Chapter I

INTRODUCTION

1.0 INTRODUCTION

It is known that all children didn’t learn alike. Individuals differ in their interests and abilities of learning from one another. Further, it is important to note that the same student’s achievement across different areas of performance is also not uniform. But if there is a significant difference between a student’s achievement in one or more specific areas such as reading, writing, arithmetic and speech and language when compared to the other areas in spite of no apparent physical, social, emotional or intellectual reason for such discrepancy this may be due to learning difficulties in that area(s). Further, these learning difficulties are associated with problems in listening, reasoning, memory, attention, selecting and focusing on relevant stimuli, and the perception and processing of visual and/or auditory information. These perceptual and cognitive processing difficulties are assumed to be the underlying reason why students with learning difficulties experience one or more of the following characteristics: reading problems, deficits in written language, underachievement in math, poor social skills, attention deficits and hyperactivity, and behavioral problems. Further, these difficulties can lead to academic backwardness or under achievement in specific school subject areas. Students facing such difficulties in learning science are referred as learning difficulties in science. An attempt is made in this research work to identify the learning difficulties in science among secondary school students.
1.1 INDIAN EDUCATION

A good education system is fundamental to a nation and for a nation like India which is growing, it is of paramount importance to reflect on our present education system and incorporate sustainable changes in it, to make it compatible with the global dynamism.

The word education comes from the word 'educere' which means to bring about what is already in. As Swami Vivekananda said, "Education is the manifestation of perfection, already present in man". The purpose of education is to detect talent proactively and the purpose of school education is to guide the child's discovery of self, identify and nurture his/her potential to the fullest. Teachers must perceive children as seeds to be nurtured and not as clay to be moulded. They must act as gardeners and not as potters. This attitude must change and if it does so would the education system. It is essential that education should be based on application and intelligence instead of trying to test memory of knowledge. Memory doesn't have much relevance in today's times given the volume of information which is available on the internet. It is the application of information that matters and be tested.

Children must be taught the difference between being wise and being knowledgeable; being well informed and being intelligent. One must be cautious of "Information pollution" which comes along with globalisation and which often blurs the distinction between knowledge and wisdom. The education system must encourage children to imagine and invent and not reinvent the same wheel. Each child's imagination is different and, therefore, he has to be guided correctly.
to choose his occupation in life. There is no denying that a person who has found
his vocation in life is a blessed human being.

One of the main limitations of our present education system is it lacks
practicality and relevance. It's time for the educationists to instill some life in the
system by connecting classroom lectures with real-life experiences. For example,
students must be taught the management of money and people because nobody
in practical life can escape management of money and particularly in the current
era which is full of new challenges.

Further, the system lacks programs on personality development and
inculcation of moral and ethical values. Children must be taught to go beyond
religion, region and language. Our current endeavor must be to create 'One India'
transcending all parochial barriers. Only then our children would grow up to be
sensible, sensitive and responsible global citizens.

The present education system seems that it does not prepare a child for
life; rather, it prepares the child for an exam. It is based on a premise that needs
to be challenged — that is getting outstanding grades is the secret of a
successful life. They must be taught not to chase Grade A and instead be taught
that it's one's attitude that determines success. Thus, the present education
system unfortunately leaves behind the millions of average children with an
incredible potential, but who are paralysed by the fear of "failure". Getting good
grades is not a problem but allowing grades to dictate one's life is. This defeats
the whole purpose of education which is meant to build and not destroy.
We must evolve a system that is not one of indoctrination. Children have to be educated, but they have also to be left alone to educate themselves. A true education system must be organic to the process of nation building "When a child grows so does the nation".

Present Education Scenario

The present educational system of India is an implantation of British rulers. Wood's Dispatch of 1854 laid the foundation of present system of education in India. Before the advent of British in India, education system was private one. With the introduction of Wood's Dispatch known as Magna Carta of Indian education, the whole scenario changed. The main purpose of it was to prepare Indian Clerks for running local administration. Under it the means of school educations were the vernacular languages while the higher education was granted in English only. British government started giving funds to indigenous schools in need of help and thus slowly some of the schools became government-aided.

Contemplating on the new system which was introduced Mahatma Gandhi expressed his anguish in following words, "I say without fear of my figures being challenged successfully, that today India is more illiterate than it was fifty or a hundred years ago, and so is Burma, because the British administrators, when they came to India, instead of taking hold of things as they were, began to root them out. They scratched the soil and began to look at the root, and left the root like that, and the beautiful tree perished. The village schools were not good enough for the British administrator, so he came out with his program. Every
school must have so much paraphernalia, building, and so forth. Well, there were no such schools at all. There are statistics left by a British administrator which show that, in places where they have carried out a survey, ancient schools have gone by the board, because there was no recognition for these schools, and the schools established after the European pattern were too expensive for the people, and therefore they could not possibly overtake the thing. I defy anybody to fulfill a program of compulsory primary education of these masses inside of a century. This very poor country of mine is ill able to sustain such an expensive method of education. Our state would revive the old village schoolmaster and dot every village with a school both for boys and girls."

**Education Policy**

The National Policy of Education (1986) and Program of Action (1992) lay down the objectives and features of Indian education policy. It includes:

- Development of International cooperation and peaceful coexistence through education.
- Promotion of equality. It could be achieved by providing equal access and equal condition of success to children.
- A common educational structure (10+2+3) for the whole of India.
- Education for women’s equality. The Indian education should be used as a tool to change the status of women in the society.
- Equalization of Scheduled Caste (SC) population with others in the matter of education. This is ensured by giving incentives to parents who send their children to schools, providing scholarship to SC
students for higher studies, reservation of seats in institution of higher 
studies in India, recruitment of SC teachers.

- Opening of primary schools in tribal area for promotion of education 
among Scheduled Tribe (ST) people.
- Development of curriculum and study material in the language of tribal 
people.
- Emphasis on the education of minorities.
- Adult education - Initiation of National Literacy Mission, for teaching 
illiterate people of age group 15-35, and making them aware of the 
day-to-day realities of their surroundings.
- Special emphasis on early childhood care and education by opening up 
of day care centers, promotion of child focused programs.
- Increasing the scope of Operation Blackboard for upliftment of 
standard of primary education in India.
- Secondary education curriculum should expose the students to 
differentiated roles of science, the humanities, and social science.
- Redesigning of courses of higher education to meet the increasing 
demand of professionalism.
- Providing enhanced support to the research work in Universities. 
Efforts to relate ancient Indian knowledge with the contemporary 
reality.
- Setting up of Open Universities and Distance Learning centers to 
promote the goal of education as a life long process.
- A combined perspective of technical and management education.
• Minimum exposure to computers and training in their use to be the part of professional education.

• The All India Council for Technical Education will be responsible for maintenance of norms and standards, accreditation, funding, and monitoring of technical and management education in India.

• Multiple task performance for teachers such as teaching, research, development of learning resource material, extension and management of the institution.

• Providing teachers a better deal to make education system in India work in proper way, as teachers are the backbone of the system. Providing better facilities to institutions and improved services to students.

• Development of languages in great deal.

• Measures to be taken for easy accessibility of books at minimum costs to all sections of students.

• Strengthening of science education for the development of spirit of inquiry and objectivity in the minds of students.

• The purpose of examination to be to bring about qualitative improvement in education. It should discourage memorization.

• Methods of teacher recruitment to be recognized one to ensure merit and objectivity in the system.

• Overhauling of the system of teacher education and establishment of District Institutes of Education and Training (DIET) to organize courses for elementary school teachers.
• Reviewing of educational developments by the Central Advisory Board of Education (CABE)
• Involvement of local communities for school improvement programmes.
• Review of the implementation of the parameters of the policy every five years,
• Strengthening the base of pyramid of Indian population for proper development of education system in India.

The National Policy of Education (1986) and Program of Action (1992) laid down many objectives for the development of education system in India but it has not been successful in achieving all of them. It has specified that the examination system should discourage the memorizing but it is what is going on. The education in India seems to encourage rote learning instead of experimentation and questioning. There is some disparity in assessment as various State Boards have different standards of evaluation.

Though there are disparities between the objectives and their implementation in education but still education system in India has come a long way and will continue to improve in the future. The knowledge of psychology and learning will be helpful in this regard.

