some of them do not break even if hit with a larger force. So I mean that they might not have applied larger force and would have hit slowly.*

I: *Now we have two possibilities, either the force was less or they were quite strong.*

R: *If F is saying that they were of the same size then whether the foil too... thick from one side and thin from one side... that foil was of equal thickness no?*

I: *That too had equal thickness.*

F: *This is the matter, sir, whether it stopped after collision with the positive charge or the electron?*

Interpretive visualization

While reasoning with Dalton's theory after the observation of balls of different sizes, an instance of transfer from concrete mode to an abstract mode of thinking was observed which is indicative of interpretive visualization.

> *Sir, like anything that is round we can break it by smashing with some other thing, ok, so then even smashing it (atoms) with some other thing must break them... or he (Dalton) must tell the reason why they cannot be broken. (*Student F)

Another second instance of interpretive visualization where gestures were also used by SVI during the discussion was observed. This was after the explanation of the momentum of alpha particles and repulsion by the central large positive charge.

> *But sir as you have given an example of collision in between two balls, if we throw a ball with a large force, then the ball that is this side* (gesturing through directing face from one direction to other without using hands) *can even push it* (the other ball) *on the other side instead of repelling back.* (Student F)

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 held among students and the researcher, student F used the learning from Rutherford's model of the atom and that from the model of Rutherford's gold foil experiment to interpret the observations.

> F: *Sir sir, but as you have said just now that there remains empty space in it, so the maximum of these (alpha particles) pass through, but if alpha particles had to pass then they would have traveled on the same path, one after the other.. in a straight line only, why did they follow a different path.*
>
> I: (Explanation of the path of alpha particles)
>
> R: *Sir as you said there is a space in between positive charge and electrons then why do not the alpha particles stop in that empty space.*

Evidence of all the three forms of visualizations were elicited from the SVIs during the course of their discussions. Such visualizations and higher-order thinking demonstrated by the students during discussions on Rutherford's experiment is interesting. The instances and dialogues demonstrate the struggle going on within the minds of students regarding their 'image' of the atom prior to the activities and its mismatch with the activities and the experimental observations. The struggle was clear from the questions raised by the students in an attempt to fit their observations into the existing mental models.

6.3.3.3.4 Instances of learning through cooperation

While drawing the representation of atom as theorized by Dalton, students were seen to be cooperating on how to draw the 3D representation on plain paper. The challenge that the students faced was to depict the properties of atom as conceptualized by Dalton, to be solid, spherical and indivisible. Following dialogues took place among the students:

> F*: Did you make Dalton's (model of the atom)? Make it a little dark.*
>
> B*: No ... he (Dalton) did not know about what is inside it (atom).*
>
> F*: Yes but you need to make it dark (*inside of atom as perceived by Dalton*).*
>
> B*: No.*
>
> F*: Color it smoothly.*
>
> B*: But when he did not know what is inside it then.*
>
> F*: But some part of it is visible as white.*
>
> B*: White- is visible only because he did not know about it. At that time he did not know about inside. It was Thomson who came to know about inside.*
>
> F*: But it is filled from sides.*
>
> B*: (*Tauntingly*) filled from sides, this is the shape... this is the shape... (holding F's thumb and explaining by moving her finger along the margins of thumb) you need to draw from the sides but this won't look dark.. you agree no. You need to represent this.*
>
> R*: Draw a circle.*
>
> F*: Ok draw a circle…draw a circle.*

In the above social context of learning about how to represent the atom as conceptualized by Dalton, the students had to deal with a conflicting situation. Student F was 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 the margins. Finally, student R suggested drawing the outline of a circle, which was accepted by others as well. In this way, the conflict finally got resolved constructively through the suggestion of a ‘more knowledgeable other’, who was student R here. The figures drawn by the three students and the others have been shown in Figure 6.9, under the column of Dalton’s atom.

Such a method of teaching in which students cooperate to constructively discuss; resolve conflicts and controversies and develop shared mental models has been strongly advocated by Deutsch (2006). These dialogues clearly give a good instance of cooperation among students regarding the drawing task to reach a constructive solution.

6.3.3.4 Analysis

Several investigations in the past have focused on students' problems in understanding abstract topics like atomic structure (Gilbert & Treagust, 2009; Park & Light, 2009). Most studies exploring student conceptions about scientific concepts have been conducted with sighted students, with a few exceptions. Jones and Broadwell (2008) who have worked with SVIs state that 'modern science phenomena are often embedded in visual representations that attempt to capture the complexity of structures, functions, and processes' (p. 283). According to them, visual representations are ubiquitous for communication of scientific concepts and thus can be quite challenging for SVIs and hence the need for teaching aids that use perceptual abilities (tactile, auditory) to facilitate the learning of science, including abstract topics like atoms, for SVIs.

However, another point of view is suggested by Wedler, (2012), a visually impaired doctoral candidate at UC Davis. According to him, Chemistry is possible for the visually impaired, since anyway no one can see atoms and this is thus a cerebral subject and equally possible for SVIs. Regarding the use of drawings too, research, suggests that drawings created by the visually impaired have similar features as those produced by sighted people (Kennedy, 1993; 2003).

One focus of the study was to explore SVIs prior conceptions of atoms through their verbal descriptions and drawings. These included notions of shape, size, location and structure of atoms, and the analogies used to describe them. Not surprisingly, SVIs who had limited exposure to science (as in the special schools) could only recall the association of atoms with ‘atom bombs’ learned in history classes. SVIs with prior exposure to the topic displayed several alternative conceptions of atoms.

Regarding the size of atoms, one student with no vision mentioned that all atoms were of the same size and that sizes of objects were proportional to the number of atoms contained within. The same student also felt that while atoms are invisible to unaided eyes, they may become visible with some instrument. Students also used analogies to describe their understanding about atoms, such as balls to suggest the shape of atoms, water to explain that atoms are indefinite in shape and a light ray to explain the invisibility of atoms. Some of these alternative conceptions have been reported in earlier studies with students having vision (Harrison & Treagust, 1996; Gilbert & Treagust, 2009). Thus, there is a similarity between the sighted and the impaired in terms of alternative conceptions about atoms and the perception about atoms cannot be attributed to the presence of absence of sight among the learner

The other focus of the study was on students’ drawings as external representations of mental models presented through 3D models with instructions regarding the evolving theory of atoms from Dalton, Thomson and Rutherford to Bohr. In the drawing task, students in the inclusive setting seemed to have a clear advantage over the students in special education. There can be various reasons for this advantage including increased opportunities for learning from varied resources. Just the availability of science teachers in the inclusive setting must be a great help, but probably the most significant advantage in the inclusive setting was our observation of the spontaneously initiated cooperation among peers (Stoffers, 2011) which was helpful not only for the SVIs but also for the other students.