1.2 PSYCHOLOGY - LEARNING

(a) Learning is Not Necessarily an Outcome of Teaching: Cognitive research is revealing that even with what is taken to be good instruction, many students, including academically talented ones, understand less than we think
they do. With determination, students taking an examination are commonly able to identify what they have been told or what they have read; careful probing, however, often shows that their understanding is limited or distorted, if not altogether wrong. This finding suggests that parsimony is essential in setting out educational goals: Schools should pick the most important concepts and skills to emphasize so that they can concentrate on the quality of understanding rather than on the quantity of information presented.

(b) **What Students Learn is influenced by their Existing Ideas:** People have to construct their own meaning regardless of how clearly teachers or books tell them things. Mostly, a person does this by connecting new information and concepts to what he or she already believes. Concepts—the essential units of human thought—that do not have multiple links with how a student thinks about the world are not likely to be remembered or useful. Or, if they do remain in memory, they will be tucked away in a drawer labeled, say, "biology course, 1995," and will not be available to affect thoughts about any other aspect of the world. Concepts are learned best when they are encountered in a variety of contexts and expressed in a variety of ways, for that ensures that there are more opportunities for them to become imbedded in a student's knowledge system. But effective learning often requires more than just making multiple connections of new ideas to old ones; it sometimes requires that people restructure their thinking radically. That is, to incorporate some new idea, learners must change the connections among the things they already know, or even discard some long-held beliefs about the world. The alternatives to the necessary restructuring are to distort the new information to fit their old ideas or to reject the new information
entirely. Students come to school with their own ideas, some correct and some not, about almost every topic they are likely to encounter. If their intuition and misconceptions are ignored or dismissed out of hand, their original beliefs are likely to win out in the long run, even though they may give the test answers their teachers want. Mere contradiction is not sufficient; students must be encouraged to develop new views by seeing how such views help them make better sense of the world.

(c) Progression in Learning is usually from the Concrete to the Abstract: Young people can learn most readily about things that are tangible and directly accessible to their senses—visual, auditory, tactile, and kinesthetic. With experience, they grow in their ability to understand abstract concepts, manipulate symbols, reason logically, and generalize. These skills develop slowly, however, and the dependence of most people on concrete examples of new ideas persists throughout life. Concrete experiences are most effective in learning when they occur in the context of some relevant conceptual structure. The difficulties many students have in grasping abstractions are often masked by their ability to remember and recite technical terms that they do not understand. As a result, teachers—from kindergarten through college—sometimes overestimate the ability of their students to handle abstractions, and they take the students' use of the right words as evidence of understanding.

(d) People Learn to Do Well Only What They Practice Doing: If students are expected to apply ideas in novel situations, then they must practice applying them in novel situations. If they practice only calculating answers to
predictable exercises or unrealistic "word problems," then that is all they are likely to learn. Similarly, students cannot learn to think critically, analyze information, communicate scientific ideas, make logical arguments, work as part of a team, and acquire other desirable skills unless they are permitted and encouraged to do those things over and over in many contexts.

(e) **Effective Learning by Students Requires Feedback:** The mere repetition of tasks by students—whether manual or intellectual—is unlikely to lead to improved skills or keen insights. Learning often takes place best when students have opportunities to express ideas and get feedback from their peers. But for feedback to be most helpful to learners, it must consist of more than the provision of correct answers. Feedback ought to be analytical, to be suggestive, and to come at a time when students are interested in it. And then there must be time for students to reflect on the feedback they receive, to make adjustments and to try again—a requirement that is neglected, it is worth noting, by most examinations—especially finals.

(f) **Expectations Affect Performance:** Students respond to their own expectations of what they can and cannot learn. If they believe they are able to learn something, whether solving equations or riding a bicycle, they usually make headway. But when they lack confidence, learning eludes them. Students grow in self-confidence as they experience success in learning, just as they lose confidence in the face of repeated failure. Thus, teachers need to provide students with challenging but attainable learning tasks and help them succeed. What is more, students are quick to pick up the expectations of success or failure
that others have for them. The positive and negative expectations shown by parents, counselors, principals, peers, and—more generally—by the news media affect students' expectations and hence their learning behavior. When, for instance, a teacher signals his or her lack of confidence in the ability of students to understand certain subjects, the students may lose confidence in their ability and may perform more poorly than they otherwise might. If this apparent failure reinforces the teacher's original judgment, a disheartening spiral of decreasing confidence and performance can result.

There are many different learning types and approaches to learning. To learn effectively it is important to tailor your study habits to your own needs and approach, this often means choosing techniques that work for you and evaluating them from time to time to determine if you need to try something new. Examination of Kolb’s model of experimental learning helps to understand the learning process.

1.2.1 Kolb’s Model of Experiential Learning

Kolb’s holistic model builds on the earlier work of prominent scholars on human learning and development, but it doesn’t say much about the value of social connection and the possibilities for more of these connections made available through online technologies. These include values and cultural influences, the values of the institution and the learning community created by the instructor. The model used to inform the self assessment survey was based on the work of David Kolb (1984). The image below is a diagram of the learning process which is explained in more detail below:
Kolb’s model (based on experiential learning theory) identifies four modes in the learning cycle:

- Concrete Experimentation
- Reflection
- Abstract Conceptualization
- Active Experimentation.
Basically, this is a fancy way of saying that we learn by:

- Doing something (Concrete Experimentation)
- Thinking about it (Reflection)
- Doing some research
- Talking with others and applying what we already know to the situation (Abstract Conceptualization)
- Doing something new or doing the same thing in a more sophisticated way based on our learning (Active Experimentation).

Kolb’s holistic model builds on the earlier work of prominent scholars on human learning and development, but it doesn’t say much about the value of social connection and the possibilities for more of these connections made available through online technologies. We have expanded on it to include some of the “big picture” influences that are important in the learning process. These include your values and cultural influences, the values of the institution and the learning community created by the instructor, your peers and your support network.

Honey and Mumford (1982) identified four learning types associated with Kolb’s modes in the learning cycle:

- Activists
- Reflectors
- Theorists
- Pragmatists.
Activists learn best from activities where they can engross themselves in short here-and-now activities such as business games and competitive teamwork tasks where they are thrown in at the deep end with a task they think is difficult; where they learn less from and may react against activities where learning involves a passive role, e.g. listening to lectures, reading; or where they are offered statements they see as theoretical, i.e. explanation of cause or background.

Reflectors learn best from activities where they are able to stand back from events and listen and observe; where they are asked to produce carefully considered analyses and reports; where they learn less well from activities where they are involved in situations which require action without planning; or where they are worried by time pressures and being rushed from one activity to another.

Theorists learn best from activities where what is being offered is part of a system, model, concept or theory; where they are offered interesting ideas and concepts even though they are not immediately relevant; where they learn less well from activities where they are involved in unstructured activities where ambiguity and uncertainty are great; or where they feel themselves out of tune with other participants, especially when of a lower intellectual caliber.

Pragmatists learn best from activities where there is an obvious link between the subject-matter and the problem or opportunity on the job, where: they are exposed to a model they can emulate, e.g. respected boss, a film showing how it is done; where they learn less well from activities where the
learning event seems distant from reality or there is no practice or clear
guidelines on how to do it.

These might be considered approaches to learning. Other learning styles
theorists have developed models based heavily on the processes involved in
perceiving and processing new information. Howard Gardner’s theory on multiple
intelligences is an example of this.

Kolb identified two separate learning activities that occur in the learning
cycle:

- **Perception** (the way we take in information) and
- **Processing** (how we deal with information).

This is represented on the diagram as two axis dividing the cycle into four
quadrants. Each quadrant represents different learning processes as follows:

- **Converging** processes relate to bringing a number of perspectives to
finding a single answer – usually right or wrong. You may use this way
of thinking in a scientific context.
- **Diverging** processes are about generating a number of accounts of
different experiences. Typically, these are more creative processes.
- **Assimilating** processes describe (roughly) the taking in of new
knowledge.
- **Accommodating** processes describe (again, roughly) the related of
the new knowledge to our prior experiences and beliefs.
The perception and processing activities that Kolb describes can be divided into opposites. For example, some people best perceive information using concrete experiences and emotions (like feeling, touching, seeing, and hearing) while others best perceive information abstractly (using mental or visual representations). Once information is perceived it must be processed. You may process information best through active experimentation (doing something with the information) while others process best through reflective observation (thinking about it).

In spite of our understanding about learning process and providing teaching learning experiences in view of the same some children face difficulties in specific areas referred as Learning Difficulties.