The findings corroborate the recommendations given by Harrison and Treagust (2000) regarding social cooperative negotiations among students and the use of multiple representations for better understanding of concepts. However, it is also important to note that skills for co-operating may have to be developed. Baker and Clark (2010) and Le et al. (2018) have stressed the need of developing the required skills for working in groups prior to using cooperative strategy in classes. If such skills are lacking there maybe unequal participation of students in the tasks.

The study also offers indications of all the three forms of visualization namely visualization object, introspective visualization and interpretive visualizations by SVIs. These were done through verbal descriptions, discussions, tactile perceptions, 3-dimensional models and drawings. The indicators of visual thinking by SVIs during reasoning with the mental models of atoms are enough to support the author's views on raising the expectations from SVIs in science. The modes of representation of visualized learning by SVIs were found to be (i) verbal explanations (ii) gestures and (iii) drawings, which were similar to their counterparts.

The study highlights the need for an inclusive environment and the use of the multi-sensory approach for science learning which supports cooperative learning among students (Stoffers, 2011) with vision, low vision, or without vision. This can also enable learners with sensory disabilities to learn with the same resources as used by others (Jubran, 2012). It supports the use of students' drawings as tools for external representation, thinking and visualization. Moreover, these drawings made it easier for the instructor to learn students' conceptions and communicate with them regarding their understanding, and thus may be used in actual classrooms to assess learning among SVIs too. However, for SVIs to draw, some more appropriate instruments are needed that may be developed to ease the efforts on the part of the SVIs. For example, a tool, 'Sewell kit' has been described by Taraporevala et al. (2013), but research still needs to be directed at the effectiveness of this as a drawing tool for SVIs.

In this study, despite the problems with drawing instruments, SVIs in the inclusive setting could represent their understanding through drawings. We advocate that SVIs be provided opportunities to learn science and also that they are initiated into the use of multiple external representations in learning and in communicating their understanding. What is imperative is the need for carefully planned cooperative and multi-representational pedagogical strategies that improve the learning of abstract and difficult science concepts for SVIs.

6.4 Summary and conclusion of the three studies

Through the three studies reported in this chapter, an attempt has been made to understand the processes that occur when SVIs cooperate with students having the vision when learning about scientific concepts through diagrams. Another objective was to understand how SVIs would represent their visualization. The studies used the strategies of multiple representations for visualization among students; representation of learning by students through drawings (raised lined drawings by SVIs), models and cooperative learning to learn concepts of science namely structures of micro-organisms, structures of different types of teeth in humans and structure of the atom as proposed by different scientific theories.

Considering the sub-questions of the study following conclusions are drawn:

1) What pedagogical strategies are helpful for SWDs and SVIs for learning science at school?

- Through the use of multiple representations complimented with verbal descriptions and discussions, information that is accessible only to students with vision can effectively pass on to SVIs in cooperative, inclusive settings. Such multiple representations must also be multi-modal so that the learners may construct their learning either through their preferred mode of perception or more than one mode of perception. In this study, the learning about represented objects may have been facilitated for SVIs during the explicit verbal communication about diagrams/models that took place between the peers and SVIs 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 SVIs which in turn helps in science learning.

- The use of analogies by students in this study to compare the observed object with the known objects is a good strategy that may be used by developers of learning materials and teachers to introduce concepts.

- As evident in the study, SVIs can represent their learning about structures of objects through drawings, if (i) appropriate contexts of drawing are used during science learning and (ii) practice for using proper drawing tools is given to them.

- The diagrams with colors and raised outlines; without colors & with raised lines (continuous and dotted); raised lined and raised inner space (colorless and colored) may be useful for students with vision as well.

- In the existing conditions that were observed during the study, there are more chances of learning science for SVIs in inclusive settings as compared to the special school settings. This has been prominently evident through the better performance of SVIs in the inclusive setting as compared to their counterparts in the special education setting.

- The lack of training to the SVI in the study, to draw diagrams, can be a result of low expectations from them even in inclusive settings (Fraser & Maguvhe, 2008).

2) What do students with/without vision observe in diagrams in inclusive cooperative learning situations?

The study uses the raised lined diagrams to find what students' observed in cooperative settings. Some of the features were-

- analogy in the shape of represented objects with familiar ones
- the material used for developing a diagram
- color of the diagram

- features inside the margins of diagrams
- functions and significance of represented objects and
- names of the represented objects.

In the study it was noticed that when diagrams were made by pasting thread along outlines or made by some objects like medicinal capsules, then students observed the diagrams both as objects as well as the representations of objects. However, the observation delimits to the represented objects when the diagrams embossed on sheets of paper were used. This may give a strong reason to prefer the latter diagrams over the former.

3) What questions are raised by students with/without vision while observing diagrams?

Student questions are very important resource for leading inquiry based and meaningful science learning discourse. (Chin & Osborne, 2008). Chin (2002) describes students' questions in science as thinking tools that help in scaffolding ideas that result in active learning and better understanding of scientific concepts. Therefore, the generation of questions by students needs to be an integral part of science learning. In this study, the questions raised by students were mostly related to the observations that have been made by them. The questions were related to the-

- reason for a particular color of the diagram
- the material used for developing the diagram
- the cause behind the particular name of the represented object
- harms or benefits of represented objects to humans
- shape and location of the represented object
- mode of development and mode of action of the represented object and
- a comparison between the objects represented in all the related diagrams.

Similar to the effect of material used in diagrams on the observations, the students again asked questions by considering the diagrams both as objects as well as the representations of objects. But if diagrams can lead to questions, it is a good pedagogical tool and breaks the monologue of the teachers.

4) What drawings are made by SVIs while learning about atoms?

The drawings made by the students during part 3 of the study were expected to reveal the conceptual understanding that was developing among the learners before and after learning about the atom. The drawing of dots and then circles by 3 students (with and without vision) from inclusive settings to represent atoms as per their prior understanding revealed that the mental image of an atom that these students possess is a very small-sized spherical body. The drawing made by one student that resembled the growth of fungi on bread again matched her description and disclosed her misunderstanding.

While gaining learning experiences through verbal explanations, discussions and observation of 3D models, students in the inclusive setting made a variety of drawings. A difference was visible in one of the circles made to represent the structure of the atom as theorized by Dalton. This circle had an inner curved line and was made by one student with no vision to represent the 3D surface of the sphere. This student also did not have experience of drawing prior to the study. Such convention is not visible in the circles made by learners who had earlier experience of drawing. The difficulties faced by this student were also visible while attempting to close circles and relative placement of different parts of represented objects in every drawing.