### 1.3 LEARNING DIFFICULTIES

Learning difficulties also referred as Learning disabilities that affect how a person understands, remembers and responds to new information. People with learning disabilities / difficulties may have problems like: (i) Listening or paying attention, (ii) Speaking, (iii) Reading or writing and (iv) Doing mathematics. Although learning difficulties occur in very young children, they are usually not recognized until the child reaches school age. Evaluation and testing by a trained professional can help identify learning difficulties. The next step is individualized education, which involves helping your child in the areas where he or she needs the most help. Sometimes tutors or speech or language therapists also work with the children. Learning difficulties may not go away, but strategies to work around them can make them less of a problem.
Learning difficulties are by far the most common disability among school-age children — more than half of students with disabilities are learning disabled. About one-third of all secondary mathematics and science classes — and half of all primary grade classes — include students with learning disabilities (National Science Foundation, 1996). Generally, students with learning disabilities have difficulties in listening, speaking, reading, writing, reasoning, or mathematics. They also often have trouble sustaining attention to task; remembering procedures, deadlines, and verbal information; and applying organizational skills (Mastropieri & Scruggs, 1993).

In mathematics and science, students with learning disabilities frequently have difficulty with computation, problem solving, terminology, making inferences, and integrating new and prior knowledge. Memory, motor, and attention deficits are also common and impact students’ mathematics and science achievement (Miller & Mercer, 1998).

Finally, many students have had a frustrating history of school failure, and they struggle with low self-esteem. Like all young people, students with learning disabilities are varied and complex individuals. While they may have learning difficulties in certain areas, such as in language or organizational skills, they may be gifted in other domains, such as in art or performance. These students’ talents or intellectual gifts are often overshadowed by their weaknesses. Many times, they are first noticed for what they cannot do, rather than for the specific talent they may have. Thus, teachers will want to identify and support students’ strengths and interests as well as address their disabilities. “[Students] require
an environment that will nurture their gifts, attend to the learning disability and provide the emotional support to deal with their inconsistent abilities”. When a teacher recognizes and supports the intellectual and personal strengths of a student with a learning disability, he will likely raise that child’s self-confidence and heighten her determination to persevere. Working with these students can be a particularly rewarding experience, says Suzanne Moe, science teacher at North Eugene High School in Oregon (Baum, 1990).

1.3.1 Different Types of Learning Disabilities

A learning disability can be caused by brain injury or medical condition. Children who suffer from a specific learning disability may find it difficult to read and write. Solving simple arithmetic problems can also difficult for a child with certain type of learning disabilities that exist. Studies and research show that almost 30 percent of the general population suffers from one kind of learning disability or another. Let’s look at the five most common types of learning disabilities.

(i) Dysgraphia: Children with dysgraphia may be unable to differentiate between words so writing can be difficult. In most of the cases, the child also finds it difficult to understand different sounds and words which are spoken. The common dysgraphia symptoms are explained in the following paragraphs.

- Even if the child is provided with high quality education, he or she finds difficulty in writing words and numbers when they have this specific learning disability.
• Some children affected with dysgraphia find it difficult to process the language.
• The handwriting of dysgraphia-affected children is also very difficult to interpret.
• Typically, dysgraphia-affected children have problems with spelling and they mix up the alphabet.

**Treatments for Dysgraphia:** Even though there are some common symptoms of dysgraphia, the victim may also have his or her own unique set of symptoms. Dysgraphia generally occurs among children below 15 years of age but this specific learning disability may also be present in adults as well. Treating dysgraphia may take weeks or even months but patience is essential. Here are some popular and effective treatments of dysgraphia:

• Language therapy programs for improving general writing ability of the child.
• Special training for better recognition of letters and numbers.
• Special training which emphasizes the motor skills of the child such as the coordination of the hands.

(ii) **Nonverbal Learning Disability:** It may be hard to identify children who are affected by nonverbal learning disability or NLD at an early age. It is only when they enter higher grades that they begin to face problems, especially in social matters. The common non-verbal learning disability symptoms are:

• Degraded abstract reasoning.
• The nonverbal learning disability affected child develops a fear of facing new situations.
• The affected child also lacks good common sense.
• Subjects like math and English are the most difficult subjects for the child who is affected with nonverbal learning disability.
• The nonverbal learning disability affected child has very low self-esteem which consequently creates social problems.
• The ability to think clearly and the reasoning power of the child declines.

(iii) **Dyscalculia**: Dyscalculia is a specific learning disability which causes difficulties in understanding basic math principles and solving simple problems. The dyscalculia-affected child finds it hard to interpret mathematical symbols and numbers. Even simple arithmetic problems are difficult for him or her to solve. The common symptoms of dyscalculia are:

• The dyscalculia-affected child finds it difficult to judge time and distance.
• The dyscalculia-affected child also finds it difficult to differentiate between directions.
• Mental visualizations are hard for the child.
• Simple calculations in the mind are hard to render for a dyscalculia-affected child.

(iv) **Memory Disabilities**: People who are affected by memory disabilities may find it really difficult to memorize things. Memory disabilities are just some of
the types of learning disabilities that affect memorization. For instance, the person with a particular mental disability may forget a sentence spoken by someone two minutes ago. The common symptoms of memory disabilities are:

- Difficulty in remembering even simple things like the name of the person whom he/she just met.
- Difficulty in solving those types of math problems which require memorizing formulas.

(v) **Visual and Auditory Disabilities:** People with visual and auditory disabilities are able to hear and see properly but it is hard for them to communicate properly. The tips for treating children with visual and auditory disabilities

- As with other learning disabilities, special attention should be given to help children overcome their disability.
- It’s best to enroll the child in a school with a special education programs sensitivity.

In view of the scope and concern of the present study let us examine the learning of science with special reference to learning difficulties in science.

### 1.4 LEARNING SCIENCE

Science is one of the major content areas of the general education curriculum on which the educational reform movement has focused. In such nationwide reports as Science for All Americans, the nation’s schools in American have been exhorted to make science literacy a reality for all students, including
those with disabilities. In 1993, the National Committee on Science Education Standards and Assessment noted that "the commitment to Science for All implies inclusion not only of those who traditionally have received encouragement and opportunity to pursue science, but of women and girls, all racial and ethnic groups, the physically and educationally challenged, and those with limited English proficiency" (American Association for the Advancement of Science, 1989).

Science can be related to the lives of all students, and it is essential to preparing students for the transition to adulthood and for membership in an increasingly technological workforce (Fradd & Lee, 1995; Gurganus, Janas, & Schmitt, 1995; Patton, 1995). Science education can help students learn about the physical environments in which they live and develop a multicultural worldview of scientific phenomena. For many students, particularly those who are learning English, science activities can serve as a vehicle for developing language skills and social behaviors (Fathman, Quinn, & Kessler, 1992).

Although the growing importance of science education for students with disabilities has been recognized, research by Patton, Polloway and Cronin (Cawley, 1994) indicated that many students with disabilities receive very little or no science instruction. Further, because many special and general educators have not been adequately prepared to teach science to students with disabilities (Gurganus et al., 1995), they often use a content-oriented approach that focuses on learning vocabulary and factual text-based information through textbooks and teacher-directed presentations such as lectures and demonstrations (Mastropieri &
Scruggs, 1994; Weiss, 1993). Because such an approach requires that students have certain levels of reading, writing, and memory skills, many students with disabilities do not benefit from it (Scruggs & Mastropieri, 1993). They therefore often receive low grades and perform significantly below their general education peers (Holahan, McFarland, & Piccillo, 1994; Parmar & Cawley, 1993). However, students with disabilities can learn and master content in the general education curriculum when teachers employ instructional adaptations based on certain kinds of effective practices (Grossen & Carnine, 1996).

1.4.1 Activities-Oriented Approach

Many students with disabilities benefit from learning science through an activities oriented approach that reduces the reliance on textbooks, lectures, knowledge of vocabulary, and pencil-and-paper tests. This kind of approach seeks to promote learning by providing students with experiences that allow them to discover and experiment with science. Through discovery and inquiry, teachers involve students in creating and expanding their knowledge and understanding about the content area being studied (Mastropieri & Scruggs, 1995).

(a) Structured Learning Cycle: When employing an activities-oriented approach, teachers offer students a variety of active educational experiences structured according to a learning cycle. This cycle consists of an instructional sequence that includes engagement, exploration, development, and extension (Guillaume, Yopp, & Yopp, 1996; Gurganus et al., 1995). The learning cycle begins with the engagement phase, whereby teachers use real-life activities, problems, and questions to motivate students to learn about the topic and to
assess their prior knowledge. Students explore the content and phenomena by manipulating materials and start to address the presented questions. For example, as part of a unit on simple machines, teachers can ask students to identify simple machines that they use and have students take apart broken household appliances. During the exploration phase, students formulate new ideas and questions to be developed in the subsequent phases. For example, teachers can have students explore how the household appliances work, identify their components, and formulate hypotheses about how to fix them. In the development phase, students add to their understanding by gathering more information and making conclusions about the concepts, phenomena, and questions previously generated. For example, students can use the Internet to learn more about the appliances and to draw conclusions about how they work. In the final stage, extension, students extend their learning by applying it to new and different situations as well as to their own experiences. For example, students can hypothesize about how other machines and household appliances that they use work. Educators help students move through the learning cycle by asking them to think about questions, helping them find solutions, providing additional activities that further students' learning, and aiding them in summarizing and evaluating their learning.

An integral part of an activities-oriented approach is providing hands-on, multisensory experiences and materials. Hands-on learning gives students concrete experiences that establish a foundation for learning more abstract concepts. These kinds of activities also help students actively explore and discover content, and they lessen the language and literacy demands that may
interfere with learning for students who have learning difficulties and/or are second-language learners (Fradd & Lee, 1995). For example, students can learn about electricity by building electric circuits or about earth science by creating models out of papier-mâché.

**b) Special Concerns:** Because students with physical, sensory, and fine-motor disabilities may experience some difficulties using manipulatives and scientific materials and equipment, educators may need to offer adapted equipment (Mastropieri & Scruggs, 1995). Students with visual disabilities, for example, may need Braille-marked and talking materials and equipment such as a Braille labeler, ruler, and meter stick; talking thermometer and balance; enlarged three-dimensional models; and large-screen video and microprojectors to enhance visual images.

In an activities-based science instruction approach, students often work in labs solving problems and conducting experiments. Educators can maximize this type of learning experience by showcasing and demonstrating essential aspects of problems and experiments, letting students with disabilities team up with nondisabled peers, disseminating a checklist of steps students can consider when working on a task, checking their progress, and asking them to maintain lab journals.

Teachers also can ensure that all students are able to work safely and successfully in laboratories and with materials (Kucera, 1993). For example, teachers can begin each experiment by posting, discussing, and reviewing the
rules, safety factors, and evacuation procedures and assessing students' knowledge of them. They can use print and tactile substances to label important areas, materials, and substances; have all students wear safety equipment (e.g., splash-proof goggles, rubber aprons, and gloves); and assign lab partners.

Teachers must know whether some students need adapted workstations and specialized equipment (Kucera, 1993). Students with physical disabilities may need a workstation with a work surface 30 inches from the floor, accessible equipment controls, and appropriate clearance and leg space, as well as good aisle widths. These students also may benefit from adjustable-height storage units; pull-out or drop-leaf shelves and countertops; single-action lever controls and blade-type handles; flexible connections to water, electrical, and gas lines; and lightweight fire extinguishers. Similarly, the performance and safety of students with sensory disabilities may be enhanced through the use of adaptive equipment such as electric machines and alarm systems that have visual and auditory cues to indicate their on/off status, spoons with sliding covers, and glassware with raised letters and numbers.

(c) Relate Science to Students' Lives: Relating science instruction to students' personal experiences and to general societal problems is an essential component of an activities-oriented approach. Relating science to practical, civic, professional, recreational, and cultural events that are familiar and relevant to students' backgrounds and experiences can promote science literacy, motivate students, and help them learn to value science. To aid students in seeing the relevance of science to their lives, teachers can present them with information,
issues, and problems that relate to real-life situations and discuss with them the relevance of these problems to their lives and the situations in which this content can be applied. For example, students can investigate socially significant problems such as water supply, weather, pollution, nutrition, and solar energy.

Teachers can make connections between science and students’ cultural backgrounds by using learning activities and instructional materials that

- explore the different cultural origins of science,
- discuss scientific solutions and practices developed and used in all parts of the world,
- highlight the achievements of culturally and linguistically diverse scientists, and
- present a range of culturally diverse practical applications.

Connections to students' lives and cultures also can be established by having students

- conduct problem-solving activities that address community-based problems,
- use artifacts, buildings, geographical sites, museums, and other resources in their community, and
- interview community members.

These experiences will help illustrate and reinforce concepts, issues, phenomena, and events (Fradd & Lee, 1995; Taylor, Gutierrez, Whittaker, & Salend, 1995).
(d) **Take Students on Field Trips:** Class field trips that are directly related to the curriculum can make learning more meaningful and real for students. They can also serve as the basis for developing instructional units. Trips to community and regional science museums and ecological sites can offer direct experiences and authentic tasks related to what students are learning. In addition, many field trips provide hands-on experiences that promote the learning not just of factual information, but also of processes. "Virtual field trips" to various museums and scientific sites can be done via the Internet.

To help teachers and students benefit from field trips, many museums provide teacher training programs, model curricula and teaching strategies, special tours, exhibits, and materials for school groups and traveling exhibits that prepare students for and build upon experiences at the museum. Prior to taking their classes on trips, many teachers make pre-visits to familiarize themselves with various aspects of the facility (e.g., available exhibits and activities, admission costs, facility and restroom accessibility, rules on photography, whether there are lunchrooms and coatrooms, etc.). Teachers may also meet with the facility's staff concerning the size and unique needs of their classes and the availability and scope of guided tours. Field trips also can be enhanced by giving students a variety of pre-trip learning experiences to prepare them, explaining expectations regarding their behavior on the trip, giving them notepads on which to take notes and make sketches, eliciting and answering questions on the ride to the site, and discussing positive and negative aspects of the trip with them on the ride back to school (Roberts & Kellough, 1996). Teachers can also prepare trip chaperones by giving them information about the facility and their responsibilities.
The educational benefit of field trips can be enhanced by videotaping them. These videos can subsequently be viewed and discussed in class and can serve as a basis for lessons to help students understand important information presented on the trip. Students can show the video and discuss it with other classes or students who were not able to make the field trip.

(e) Organize Instruction around "Big Ideas" and Interdisciplinary Themes: In activities-oriented approaches, teachers focus on breadth of understanding rather than a broad coverage of science. Carnine (1995) proposed that educators structure instruction in science according to "big ideas," which he defined as important concepts or principles that help students organize, connect, and apply material so that they see a meaningful relationship between the material to be learned and their own lives. Carnine also suggested that teachers sequence instruction by employing big ideas to help students develop a mechanism for learning "smaller ideas" such as facts that relate to the broader concepts and big ideas being presented.

The science performance of students with disabilities will be enhanced when teachers organize instruction around broad-based, common, and interdisciplinary theme concepts (Kataoka & Lock, 1995; Rutherford & Ahlgren, 1990). Interdisciplinary themes can link the various science disciplines (e.g., biology, chemistry, earth science, physics) as well as relate science themes to other subject areas (e.g., English, mathematics, social studies, foreign languages, art, music). For example, for an interdisciplinary thematic unit on weather, students would study the scientific principles undergirding various
weather patterns as part of science class and the history of weather and its
effects on lifestyles and cultural traditions in social studies class. As part of their
mathematics classes, students would be asked to solve various mathematical
problems related to weather and, for language arts classes, to read literature and
poetry related to weather. In art class, students would see how weather changes
the appearance of various landscapes and then produce art forms to reflect these
landscapes.

When selecting common and interdisciplinary themes around which to
organize instruction, teachers should consider several factors, including whether
the themes (a) are feasible for students and teachers in terms of motivation,
relevance to the curriculum and students' lives, length of time, availability of
materials and resources; (b) provide sufficient opportunities to teach basic- and
higher-level content, information, and skills; and (c) relate to meaningful and
worthwhile contextualized content (Savage & Armstrong, 1996). Once themes
are selected, teachers formulate objectives and develop, select, and organize the
content and instructional resources; implement with students a diverse set of
theme-connected direct and hands-on learning activities that integrate science,
social studies, language arts, music, art, and other content areas; and devise
appropriate assessment procedures to be employed throughout the instructional
unit (Roberts & Kellough, 1996). Interdisciplinary thematic units usually conclude
with students completing a culminating activity that allows them to summarize
and present what they have learned.
(f) **Have Students Work in Cooperative Learning Groups:** In an activities-based approach, teachers often structure learning so that students work in cooperative learning groups (Gurganus et al., 1995). The use of such groups can encourage the establishment of scientific classroom communities where students work in groups to communicate about and experiment with solutions to scientific problems. Cooperatively structured learning lets students formulate and pose questions, share ideas, clarify thoughts, experiment, brainstorm, and present solutions with their classmates. Students can see multiple perspectives and solutions to scientific problems. For example, in a unit about flowers, students can be assigned to work in cooperative groups to design a flower garden for their school. The group can plan their garden by posing questions (What flowers grow best in the available soil and lighting conditions? What flowers and colors go together? What materials will be needed to maintain the garden?) and gathering data to address these questions. The group also can share a drawing of their proposed garden and the reasons that guided their design with the whole class.