Another innovation in representation was visible in the circle drawn by a student B with low vision who also labeled the drawing with the words 'atom' and 'Dalton'. The alternative conception of Thomson's atom that was held by this student also got visible when the electron (labeled) was placed in the center of a circle and was depicted as a dark circular mass and the space in between the electron and the outer circle was labeled as a positive charge. This signifies the importance of drawing to represent the learned concepts for teachers to assess the understanding of learners. It also points to a possibility of diversity in ways of representation when students with diverse modes of perceptions are included in science classes. But such indications are not without a caution which arises out of the difficulty that SVIs face in drawing as per the mental image held by them. This points to the need for selection and availability of appropriate tools and practice to learners with vision impairment to make representations through drawings.

Such a need is reiterated when we look at the non-representative lines, scribbles drawn by the students in special school despite being provided similar learning aids and despite the similar activities in both the settings. The situation in the special education setting may have arisen due to lack of contexts and expectations for experiencing drawings in such settings and lack of diverse experiences among students living in a residential.

Through this section, the chapters that specifically focused on different surveys and explorations done by researchers end here. The next chapter, which is the last, summarizes the entire thesis and answers all the research questions one by one. Also the contributions, recommendations and limitations of the research and a personal postscript have been compiled in chapter 7.

Chapter 7

Conclusions and Recommendations

7.1 Introduction and summary of the research

This study presents the sad state of inclusion in science education and tries to explore some ways to bring inclusion into science education. The backdrop of this study is the general consensus that science in India is an exclusionary tool. There is a popular consideration among stakeholders about science being elitist and it being more rigorous in nature as compared to some of the other areas of study (Aikenhead, 2009). This very nature of science has been used as an excuse for gate-keeping large proportions of the population in society from entering into endeavors of science although always believing in its superiority. Sometimes, students are advised to look up for alternate subjects/disciplines that they can “cope up” with (Palan R. 2020) that is in some ways, deciding who can and will be contributing to the discipline. A large fraction of the excluded has always been from the marginalized groups as the educational institutions, curricula and policies perhaps have been developed keeping in view the child that is closest to the dominant groups in society. This study makes an effort to understand inclusion in the context of education of the largest marginalized group in India, that is, students with disabilities. There are around 7.86 million SWDs in India, as reported by United Nations Educational, Scientific and Cultural Organization (2019). Quality science education can positively impact lives of a large number of SWDs, on the other hand, a lack of (systemic as well as emotional) support from stakeholders is likely to lead to complex social and financial challenges in future.

The literature survey for the thesis provided information about the development of inclusive education movement and the status of inclusion in Indian school education and science education. A descriptive survey conducted to collect the aspirations of SWDs in this thesis found that SWDs have high aspirations for participating in science, and in fact, this was their most preferred subject for continuing in higher education. This finding is in contrast to the low expectations from SWDs held by different stakeholders (Sacks et al., 1992; Fraser

& Maguvhe, 2008), thus limiting the utilization of full potential of SWDs in science. In our survey, more students from the inclusive setting reported that they do not face difficulties in science indicating better conditions for learning science in inclusive settings. Also, a larger number of SWDs mentioned wanting to learn the processes of science. SWDs did report facing difficulties in learning science but they still had a positive attitude towards science and perceived it as important, interesting and useful. These findings suggest that there is a mismatch between the aspirations of SWDs in science and their actual status in science education.

To explore the factors affecting the inclusion of SWDs in education, the views of teachers, parents and students regarding the social acceptance of inclusion in education were collected through a qualitative and quantitative survey. This comprehensive study indicated that the negativity among the stakeholders towards the inclusion of students with severe or sensory disabilities has roots in their concerns regarding the abilities of teachers to handle the SWDs in the classroom. These concerns were shared by teachers too who reported that they are under-prepared for inclusion due to reasons such as lack of experience of teaching SWDs as well as a lack of knowledge of adaptive technologies that may assist SWDs. In addition students, in particular, were also negative towards the inclusion of those students who displayed delinquent behavior. Such behavior, although not a major concern for teachers and parents, was a matter of deep concern for students. Although the focus in this thesis was not on the delinquent behaviors particularly, having some questions about it allowed me to recognize (and study) all possible attitudes of stakeholders that can be associated with the school system and how the actions of individuals may impact attitudes.

A hopeful sign was reported from inclusive schools where students were more positive towards inclusion as compared to students from special as well as general schools. This is definitely a reflection of their personal experiences of the process of inclusion where students (including SWDs) have witnessed smooth inclusion in various curricular activities.

After developing a good understanding of the aspirations of SWDs in science and the views of teachers, parents and peers regarding inclusion in education, the research further narrowed its focus on science education for students with one particular disability that is visual impairment. The reason for the selection of this particular disability has been the responses of the stakeholders on ATIEIS scale and interviews which report this group of SWDs as among the most challenged with respect to inclusion in education. The other reason is the observation of problematic education status of SVIs in science due to interaction of visual impairment with systemic exclusion and pedagogy (Jaworska-Biskup, 2011).

Thus, considering the challenges faced by SVIs in science education, three different studies were taken up to explore the tools and strategies that may be effective for SVIs in learning complex and difficult concepts of science. Part 1 and part 2 of these studies provided evidence that raised lined diagrams when used in inclusive settings and through cooperative peer group learners with and without vision, could effectively communicate science concepts. Regarding the drawings that were made by the participants in part 3 of the study, the drawings of SVIs from inclusive settings were found to resemble the observed objects and it was found that the students could represent and communicate their learning through drawings. This suggests a need to raise expectations from SVIs regarding science education and to promote the use of drawings as an aid while conducting science learning activities with SVIs for inclusion. However, it should be a thoughtful intervention, particularly in terms of availability of appropriate tools for drawing. Just like written or verbal discourse, diagrams drawn by SVIs can also provide a window for teachers to understand how SVIs are thinking about the discussed ideas.

7.2 Contribution to body of knowledge

This research has contributed to the area of inclusive science education at school level by providing insights from the surveys conducted on the aspirations of SWDs in science; and the attitudes of teachers, parents and students towards inclusive education; and then by developing pedagogic strategies for SVIs. These contributions have been more systematically and elaborately presented under the subheadings of methodological contribution and contribution to literature.

7.2.1 Methodological contribution

1. This study has tried to explore the field of inclusive education in breadth but within the limits of a single research project. It begins with the broad theme of inclusive education and narrows its focus to inclusive education for the SWDs. In the last stages, this focus further narrows down to inclusive science education for students with visual impairments. Such a funneled research trajectory is partly imposed by the limitations of research procedure to explore unique interest group that can get benefited most through the research findings, still, the expansive vision of the research is the development of such a system of education that endeavors towards the inclusion of all. Such a metaphoric 'research funnel' explains how finding through this study contributes to wide as well as deeper objectives in the inclusion studies.

2. The within-stage, mixed-method design has been used in the present study by triangulating the quantitative exploration of attitudes of teachers, students and parents towards inclusive education through ATIEIS with the semi-structured interviews. This design has helped to demystify the perceptions of educational stakeholders. In particular, students' overall positive attitude towards inclusion of all, similarly, varying attitude of stakeholders depending on the type of disabilities could be successfully understood through the comprehensiveness brought in this study as additional insight via triangulation. Overall, this work shows a successful use of mixed-method design in studying attitudes towards inclusive education in the Indian school context.

3. Another methodological contribution is the use of three concatenated exploratory studies regarding the use of tools and strategies for cooperative learning experiences to students with and without vision in science. The concatenation process has helped to accumulate detailed, broad and valid qualitative data, thereby making the findings more generalized and applicable (Stebbins, 2001). Such an outcome would have been very difficult through a single study in this less explored research area of inclusive science education.

7.2.2 Contribution to literature

1. The aspirations of SWDs in science and attitudes of teachers, students and parents towards inclusive education reported in this study give important evidence for justifying that inclusive settings are more effective in developing positive attitudes among teachers and peers towards the inclusion of SWDs.

2. Regarding the attitudes of students, it has been identified that the delinquent behavior of students towards their peers in schools is a matter of great concern for students. To ensure the well being of all the students in schools, the education authorities must give appropriate attention to this issue. In our study, we noticed that students preferred to isolate themselves from students indulging in delinquent behaviors irrespective of how good academic support such students could offer. Teacher could establish norms about socially acceptable (or desirable) behaviors for class to avoid dissertation of any student due to participating in (or experiencing) delinquent behaviors.

3. The study gives a good reason to raise expectations from SVIs in science in terms of their skills to observe, draw diagrams and learn abstract concepts of science which are often considered as important processes in the science curriculum. The strong reason behind the assertion being the similarity in the abilities of students with and without vision to manipulate mental images (visual or spatial),. To facilitate such opportunities, it would need (a) the printing of embossed diagrams in the Brailled science textbooks (b) giving opportunities to learners in inclusive classes for observing and manipulating embossed colored diagrams and 3-D models (c) by using tools and methods to develop drawing skills in SVIs (d) giving opportunities to learners to express the learned scientific concepts through drawings.

4. The three exploratory studies in the later parts of the thesis have used the strategies of cooperative learning among SVIs and students with diverse abilities; multiple representations (in form of raised lined diagrams, models, descriptions and discussions); opportunities for visualization; representation of learning through drawings in inclusive learning situations. All these strategies in combination were

observed as effective in providing positive learning experiences to SVIs in science and hence this study strongly suggests the use of strategies mentioned above (in combinations), in the inclusive science classes with SVIs.

5. Another important contribution of this study arises from interpretation of interactive instances with SVIs and students with sight in their verbal exchanges. I witnessed ample instances when the flow of information happened from students with sight to SVIs in inclusive classes, as well as the learners with sight getting ideas of drawing from SVIs during cooperative learning activities. These instances provide strong evidence regarding how cooperation among students with different modes of perception is beneficial to both (students with/without sight). This is contrary to the commonly held belief that inclusion in education is beneficial to SVIs (or in larger context,) SWDs only, and efforts for inclusion may be taken up only in the spirit of providing SWDs equal opportunities. In the inclusive learning communities of students, both students with/without sight can contribute in the exchange of information. Teachers in turn should consider this information when designing science activities, and should consider how potential of all students is utilized during its conduct.

6. The study reports a very important role of skills and abilities of teachers in making inclusive education successful, and who very urgently need experience and training regarding inclusive pedagogy and technologies. It has been suggested 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 with SWDs and inclusive settings can be shared with novices.

7.3 The findings: Answering the research questions

The review of the status of the participation of SWDs in science learning suggests that this is negligible at present in the Indian context. And this poor state is despite the strong legislation and policies that have been carefully formulated with good intentions to give a push to the process of inclusion for SWDs. Based on review of literature, some research questions were formulated and answers to these research questions have been presented in the next sub-section.

7.3.1 Research question 1

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

The study reports the high aspirations of SWDs with respect to science and their preference for this subject for higher education. Besides, the views of SWDs about nature of science were that “science is an accumulated and systematized body of knowledge” and “science is a creator of technological products”. A large number of SWDs in the study reported a desire to learn processes of science as compared to those who wanted to learn different areas of knowledge in science. SWDs did face difficulties in learning science which they have reported, but they still had a positive attitude towards science and perceived it as important, interesting and useful. Thus, regardless of the level of ease of science in SWDs minds, it can be said that it is perceived as ‘important’ and ‘interesting’ or ‘useful’ on many fronts as suggested from the responses. Even those who expressed a desire to learn the processes in science as compared to the different areas of knowledge, felt overwhelmed with the vastness of information at times but were highly interested to understand the ‘how’ through their choice of learning about processes. Perhaps, pursuing the process approach makes science interesting and joyful experience. One may thus conclude science is seen as a capital one feels to possess/occupy in classroom or in the outer world when leading a day to day life. The reporting by more students from inclusive settings that they do not face difficulties in science indicates better science education conditions in inclusive settings.

The high aspirations of SWDs are in contrast with the already stated low expectations of stakeholders of education which creates a barrier for their effective inclusion in the science curriculum. For the removal of such a barrier, SWDs themselves have suggested some ways for making science more interesting, useful and effective like focusing on activities, experiments, practicals, projects and drawings and diagrams. A very important point to note is that the suggestions made by SWDs would make science more interesting, useful and effective not only for SWDs but also for all students with diverse learning needs and diverse backgrounds.

7.3.2 Research question 2

What are the views of teachers, students and parents regarding the inclusion of students with disabilities in education?

As stated earlier, the attitudes of stakeholders play an important role in the success of any educational program. The study reports positive attitudes of teachers, students and parents towards the inclusion of SWDs in general, but the attitudes vary in case of severe and sensory disabilities. Among all the stakeholders, such negativity was found to be rooted in the concerns regarding the abilities of teachers for handling students with physical and sensory disabilities in the classroom. The concerns were corroborated by the teachers themselves who felt under-prepared for inclusion as they lacked experience of teaching SWDs, and knowledge of adaptive technologies that may assist such students.