(g) **Use Instructional Technology and Multimedia:** Instructional technology and interactive multimedia provide students with access to learning environments that link text, sound, animation, video, and graphics to present content in a nonlinear and instantaneous fashion that can foster critical thinking skills and social interactions (The Cognition and Technology Group at Vanderbilt Learning Technology Center, 1993). These technologies also can be incorporated throughout the curriculum to adapt instruction to students' learning styles and provide them with experiences that allow them to control their learning.
Instructional technology and interactive multimedia such as computer software, hypertext/hypermedia, computer simulations, videocassettes, videodiscs, captioned television, liquid crystal display (LCD) computer projection panels, CD-ROM, virtual reality, and the Internet can be used to introduce, review, and apply science concepts and have students experience events, places, and phenomena (Trowbridge & Bybee, 1996). For example, through virtual reality systems, students can experience Newton's law of gravity firsthand or through multimedia applications, they can perform complicated scientific experiments such as studying chemical reactions. In addition to providing students with an opportunity to obtain information about and interact with unique aspects of science, these instructional delivery systems can motivate them and stimulate their curiosity.

The Internet holds great promise as an instructional tool because it provides educators and students with access to the information superhighway and a variety of exploratory- and discovery-based learning and communication experiences (Peha, 1995). The Internet also can offer students greater control over the curriculum because it provides them with many choices related to what and how they learn. Specifically, students can learn science by having access to information, educational resources, pictorials, databases, problemsolving experiences, and communications with other students and professionals from throughout the world. For example, the National Geographic Society and the Technical Education Research Center sponsor the Kids Network, an international telecommunications-based curriculum to teach science and geography to elementary and middle school students (Bradsher & Hagan, 1995). Students
work in small groups to pose questions concerning socially significant problems, conduct experiments, and collect and analyze data related to their questions. Through the network, students exchange information and share their findings with peers worldwide. Listings and descriptions of computer networking resources for educators and students are available and can be obtained by contacting professional organizations, state education departments, and computer-based companies.

(h) Support Instruction through Specially Designed Programs and Curricula: Specially designed science programs and curricula can be incorporated into an activities based instructional program. An example would be the Full Option Science System (FOSS; Encyclopedia Britannica Co., 1992), which offers teachers a hands-on, laboratory-based K-6 curriculum structured around four themes: scientific reasoning, physical science, earth science, and life science. FOSS also uses discovery learning, cooperative learning groups, interdisciplinary activities, and other types of activities to teach science language and the use of scientific equipment. It also includes Science Activities for the Visually Impaired (SAVI) and Science Enrichment Learning for Learners with Physical Handicaps (SELPH), activities-based science programs for students with disabilities.

Two hands-on laboratory-based curriculum models are

- Science for All Children (SAC; Cawley, Miller, Sentman, & Bennett, 1993), which addresses four interrelated themes and thinking processes: systems, change, structure, and relationship, has been designed as a multiple-option curriculum for elementary-level students
and allows teachers to adapt the activities to the cognitive, cultural, language, and social-personal needs of their students.

* Applications in Biology/Chemistry (ABC; Prescott, Rinard, Cockerill, & Baker, 1996), which seeks to promote the science literacy skills of secondary students in the middle 50% range by linking science concepts to personal and societal contexts and the world of work. Through the use of real-world activities, job profiles, cooperative learning, learning-style adaptations, laboratory exercises, and hands-on activities, the ABC curriculum provides teachers with a framework for teaching science in context.

Science curricula and programs designed to address the needs of students from culturally and linguistically diverse backgrounds also are available:

- Finding Out/Descubrimiento (De Avila, 1988) is a collaborative learning, hands-on, problem-solving math and science program for second-language learners that includes materials in English and Spanish and pictorial directions.

- Beginning Science Equitably is an early childhood science program designed to provide teachers with developmentally appropriate lessons that help students, regardless of gender, race, disability, or socioeconomic status, to develop the visual-spatial, problem-solving, and decision-making skills that promote positive attitudes toward and future success in science. The program also includes a hands-on curriculum that introduces a variety of science concepts using the scientific method and a series of science activities that families can do to help their children learn about science.
1.5 LEARNING DIFFICULTIES IN SCIENCE

Students with learning difficulties (LD) frequently take general education science classes because their disabilities are very mild. Sometimes, however, it is difficult for students with LD to succeed in the classes and pass the related high-stakes assessments mandated by No Child Left Behind. In an article, the author reviewed the typical LD characteristics that interfere with science instruction and then present classroom modifications that are critical for students with LD and may also be valuable for all students in the class.

Students with the LD label have at least one low basic academic skill (reading, writing, or mathematics), which may interfere with their science learning (McNamara, 2007). A unit on energy that incorporates vocabulary terms such as nuclear fission, geothermal energy, and biomass fuel, may be challenging for students with reading problems. Students with writing problems may have difficulty completing homework assignments that require them to, for example, name body organs used for specific functions or describe the purposes of body tissues. Students with LD who have trouble in mathematics may struggle with comparing electronegativity and bonding types using a graphing calculator.

Other problems for students with LD include organization and attention (Lerner and Kline, 2006; McNamara, 2007). Typically, students with LD have difficulty completing long-term assignments, keeping track of daily work, and bringing home appropriate materials needed to study for tests. Students may have trouble maintaining focus during long class periods involving lectures, experiments, labs, and written work often required for science instruction.
Students may also have trouble reading continuously for the long periods of time required for homework assignments and test preparation.

These characteristics can make science instruction and testing a challenge for students with LD; however, with some basic modifications, students will have a better chance to succeed in science courses and on the highstakes tests that are now required.

**LD characteristics**

Although many students with LD have average to very high intelligence, they also exhibit behaviors that can interfere with performance in science. Students diagnosed with LD have at least one type of processing disorder (Lerner and Kline, 2006). Students with visual processing disorders have difficulty understanding presentations on the board, PowerPoint slides, overhead documents, or textbook graphics. Bar, circle, and line graphs that illustrate concepts such as population increase and decrease may present challenges for students with LD.

Students diagnosed with auditory processing problems, on the other hand, struggle with lectures, discussions, and group work. Memory disorders, typical characteristics of many students with LD (McNamara 2007), also interfere with science instruction and particularly with science testing. Although today’s science curriculum emphasizes inquiry and problem solving, memory skills provide a foundation for these higher-order tasks. For example, students with visual memory difficulties may have trouble learning the names of the bones in the
human skeleton by looking at an illustration, while students with auditory memory deficits may have trouble remembering what symbols and numbers in the periodic table represent after an oral review.

Classroom modifications

To help students with LD better learn science, teachers can implement basic modifications to their lectures, class time, textbook readings, homework assignments, and assessments. Details of these modifications are provided in the following paragraphs.

Lectures and class time

Before making classroom modifications, science teachers should begin by collaborating with special education teachers to plan appropriate strategies based on students' individual needs and then determine how each teacher will implement different parts of the lesson. In some cases, students will benefit from instruction in the general science classroom that is later clarified and reinforced by the special education teacher through additional discussion of key ideas in smaller groups (Morocco et al., 2006). In other situations, students may benefit from having both teachers in the science classroom coordinating instruction (Brigham et al., 2006).

For students with LD who have deficits in memory, attention, and organizational skills, it helps to focus lectures and class activities around unifying science themes. To emphasize key ideas, teachers can list major questions on the board at the start of a unit and then highlight the relationship of concepts to
the themes as students read their textbooks, engage in class discussions, and work on group activities (Morocco et al., 2006). Advance organizers with big ideas of central concepts clearly identified can also be used in study guides, graphic displays, charts, or orally in a discussion of key concepts (Friend and Bursuck, 2006). The National Science Education Standards emphasize major themes such as change, environment, and inquiry related to secondary science courses (NRC, 1996); themes that are more specific to each unit, such as pollution and conservation for a unit on water, can also be stressed. The use of key ideas narrows the focus, provides structure, and organizes a large amount of information. The themes are applicable across science subjects, and even other content subjects, and therefore provide review and repetition (Freund and Rich, 2005).

The incorporation of explicit instruction in an inquiry lesson can provide structure and support for students with LD who have organizational, attention, and memory deficits. Teachers can use prompts during a lecture, such as “an important point to remember” and “the next step in the experiment” (Friend and Bursuck, 2006). In addition, vocabulary can be clarified for students during tutoring sessions with a special education teacher or during class time if the preview is useful for all students (Morocco et al., 2006). In a lesson on cells, for example, a list of key terms—such as osmosis, diffusion, exocytosis, and endocytosis—may be listed on PowerPoint slides, the board, or on handouts with explanations and illustrations.
Special education teachers, tutors, or science teachers can provide everyday-life examples to connect new content to student experiences, thereby clarifying complex science material for students with processing and attention disorders (Morocco et al., 2006). The connections can be accomplished through discussion, simulations, videos, and brainstorming activities (Freund and Rich, 2005). For example, students could simulate a city election and give speeches with ideas to help a community deal with their land problems.

Note taking during lectures is a critical skill and often a problem for high school students with LD, especially those who have organizational, processing, and writing deficits. Special education teachers can provide study strategy instruction or teacher-made notes that focus on critical information. The notes can be in the form of outlines, PowerPoint slides, or lists of key ideas that will be covered (Brigham et al., 2006; Polloway, Patton, and Serna 2005). Teachers can demonstrate specific note-taking formats, such as two-column charts with one side for main topics and the other side for details and examples, and can also review notes and main ideas from the previous day at the beginning of class to help students organize their notes. During the lecture, teachers can provide organizational clues, such as verbal prompts signaling important information or repeating key ideas after a discussion to help students focus. Then at the end of class, teachers can remind students to review and revise notes that night or actually assign the task for part of their homework (Freund and Rich, 2005). Regular notebook checks can help teachers identify note-taking deficiencies and make suggestions for improvement.
Finally, group activities and projects during class time assist with memory and focus on main ideas in science lessons (Brigham et al., 2006). For example, students can work in groups to practice chemistry calculations, use formulas, and balance equations.

**Textbook readings**

In addition to the strategies for lecture and class time, modifications for reading assignments are valuable for students with low-level reading skills given the complexity of high school science textbooks. To help students with organization, teachers can point out specific textbook elements, such as summaries, introductory objectives, and questions (Polloway, Patton, and Serna, 2005). Introducing key ideas, reviewing prerequisite knowledge, clarifying the purpose of the chapters with advance organizers, and reviewing difficult and abstract scientific terms in the chapter are important strategies to use before students read assigned chapters (Friend and Bursuck, 2006). After reading, teachers can summarize and review the key ideas, including complicated charts and figures, and show students how to use mnemonic strategies when text material has to be memorized (Polloway, Patton, and Serna, 2005).

With very difficult chapters, it helps to provide students with chapter notes. Students can then focus their attention on learning the material rather than struggling with the textbook chapters (Brigham et al., 2006). The notes can be organized around key questions, topics, or summary statements about the most important content in the chapter (Polloway, Patton, and Serna 2005). Although
the notes take time to prepare, they can be used in subsequent years. Special education teachers can also assist by making the chapter notes in advance.

**Homework assignments**

Special education and science teachers can modify homework assignments to assist students with processing, memory, or attention problems by ensuring that directions are clear and by providing oral and written explanations of specific requirements (Polloway, Patton, and Serna 2005). Special education teachers can assist with homework during class instructional time to provide extra support on an individual or small-group basis (Brigham et al., 2006). Special education teachers can also help monitor homework progress, check and edit drafts, and ensure that tasks are accomplished prior to deadlines (Polloway, Patton, and Serna 2005). If all students in the class will benefit, science teachers can allocate class time for students to begin complex and long-term assignments with guidance (Morocco et al., 2006). Breaking down assignments into smaller segments with intermediate due dates is also helpful for students with attention and organizational deficits (Freund and Rich 2005).

Smith, Dittmer, and Skinner (2002) suggested teaching self-management interventions for students with LD to improve their science homework. An example is the “cover, copy, and compare” strategy in which students first preview the material and cover up the part to be studied, then write out (copy) what the information means, and finally compare to the actual material for accuracy. Students repeat the three steps until achieving mastery.
Assessment

Students can practice test-taking strategies for highstakes science tests and to enhance performance on teacher-made assessments. Encouraging students to organize specific study time is the first step for assisting with science comprehension and test preparation. Teachers can model a review for students during class time to get them started (Bos and Vaughn, 2006). This review is valuable for students with memory, attention, and organizational problems and also provides a model for strong science students to reinforce study strategies for college.

At the beginning of standardized tests, students should be encouraged to preview the entire test so they can plan their time for all sections (Bos and Vaughn, 2006). This strategy is important for students with attention and organizational problems who may get started on one section of the test and perseverate so that they leave later questions unanswered. Another initial strategy for both classroom and end-of-the-year assessments is for students to analyze the directions carefully. Teachers can emphasize key vocabulary words that are likely to appear in directions and focus on examples of typical directions for different formats. Teachers can discuss, for example, the difference between list, compare, and explain, and then encourage students to underline such words as they read the directions during the test (Freund and Rich, 2005). At the beginning of the test, students, especially those with memory deficits, should record formulas, mnemonics, or lists they have memorized so they will be available as needed (Bos and Vaughn 2006).
During the tests, students with organizational, attention, and processing problems should not spend too much time on difficult items initially or they may not get to items that they have a chance to answer correctly—a check mark next to the difficult item will remind them to try again later if there is time (Bos and Vaughn, 2006).

Practice with specific strategies for each type of question (e.g., multiple choice, essay, true-false) will also help students with LD feel more confident and work more effectively. Students can learn to look for key words in true-false and multiple-choice items and eliminate answers that cannot possibly be correct to narrow the options. Students can practice using a particular pattern for essays, such as an introductory paragraph with a thesis statement, three developing paragraphs with details to support, and a conclusion summing up the topic. Finally, students with writing and processing deficits should attempt to save time at the end of the test to review responses and edit essays (Bos and Vaughn 2006).

These strategies are valuable for science assessments and for other subjects as well. In addition, the strategies may improve memory, organization, focus, time management, and ability to follow directions, which are useful for other tasks in high school, college, and everyday life.

1.6 OVERCOMING OF LEARNING DIFFICULTIES

1.6.1 Understanding Students Learning Difficulties

As long as the focus of learning remains a well-organized presentation of complex and stimulating ideas, and the work assigned encourages critical
thought and reasoning, Understanding learners’ abilities to attend to presentations, read and examine texts, and concentrate on the demands of the work at hand can be truly extraordinary. But when ideas become basic or poorly organized, when questioning is not allowed or encouraged, when the subject under discussion revolves around personal feelings or experiences, when the work assigned resembles drill and practice more than discussion, debate, or critique, the Understanding learner’s attention begins to wane, motivation erodes, and they may:

- Withdraw from classroom participation, preferring the stimulation of their own thoughts.
- Increase the questions or challenges to the teacher in an attempt to provoke an intellectual response they can grasp and use to focus their attention.
- Become intolerant of the contributions of their classmates and others, using condescension or sarcasm to communicate their distaste for others’ ideas.

In general, Understanding learners like to be engaged in critical thinking and academic learning. When they withdraw from learning, many of their problems can be addressed cognitively according to four basic principles:

1. Increase the intellectual content of the curriculum and the complexity of the thinking tasks assigned.
2. Provide clear reasons for routine work and a system that permits Understanding learners to measure and assess their own progress in these areas.
3. Where the curriculum calls for exploration of personal experiences and feelings, use of physical equations, or cooperative groupwork, model explicitly how this work is done but also permit discussion of why it is important.

4. Emphasize the role of reflection in deep learning. Model and practice with students how to become aware of the processes of thinking and attention they are using in solving problems or collecting information.

**Learners with Attention:** Problems in paying and keeping attention for the Understanding learner usually occur when they perceive what they are learning as overly basic, when they are asked to discuss personal feelings, when they are not encouraged to ask questions about content, or when they feel it is time to move on and learn new information instead of stopping to practice previous learning. The possible solutions are as follows:

- Begin lessons by focusing on intellectual content.
- Use questions and provocations to stimulate thought and expose complexities.
- Design assessment tasks that require a questioning attitude on the part of students, and that provoke them to analyze, interpret, and organize complex ideas and data.
- Present information in the form of rigorous texts and challenging lectures, but balance this with extensive analytical work, guiding students to constructing and critiquing their own theories through investigation, experimentation, discussion, and debate.