A ray of hope emerged from the inclusive schools where students were found to be more positive in their attitude towards inclusion as compared to students from special as well as general schools. This reflects their experiences of the successful process of inclusion. Also, the greater positivity of SWDs towards inclusion as compared to students with no exposure to disabilities point at their intentions and preference for inclusion. The responses of SWDs during the interviews regarding the support they receive from their peers with varied abilities builds confidence regarding the benefits of inclusive education. Students also expressed aspects of bidirectional information exchange, mutual care and benefits which reduces the power dynamics that may be assumed for able-bodied students otherwise in a mixed students' group. Similar findings were from the groups of teachers who had experiences of teaching SWDs and were more positive towards inclusion than in-experienced colleagues, yet they reiterated the need of continuous support from school administration as important. However, parents rely a bit too much on the expertise of teachers to smoothly manage the class and even endorse teacher's abilities to manage the class as "most important" for successful inclusion. In the backdrop of such expectations, parents also demanded a support system for effective inclusion of SWDs in education.

The study has also come up with important suggestions made by the participants of the study to make inclusion effective. The most important suggestions made by teachers were regarding the imparting of training and exposure to practice inclusion through appropriate pedagogy and tools. Regarding the finding that students expressed negativity towards delinquent behaviors of other students, and are concerned about it to the extent of choosing isolation as a coping mechanism by students, teachers could establish norms about socially acceptable (or desirable) behaviors for class. This can avoid a social isolation of any student that is detrimental to students in their involvement in classroom communities.

7.3.3 Research question 3

What strategies are effective for teaching science to students with visual impairment at school?

Three studies have been reported in chapter 6 that used the strategies of cooperative learning among SVIs and students with diverse abilities. These used raised lined diagrams and models; multiple representations in form of raised lined diagrams, models, descriptions and discussions; and representing the learning through drawings. These strategies were found to be effective for SVIs for learning the scientific concepts of the structure of micro-organisms, structure of human teeth, and structure of atoms as conceptualized by different theories of atoms and that of Rutherford's gold-foil experiment. On the basis of these studies, these strategies can be recommended for SVIs in inclusive learning settings. It is to be noted that students with diverse abilities like, with visual impairments, hearing disabilities, speech disabilities, orthopedic disabilities and those without any disabilities had participated in the above-mentioned studies. It was found that these strategies helped make the scientific concepts of micro-organisms, structure of teeth and the structure of atoms accessible to all the participants, and providing evidence that the strategies described above are consistent with the inclusion of groups other than that of SVIs as well.

7.3.3.1 Research question 3a.

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

Part 1 and part 2 of the study reported in chapter 6 give us evidence that raised lined diagrams, when used in inclusive settings through cooperative learning with learners having vision or not, could result in effectively communicating science to SVIs. Moreover, in part 3 of the same study, the SVIs in inclusive settings could represent and communicate their scientific learning through drawings.

The drawings that were made by the participant SVIs from inclusive and special education settings have been reported in figures 6.9 and 6.10. As analyzed and compared with the actual objects which were represented through drawings, the drawing of SVIs from inclusive settings were found to resemble the observed object as compared to students from special schools. Some interesting learning from these drawings were that a student with complete lack of vision used her bangle to draw a perfect circle and this was appropriated by sighted children. Thus the learning in an inclusive setting is two way. The drawings also gave opportunity to SVIs to communicate their spontaneous conceptions of atoms and the drawings prior to any intervention. Thus drawings can play a good role in learning and expressing in science.

7.4 Limitations of the study

With a focus on 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 delimited 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, are not representative of the whole country. For example, a similar study done with a sample from rural or tribal background could have helped to draw out even richer findings.
- 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 even more. The small sample also made it difficult to compare responses between the

students from the general school, inclusive school and special school, and also between students with different disabilities.

- The responses of parents, teachers and students regarding their attitudes towards inclusive education was used to triangulating the data obtained from the ATIEIS and also from the interviews related to attitudes towards inclusion. But, a larger number of respondents of the interviews might have further enriched the data. In addition to this, a study of the correlation between the attitudes of children with their parents and teachers; effect of educational background on the parents' attitude and; that of the assessment report of the institution on parameters of inclusion would have helped to generalize the findings further.
- In this study, the teaching-learning strategies for science education for SVIs were developed with the manual tools of drawing, models and real objects only. Perhaps, incorporating other elements such as use of visits and excursions and also technologically advanced tools like computer-aided haptic tools, audio recorders, screen readers, the accessible personal digital assistant for learning science would add to the body of knowledge regarding science learning strategies for SVIs.
- The study also missed a comparison between the efficacy of different kinds of drawings that are being used for SVIs and also the drawing tools that are available or are proposed for being used by SVIs. Such a study could have been able to suggest more critically which tools may be used by SVIs for easy and effective learning.
- A deeper study of the social processes and relationships which the students from the settings of inclusive school and special school experience could have enriched the quality of the research and added to the comparison between these two settings.
- This study undertook the task of making drawings by SVIs 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.

- The research could not further explore the learning strategies for SVIs in special education settings and this needs further exploration.

7.5 Recommendations

Education like any social endeavor has a great potential of evolving as per the needs and directions of the society. And if such an evolution is guided by research-based evidence, then it has more chances of being in-tune with a larger societal evolution. Thus for the sake of improvement in the present state of science education some recommendations are being made here.

7.5.1 Recommendations for future research

No research can either be complete or static. Therefore, every research must have some take-homes that may initiate future researches. Some recommendations from this research regarding further researches arise from the above-mentioned limitations and can be stated as:

- A study regarding the aspirations of students with and disabilities in science is suggested. The sample for such a study needs to be diverse in terms of location and socioeconomic status. Such a study may provide some insights into the adaptations that are needed to make science curriculum more need-based and more related to the lives of the learners.
- A study regarding the use of visits, excursions, computer-aided haptic tools, audio recorders, screen readers, the accessible personal digital assistants for making science learning effective for SVIs in inclusive settings would add to the body of knowledge regarding effective science learning strategies.
- A comparative study regarding the effectiveness of different types of diagrams/ models/drawing tools/modeling tools for teaching science to SVIs may be conducted to suggest effective learning and representational aids.
- Research to explore the learning strategies for SVIs in special education settings may aid understanding of learning in different settings available to the SVIs.

7.5.2 Recommendations for changes in existing practices

- This study has generated some evidence to recommend that the expectations from SWDs regarding the learning of "rigorous" science be raised. Another finding is that to deliver effective learning in science, as stated by SWDs, the process approach of science is important. The processes of science are important not only to train the learners in methods and techniques of learning science, but they also make it interesting, joyful and useful. Another plausible explanation of process of science is a capital that one possesses/acquires (as methodological technical skills) and uses in classroom or day to day life. Hence, to make science education more inclusive, the curriculum designers and teachers must give more importance to the process approach of science at all the stages of learning.