The following are some of the avoidable items:

- Reducing the role of cooperation and of exploring concerns.
**Learners with Reading:** Reading is a highly preferred mode of learning for most Understanding learners. The ability to set their own pace, question, reread, criticize, and organize their thoughts while they read gives them a sense of control over learning that they cannot always exercise during classroom lectures, practice sessions, or discussions. The precision and accuracy of their thoughts, combined with their affection for academic content, makes even some relatively routine reading tasks (such as note taking and answering questions at the ends of chapters) relatively easy and comfortable for them to perform. It goes without saying that they tend to relish reading tasks they see as more demanding—those requiring critical thinking or analysis. In addition, they tend to be sensitive to text structure and can readily apply this awareness to the task of identifying the central concepts and important details. Even when reading literature—as long as the text is rigorous and demanding—they show a marked talent for reading, organizing, and responding to texts in an academic manner. However, when texts become more basic or repetitive, when the details outweigh the ideas, when the questions take on a fill-in-the-blank quality or the content dwells too long on human feelings, Understanding students become restive. Without the guidance of ideas and questions to focus their attention they lose their way, gloss over vital details, and too often believe they have understood a text when they have merely grasped a few basic ideas. The following are some possible solutions:

- In the early phases, maximize the use of nonfiction texts in which a position is argued or an opinion is stated. Gradually shift student reading to more information-rich texts and those that explore and deal with human feelings and experiences.
• Organize reading work around essential questions that provoke deeper thought and serve as organizers for ideas and details in the reading.

• Explicitly model and regularly practice:
  • How to select and record key details in reading.
  • How to infer characters’ feelings and motivations.
  • How to infer author’s purpose and technique.

• Provide modeling, practice, and discussion for interpersonal skills required for cooperative group work.

The following are some of the avoidable items in reading practice:

• Over involvement in routine drill work or “basic content.” Understanding learners acquire their foundations by working down from the top floors, not up from the basement.

**Learners with Writing:** Many Understanding learners write extremely well, if somewhat more slowly than some of their classmates. Their abilities to conceptualize and build their own organizational systems and tools provide them with a support system that makes them appear as naturally academic writers. In addition, their ability to focus on patterns and think through the implications and applications of rules and generalizations frequently turns them into remarkably good spellers and grammarians; that is, if their own distaste for routine or classrooms overly driven by drill and practice do not combine to make them careless or inattentive. However, more routine forms of writing (e.g., letters and summaries) and writing based on personal experience or feelings surprisingly elude Understanding students’ talents in other areas. Finally, strong
Understanding learners sometimes produce writing that is too full of ideas. Focusing entirely on the academic content they wish to communicate and without the feelings to guide them to their readers’ needs, some Understanding writers write prose rich in abstraction but lacking the elaboration readers need to understand what they mean. The following are some of the solutions for writing in learning difficulties:

- Begin writing instruction with pieces that ask students to argue a point and report on information collected and organized around questions they have designed.
- Use the ideas of claim, evidence, counterargument, and response to organize student writing.
- Use samples of high, medium, and low work in more routine writing forms (letters and reports) or more personal or creative writing to help Understanding learners analyze what excellence looks like in those areas.
- Provide audiences for Understanding students’ writing from learning styles not their own, especially Interpersonal learners. Audiences can help the Understanding writer identify when his writing is insufficiently clear and what can be done to increase the warmth and persuasiveness of his prose.
- Organize students into “correspondence teams” where they write—but do not talk—to each other. Exploring the same issue or topic, they stage a written debate in which each side reads, writes, and argues with the other’s written stance. (This can also be done successfully through e-mail.)
The following are some of the avoidable items in writing practice:

- Focusing exclusively on academic and analytical writing. It is the creative and personal elements of writing where most Understanding learners need work.

**Learners with Homework:** For most Understanding learners, homework is little or no problem—except occasionally in those situations where the work assigned primarily focuses on practicing routine skills and information previously taught and practiced in class. Possible solutions for doing homework for learning difficulty students:

- Teach students how to measure and reread progress in routine skills using charts and graphs of their own design.
- Use excerpts from adult journals (e.g., from artists and scientists) to provide models of what excellent reflection looks like.
- For skill work, allow students to choose the level they wish to work at. Instead of assigning large numbers of problems, allow students to work on as many as they need to show their mastery, but ask them to explain how their work demonstrates mastery.

The following are some of the avoidable items in doing homework:

- Focusing homework exclusively on skill building and critical thinking. Challenge Understanding learners to begin taking a more creative or personal approach to independent work.

### 1.7 TEACHER ROLE IN STUDENT LEARNING

Learning and effective teaching are both highly complex acts. Leinhardt and Leinhardt, G. & Greeno, J.G. (1986) write that "teaching occurs in a relatively
ill-structured, dynamic environment”. Classroom conditions change in unpredictable ways, and information arises during the act of teaching that by necessity must inform practice as it occurs. While this is true of all teaching, it is all the more so when effectively teaching science through inquiry. This, in part, may explain the all too common practices of lecturing, textbook assignments, worksheets, and cookbook activities in science teaching. Each of these approaches severely constrains students' input into a lesson and reduces the complexities in teaching. Teaching science through inquiry is more complex because through that approach students' misconceptions and thinking spill out into the classroom. Ironically, this increased complexity sets the stage for promoting learning because in expressing their misconceptions and thinking, students are more mentally engaged and teachers begin to understand and thus can better respond to students' misunderstandings.

Prefabricated direct experience cookbook laboratory activities are enticing to both teachers and students because in making most all the conceptual decisions for students, complexity is significantly reduced. However, as noted earlier, without significant decision making students are not encouraged to be mentally active, express their thinking, and face head on the inadequacies of their initial ideas.

What this means is that hands-on experiences, by themselves, are insufficient for helping students understand the scientific community's explanation for natural phenomena. Pre-fabricated cookbook activities, so ubiquitous in science teaching, rarely engage students in ways necessary to
facilitate such an understanding. As Bransford et al. (2000) write, “Hands-on experiments can be a powerful way to ground emergent knowledge, but they do not alone evoke the underlying conceptual understandings that aid generalization” (p. 22). Students must also be mentally engaged, and teaching science through inquiry demands that mental engagement.

The increased complexities inherent in effective teaching make apparent the crucial role of teachers in teaching and learning through inquiry. Teachers exert the greatest influence in the classroom through the way in which they engage students in the curriculum. However, the overwhelming layered complexities of learning and teaching often cloud the value of important findings regarding the teacher's role in creating powerful learning experiences for children. Teachers must deliberately create interactions with students (at times in a whole class setting and at other times in small groups or individually with students) that draw out students' thinking. As students express their ideas and rationale for them, teachers must think of questions or experiences that will help students scaffold to desired understandings. These crucial decisions must often be made on the fly in the act of teaching. No wonder so many science teachers resist teaching through inquiry.

How teachers interact with students—the behaviors they exhibit to draw out and play off students' ideas—is crucial for helping students abandon misconceptions and make desired connections. Too often teachers are provided foggy characterizations of their role (e.g. “facilitator,” “guide at the side,” and “giving students opportunities to construct”). Such ambiguity obscures the
importance of decisions teachers must consider and the intricate behaviors they must implement to shape classroom experiences that promote desired science education goals. This in turn interferes with teacher education efforts as teachers are presented with black boxes and vague generalizations that provide little guidance in efforts to improve practice.

Osbourne and Freyberg (1983) suggested varied roles for teachers using constructivist approaches to teach children about science. These roles included those of motivator, diagnostician, guide, innovator, experimenter, and researcher. Jake adopted these same roles at various times. However, Jake took on additional roles that implied an even more complex look at what it means to be a teacher in an inquiry-based classroom. The ten roles that Jake assumed and evidence from the data included the following:

(1) The role of motivator involves the teacher encouraging students to take responsibility for their own learning. When describing his teaching Jake stated that, "we try to build them up all the time, and say, you know, you guys are sharp people, and we're depending on you to do this accurately and well, so what do we need to think about here when we're designing this?" Jake's students acknowledged their teacher's role of motivator as illustrated by these written comments: "You enjoy teaching ecology and this is very apparent when you teach. Your enthusiasm is contagious"; and "I liked the fact that you are interested in what you teach and your enthusiasm rubs off on us."