- As suggested by SWDs in our study and as evident through the intervention with SVIs for learning concepts of science in an inclusive setup, drawings and diagrams would make science more interesting, useful and effective not only for SWDs but also for all students with diverse learning needs and diverse backgrounds. Therefore, drawings and diagrams should be given even more importance in science to make it more inclusive. This is an important recommendation because many well meaning educators think that SVIs are being burdened by expectations of drawing.

- This study recommends an urgent need of providing training to science teachers so as to be able to effectively transact science teaching-learning in inclusive settings. Such pedagogy 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 SWDs while learning science. Besides the involvement of teachers with prior experience of inclusive settings in pre-service or in-service teacher training programs we also recommend that pre-service and in-service teachers must be given exposure to such classrooms where inclusion is working successfully. This would enrich the teachers' training curricula with case studies of the classrooms with best practices in education, where inclusion has been successfully implemented. School administration should also keep the parents informed about how teachers are well equipped with inclusion training for the goodwill of every stakeholder group.

- Most importantly, the instances of better science learning opportunities to students in inclusive settings as compared to special schools lead one to recommend that inclusive settings should be promoted for raising the learning level of SVIs and other SWDs in science. This is the foremost step that is required for creating a need for raising the expectations from SWDs and thereby developing a suitable infrastructure and support system.

7.6 Sharing of the research with the teaching community

A large part of this study has already been disseminated in teacher and researcher conferences in India through presentations and in the form of publications in an international journal and conference proceedings. The purpose of this sharing was to increase the reach of the research findings and also to sensitize the teacher community with this important and sensitive topic. Being an integral part of the science teaching community in India for a substantial duration, I feel it is of utmost importance that research-informed educational findings percolate among teachers and higher education administration at all possible avenues. This work resulted in-7 presentations in conferences where teachers were in the audience, of which 5 have been published in the conference proceedings and a publication in international journal. A detailed list of publications has been given on page number iv of this thesis.

As an evidence of the acceptance of the research work, this is to inform that an unpublished paper, Sharma, A., & Chunawala, S. (2014), Attitudes of teachers towards inclusion (which is in addition to the list of published work) was presented at a National seminar of Council for Teacher Education, Karnataka State Center, that was in a “Redefining teacher education curriculum for nation building”, at M. S. Ramaiah College of Education, Bangalore and was awarded the Late Prof. S.R. Rohidekar ‘*Best Research Paper award*’ during the conference.

Another unpublished paper, Sharma, A., & Chunawala, S. (2011) titled Science education for students with visual impairments, was presented in the annual-cum-international conference of All India Association for Educational Research: Learning Communities and Global Education Reform, Institute of professional studies, Gwalior. The methodology, results and findings of all our published and unpublished papers have formed an integral of part of this thesis.

7.7 Personal postscript

This research has been a lifetime learning experience for me and it transformed me from a teacher to a teacher-researcher. Each and every part of this study has been lived by me as a learning experience and has brought so many positive changes in me. The study on aspirations of SWDs provided 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. As adults we must understand that in a world created by them if someone is not able to contribute his/her part with full potential then it is a sign of a need for 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 with efficacy lies in all those who contribute to run the system.

The study regarding attitude provided me with insight regarding the good intentions of all stakeholders in education. Initially, the avalanche of negative attitudes of teachers, parents, and peers regarding the inclusion of SWDs with severe and sensory disabilities was a great setback to my personal feelings about inclusion. But, understanding the reasons for these responses cleared the mist, it helped to clarify that in fact the negative attitudes were deeply rooted in the concerns that everyone had for SWDs. All the stakeholders wholeheartedly supported the cause of inclusion and also suggested ways for bringing about inclusive transformation in education for all. These valuable suggestions are a beacon for further research which can address the problem of making science education accessible to the most challenged and ignored group of persons, ie. the SVIs.

As part of my study I also interviewed some well-known personalities, who have visual impairments but who have been able to overcome the hurdles in their environment and reach heights that they are deserving of. These individuals gave me the confidence that alternative ways of perceptions and tenacity that persons with visual impairments have are testament to their abilities at overcoming problems caused by the loss of vision. My further exploration of the field in some inclusive and special schools strengthened my belief that SVIs can learn science as effectively and easily as anybody else.

The difficulties faced by SVIs 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. To my aid, the suggestions given by SWDs regarding the use of drawings for making science accessible were a good starting point and the three intervention studies with SVIs in the inclusive and special schools led to my increased level of confidence in the ability of all to learn science, given that the appropriate technology and pedagogy is used. The strategies used in this study have also been shared with the government school teacher community in Delhi by me as a resource person of teachers' (primary, elementary and secondary classes) capacity building workshops. The appreciation regarding the strategies, received from the participants of these workshops,, have been another signal of approval of the research findings. 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.

Regarding the engagement of the participants of this study, the curious minds of teachers, students and their parents always intrigued me regards their responses and engagement. Many of the teachers who earlier had no experience of inclusive education happily discussed the effects of inclusion and readily shared their views off the record regarding what all would be required to be done if inclusion is to implemented effectively. Some of them are still in touch with me and I shall feel happy to inform them that the task has reached a launching pad from where the smooth takeoff lies on the shoulders of the teacher community along with the other stakeholders.

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Appendices

Appendix A

Questionnaire for Students' aspirations of science

(विज्ञान के प्रति विद्यार्थियों की आकांक्षाएँ)

Name (नाम) ________________________________(आयु) __________________

Girl / Boy (बालक/ बालिका) ____

School (विद्यालय) ____

Class (कक्षा) ____

Type of disability (किस तरह की विकलांगता है?)______________________________

Number of members in your family (आपके परिवार में रहने वाले लोगों की संख्या) ______

Any disabled person other than you in your family: Yes /No (क्या आपके परिवार में आपके आलावा कोई दूसरा व्यक्ति विकलांग है: हाँ/ नहीं)? ______________________________

If yes, nature of disability/ies (यदि हाँ, तो कैसी विकलांगता है)? ___________________

Monthly income of your family (आपके परिवार की महीने की आय)__________________

What do you think are your strong points in school (आपके अनुसार विद्यालय में आपकी खासियतें क्या हैं)? ____

____

1. According to you what is science (आपके अनुसार विज्ञान क्या है)?

____

____

2. According to you science as a subject is......... (Circle one in each of the following)

आपके अनुसार एक विषय के रूप में विज्ञान कैसा है? (निम्नलिखित में से एक पर घेरा लगाओ)

- Very important / Important / Somewhat important / Unimportant / Absolutely unimportant
  बहुत महत्वपूर्ण / महत्वपूर्ण / कुछ महत्वपूर्ण / महत्वहीन / बहुत महत्वहीन
- Very interesting / Interesting / Somewhat interesting / Boring / Very Boring
  बहुत मनोरंजक / मनोरंजक / कुछ मनोरंजक / बोर करने वाला / बहुत बोर करने वाला
- Very useful / Useful / Somewhat useful / Useless / Absolutely useless
  बहुत उपयोगी / उपयोगी / कुछ उपयोगी / अनुपयोगी / बिल्कुल अनुपयोगी
- Very easy / Easy / Somewhat easy / Difficult / Very difficult
  बहुत आसान / आसान / कुछ आसान / मुश्किल / बहुत मुश्किल

3. How does science affect your life (विज्ञान आपकी जिंदगी पर किस तरह असर डालता है)?

____

____

4. How can you get good marks in science (आप विज्ञान में अच्छे अंक कैसे पा सकते हैं)?

____

____

5. Does getting good marks in science means knowing science better? Why do you think so? (क्या विज्ञान में अच्छे अंक लेने का अर्थ होता है कि आप विज्ञान अच्छे से जानते हैं? आप ऐसा क्यों सोचते हैं?)____

____

6. Among the following what qualities are required to achieve a good understanding of science? Tick √ required qualities. (विज्ञान को अच्छी तरह से समझने के लिये इनमें से कौन से गुण ज़रूरी हैं? जरूरी गुणों पर √ निशान लगाओ।)

Good memory (अच्छी याददाश्त/ स्मरण शक्ति);

Repeated drill and practice (बार-बार दोहराना);

Categorisation (वर्गीकरण करना);

Analysis (विश्लेषण करना);

Experimentation (प्रयोग करना);

Observation (निरीक्षण करना);

Truthfulness/Honesty (सच्चाई/ईमानदारी);

Discipline (अनुशासन);

Patience (धैर्य);

Good command of English (अंग्रेजी का अच्छा ज्ञान);

Good understanding of content (विषय वस्तु को समझने की शक्ति)

7. What difficulties do you face while learning science (विज्ञान सीखने में आपको कौन सी मुश्किलें आती हैं)? ____

____

8. What would you like to learn in science (आप विज्ञान में क्या सीखना पसंद करेंगे)?

____

____

9. How can science learning in school be made more interesting (विद्यालय में विज्ञान शिक्षा को और मनोरंजक कैसे बनाया जा सकता है) ____________________________

____

10. How can science learning in school be made more useful (विद्यालय में विज्ञान शिक्षा को और उपयोगी कैसे बनाया जा सकता है? ____________________________

____

11. How can science learning in school be made more effective? (विद्यालय में विज्ञान शिक्षा को और प्रभावशाली कैसे बनाया जा सकता है)? ____________________________________

____

12. What course of higher education would you like to undertake after passing school, if possible (यदि संभव हो तो विद्यालय पास करके आप उच्च शिक्षा के लिये कौन सा कोर्स/ पाठ्यक्रम लेना पसंद करेंगे)? ____

____

13. Which profession/ job would you like to take up in the future, if you could do it (यदि आप कर सकें तो भविष्य में आप कौन सा व्यवसाय/ नौकरी करना पसंद करेंगे)?

____

____

14. Would study of science help you in your future profession (क्या विज्ञान की शिक्षा से आपके भविष्य के व्यवसाय/ नौकरी में मदद होगी)? _________________________________

14 (a). In what way (कैसे)?

____

____

15. If you are good in science what profession would you like to take up (यदि आप विज्ञान में अच्छे हों तो कौन सा व्यवसाय/ नौकरी करना पसंद करेंगे)?

____

____

16. Should science be taught to all students regardless of their disability: Yes/No (क्या सभी विद्यार्थियों को, उनकी विकलांगता की अनदेखी करके विज्ञान पढाया जाना चाहिए: हाँ / नहीं)?

____

16 (a). Why (क्यों)?____

____

17. What difficulties do all students face while learning science (विज्ञान सीखने में सभी विद्यार्थियों को क्या कठिनाइयाँ/ मुश्किलें आती हैं)?

____

____

18. What specific difficulties are faced by students with disabilities while learning science (विकलांग विद्यार्थियों को विज्ञान सीखने में किस तरह की विशेष कठिनाइयाँ/ मुश्किलें आती हैं)?

____

____

Appendix B

Interviews schedule for teachers

Teachers' particulars:

Name

____

Age (in years) _________________________ Gender (Male/ Female) __________

In which school are you teaching?_______________________________________

Type of school (Special/ Inclusive/ General) ________________________________

Classes that you are teaching ____

Subjects that you are teaching ____

Your qualifications ____

Do you have any formal training for teaching students with disabilities? If "yes", what are they? ____

Do you have any disability? ______ If yes, then which disability? ______________

Do you have any person with disability in your family or friend circle? ____________

Do you have (now) or had (in the past) students with disability in your class? ________

If you have experience of teaching students with disabilities, then please indicate number of years of experience and kinds of disabilities that your students had ________

Interview questions

1. Why are you interested in teaching? Why did you choose this particular profession?

2. What do you enjoy the most in your job as a teacher?

3. Have you come across different types of students in your tenure as a teacher? Please elaborate.

4. Are you familiar with the term 'Inclusion'?

- If yes: in what context?
- If no: (interviewer will give meaning of word)

5. Have you heard of the term 'Inclusive education'?
    - If Yes: what does 'Inclusive education' mean?
    - If no:(interviewer will explain in short)

6. Educationists talk about 'making schools inclusive'. What is your opinion about it?

7. What do you think are the benefits of 'inclusive education'?

8. In your opinion, what could be the barriers of 'inclusive education'?

9. Would inclusive education be helpful for students with disabilities? Explain.

10. Can you share any examples of teaching students with disabilities in your classroom?

11. Have you experienced/heard of students with disabilities who did very well in their studies?

12. What do you think helped them to perform well?

13. What difficulties are faced by the teachers when students with disabilities are included in their classrooms?

14. Do you think, a teacher needs to make changes in his/her teaching styles/methods for teaching students with disabilities? Explain.

15. What current educational practices and adaptations (curriculum, teaching strategies or evaluation) do you find suitable for the students with disabilities?

16. Can you suggest any changes in the current educational practices to make it suitable for the students with disabilities?

17. In the following statements please select one of the given options:

- Your knowledge of the legislation and/or policy related to children with disabilities is-

  Very good/ Good/ Average/ Poor
- Your level of confidence in teaching students with disabilities is-

  Very good/ Good/ Average/ Poor
- Your level of experience teaching a student with a disability is-

18. Given a choice, would you be comfortable teaching students with disabilities? Yes/ No. Explain.

    Very good/ Good/ Average/ Poor

Appendix C

Interview schedule for students

Aim: The interview is aimed at understanding students' views and experiences about 'inclusion' in the school system. It is further aimed to understand the probable challenges and advantages of inclusive classrooms from students' perspective.

Students' particulars:

Name ____ Class & Section ___________

Age (in years) _________________________ Gender (boy/ girl) __________________

School ____

Type of school (Special/ Inclusive/ General) ___________________________________

Do you have any disability? _______ If yes, then which disability? ________________

Do you have students with disability in your class?______ If yes, then which disability? _________

Do you have a person with disability in your family? _____ If yes, then which disability? ___________________________________

What relation do you have with that person? __________________________________

What grade or marks did you get in your last exams? ____________________________

Interview questions

1. Name your best friend in your class?
2. Describe him/her?

3. What do you like most about him/her?

4. What do you dislike about him/her?

5. Which students of your class do you get along well with (like to play, sit, study, share notes or share food)? and why?

6. Which students from your class do you avoid (do not talk to, do not sit with, do not share tiffin, do not play with) and why?

7. Do you think girls and boys should study together in same classroom? Why or why not?

8. Do you think rich and poor students should study in same classroom? Why or why not?

9. Do you think students from different communities (caste and religion) should study in same classroom? Why or why not?

10. Do you think students with and without disabilities should study in same classroom? Why or Why not?

11. Would you like to sit next to a student of your class who has some disability? Explain.

- What if the students has visual, hearing or speech related disability? Explain.
- What if the students has a physical disability? Explain.

12. Would you help a student in your class who has a physical disability? How?

13. Would you help a student in your class who has visual, hearing or speech related disability? How?

14. You are invited by a student of your class at his/her house. Would you like to go?

- What if the student has some disability?
- How will you ask permission from your parents to visit his/her house?

15. Would you like to visit your classmate's house if he/she belongs to a different family background? For example:

- Rich or poor
- Different religion
- Different caste

16. Please share your experiences (if any) regarding students with disabilities in your school.

17. Do you think other students in your class face difficulties due to the presence of students with disabilities? If yes, what kind of difficulties?

18. Do you think there are advantages of including students with disabilities in your class? Can you explain any of them?

19. Do you think teachers face any difficulties due to the presence of students with disabilities in classroom? If yes, what kind of difficulties?

20. Should teachers treat all the students in classroom in similar manner (whether disabled or not)?

21. Should teachers teach differently to a classroom which has students with disabilities?

Appendix D

Interview schedule for parents

Aim: The interview is aimed at understanding parents' views and experiences about 'inclusion' in the school system. It is further aimed to understand the probable challenges and advantages of inclusive classrooms from parents' perspective.

Particulars of children

Name(s) of your child(ren) ____

Age(s) & Gender(s) ____

School(s)

____

____

Class(es)____

Type(s) of school(s) (Special/ Inclusive/ General) __________________________

Your particulars:

Name ____________________________ Age ____________Gender (Male/ Female)

Do you have any disability? _____ If yes, then which disability? _________________

Do you have person(s) with disability in your family or friends? _____ If yes, then which disability? ____

What is your relation with that person? ______________________________________

How do you consider your knowledge of the legislation and/or policy related to children with disabilities? Is it very good, good, average or poor (please tell any one). ______________________________

Interview questions

1. Do/does your child(ren) share experiences with you about friends in class? If yes, then

   1(a) which friend/friends of your child(ren) do you like? Why?

   1(b) which of them do you not like? Why?

2. What characteristics do you wish to find in peers of your child(ren)?

3. What characteristics do you wish not to find in peers of your child(ren)?

4. Do you think boys and girls should study in the same classroom? Why or why not?

5. Do you think rich and poor students should study in the same classroom? Why or why not?

6. Do you think students from different communities (caste and religion) should study in the same classroom? Why or why not?

7. Do you think students with and without disabilities should study in the same classroom? Why or why not?

8. Would you like your child to sit next to a student of his/her class who has some disability? Explain.

- What if the student has visual, hearing or speech related disability? Explain.
- What if the student has a physical disability? Explain.

9. Would you like your child to help a student of her/his class who has a physical disability? If yes, then in what way?

10. Would you like your child to help a student of her/his class who has visual, hearing or speech related disability? If yes, then in what way?

11. Suppose your child is invited by a student of his/her class at his/her house. Would you allow him/her to go?

- What if the student has some disability?
- What instructions will you give to your child while visiting his/her house?

12. Would you allow your child to visit a classmate's house if he/she belongs to a different family background? For example:

- Rich or poor
- Different religion
- Different caste

13. Please give your comments regarding students with disabilities in schools.

14. Do you think other students in your child's class would face difficulties due to presence of students with disabilities? If yes, what kind of difficulties?

15. Do you think there are advantages of including students with disabilities in general classes? Can you explain any of them?

16. Do you think teachers face any difficulties due to presence of students with disabilities in classroom? If yes, what kind of difficulties?

17. Should teachers treat all the students in classroom in similar manner (whether disabled or not)?

18. Should teachers teach differently to a classroom which has students with disabilities?

Appendix E

Attitude Towards Inclusive Education in India Scale

A regular class means a general class which is taught by general teachers. Of the following who do you think should be in 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)

1. ___ Students who frequently fail in exams should be in regular classes.

2. ___ Students who cannot move without help from others should be in regular classes.

3. ___ Students who are shy and withdrawn should not be in regular classes.

4. ___ Students whose speech is difficult to understand should be in regular classes.

5. ___ Students who cannot read printed words and need to use Braille should be in regular classes.

6. ___ Students who are verbally aggressive toward their peers should not be in regular classes.

7. ___ Students who are dependent on others for daily life activities should be in regular classes.

8. ___ Students who cannot speak and use sign language should be in regular classes.

9. ___ Students who cannot control their behavior and disrupt the classroom activities should be in regular classes.

10. ___ Students who need separate special classes in everyday reading and math skills should be in regular classes.

11. ___ Students who cannot hear conversational speech should be in regular classes.

12. ___ Students who do not follow school rules of conduct should not be in regular classes.

13. ___ Students who are frequently absent from school should be in regular classes.

14. ___ Students who are inattentive in class should be in regular classes.

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.

19. ___ In a regular class with students with disabilities, other students may not get proper attention.

20. ___ Students with disabilities may not be accepted by other classmates.

21. ___ Teachers may not be able to handle students with physical disabilities in a regular class.

22. ___ Teachers may not be able to handle students with sensory disabilities in a regular class.