(2) The role of diagnostician involves the teacher giving students opportunity to express ideas in order to discern their understandings. Evidence from Jake's teaching illustrating his role of diagnostician includes this description:
In the beginning of a lesson after the Mary's River field trip Jake asked students, "Would you write down a paragraph, sort of reflection, on the experience. It could be scientific, the feeling you got, ecologically. It could also be related to how the class worked." In describing the lettuce project Jake stated, "I mean, I am always evaluating them out there (in the garden) trying to ask them questions when they're doing things, asking them what they are doing it, and why they are doing it."

(3) The role of guide involves the teacher directing students and helping them develop strategies. This incident illustrates Jake's role as guide: During analysis of the Mary's River samples, Jake led students in critiquing the bacterial counts. When asked if they should throw out the high count, one student suggested putting an asterisk by it. Jake agreed that throwing out the high count might skew the results. Then Jake continued his guidance with a follow-up question.

(4) The role of innovator involves the teacher designing instruction by using new ideas. Evidence of Jake taking the role of innovator includes this example from his philosophy statement. "Basically we want to draw them into some kind of meaningful study where they're doing something that is real . . . I want them to be involved in a project where they're doing science, and they're developing as a scientist as they go." Jake's students' perceptions of the impact of Jake's ideas on instruction are represented by this student's statement. Karen stated, "There're so many new things coming up, and he's always passing them out to us. He's always informed, and going to meetings and whatever."

(5) The role of experimenter involves the teacher trying out new ways to teach and assess students. This statement illustrates Jake's role as
experimenter. During an interview Jake explained that he had questioned the owner of the gourmet lettuce farm on how they determined the best varieties for production. Jake developed the idea to have his students involved in testing different lettuce varieties. Jake stated, "I thought that maybe we ought to try that too, and have the kids actually evaluate them."

(6) The role of researcher involves the teacher evaluating his or her own teaching and engaging in solving problems. Evidence from the data of Jake taking the role of researcher includes the following: Jake frequently asked his students for feedback on his instruction, both in writing and during individual and group conversations. In this way Jake researched his own teaching and modified his teaching as he received feedback.

(7) The role of modeler involves the teacher showing the attitudes and attributes of scientists by example. This particular role is one identified by Jake. Examples from his teaching confirmed adopting this role. Following is an example: During a lesson prior to the data collection field trip to Kiger Island, Jake stated: "It is really going to be interesting to get some data and to get some base line data for comparison, might give us some ideas for questions we might want to ask further, might give us some indications as to what kind of condition the river is in . . . I really have no idea. I don't really know what we're going to find out." Students confirmed Jake's role as modeler as illustrated by this written statement from the questionnaire: "I liked it even when you were in pain with your back, you still had a positive attitude and gave us your best."

(8) The role of mentor involves the teacher-supporting students in learning about scientific work. Evidence from students' questionnaires revealed that they viewed their teacher as knowledgeable and capable. For example, one student
wrote, ``You are there to help us when we need it. And try to give us work to make us think and do well.'' Another student stated during an interview, ``Mr. M. obviously knows what he is doing, and so that helps. So if we have a question, we can ask him, and if he doesn't know the answer, you know, he'll tell us where we can go...he has a lot of background on a lot of different subjects.''

(9) The role of collaborator involves the teacher and students exchanging ideas, and allowing students to take on the role of teacher. An example of Jake's relinquishing his role as director of instruction is illustrated by this incident: During one of the pre-Kiger Island lessons, Jake delegated the responsibility for organizing the important data collection trip to the second year students. ``You veterans will go back in my office and you will plan the field trip for next Wednesday.''

(10) The role of learner involves the teacher opening oneself to learning new concepts. Students in Jake's class recognized his openness to learning new ideas and taking the role of learner. An example of students' views of their teacher as learner is illustrated by this written comment from one of the student questionnaires: "You are like a student yourself, always curious and wanting to learn."

1.7.1 Teaching and Nature of Scientific Inquiry

Science, mathematics, and technology are defined as much by what they do and how they do it as they are by the results they achieve. To understand them as ways of thinking and doing, as well as bodies of knowledge, requires that students have some experience with the kinds of thought and action that are
typical of those fields. Therefore, the teachers should employ the following techniques.

(a) **Start with Questions about Nature**: Sound teaching usually begins with questions and phenomena that are interesting and familiar to students, not with abstractions or phenomena outside their range of perception, understanding, or knowledge. Students need to get acquainted with the things around them—including devices, organisms, materials, shapes, and numbers—and to observe them, collect them, handle them, describe them, become puzzled by them, ask questions about them, argue about them, and then to try to find answers to their questions.

(b) **Engage Students Actively**: Students need to have many and varied opportunities for collecting, sorting and cataloging; observing, note taking and sketching; interviewing, polling, and surveying; and using hand lenses, microscopes, thermometers, cameras, and other common instruments. They should dissect; measure, count, graph, and compute; explore the chemical properties of common substances; plant and cultivate; and systematically observe the social behavior of humans and other animals. Among these activities, none is more important than measurement, in that figuring out what to measure, what instruments to use, how to check the correctness of measurements, and how to configure and make sense out of the results are at the heart of much of science and engineering.
(c) **Concentrate on the Collection and Use of Evidence**: Students should be given problems—at levels appropriate to their maturity—that require them to decide what evidence is relevant and to offer their own interpretations of what the evidence means. This puts a premium, just as science does, on careful observation and thoughtful analysis. Students need guidance, encouragement, and practice in collecting, sorting, and analyzing evidence, and in building arguments based on it. However, if such activities are not to be destructively boring, they must lead to some intellectually satisfying payoff that students care about.

(d) **Provide Historical Perspectives**: During their school years, students should encounter many scientific ideas presented in historical context. It matters less which particular episodes teachers select than that the selection represent the scope and diversity of the scientific enterprise. Students can develop a sense of how science really happens by learning something of the growth of scientific ideas, of the twists and turns on the way to our current understanding of such ideas, of the roles played by different investigators and commentators, and of the interplay between evidence and theory over time. History is important for the effective teaching of science, mathematics, and technology also because it can lead to social perspectives—the influence of society on the development of science and technology, and the impact of science and technology on society. It is important, for example, for students to become aware that women and minorities have made significant contributions in spite of the barriers put in their way by society; that the roots of science, mathematics, and technology go back
to the early Egyptian, Greek, Arabic, and Chinese cultures; and that scientists bring to their work the values and prejudices of the cultures in which they live.

(e) **Insist on Clear Expression**: Effective oral and written communication is so important in every facet of life that teachers of every subject and at every level should place a high priority on it for all students. In addition, science teachers should emphasize clear expression, because the role of evidence and the unambiguous replication of evidence cannot be understood without some struggle to express one’s own procedures, findings, and ideas rigorously, and to decode the accounts of others.

(f) **Use a Team Approach**: The collaborative nature of scientific and technological work should be strongly reinforced by frequent group activity in the classroom. Scientists and engineers work mostly in groups and less often as isolated investigators. Similarly, students should gain experience sharing responsibility for learning with each other. In the process of coming to common understandings, students in a group must frequently inform each other about procedures and meanings, argue over findings, and assess how the task is progressing. In the context of team responsibility, feedback and communication become more realistic and of a character very different from the usual individualistic textbook-homework-recitation approach.

(g) **Do Not Separate Knowing from Finding Out**: In science, conclusions and the methods that lead to them are tightly coupled. The nature of inquiry depends on what is being investigated, and what is learned depends on the
methods used. Science teaching that attempts solely to impart to students the accumulated knowledge of a field leads to very little understanding and certainly not to the development of intellectual independence and facility. But then, to teach scientific reasoning as a set of procedures separate from any particular substance—"the scientific method," for instance—is equally futile. Science teachers should help students to acquire both scientific knowledge of the world and scientific habits of mind at the same time.

(h) **Deemphasize the Memorization of Technical Vocabulary:**
Understanding rather than vocabulary should be the main purpose of science teaching. However, unambiguous terminology is also important in scientific communication and—ultimately—for understanding. Some technical terms are therefore helpful for everyone, but the number of essential ones is relatively small. If teachers introduce technical terms only as needed to clarify thinking and promote effective communication, then students will gradually build a functional vocabulary that will survive beyond the next test. For teachers to concentrate on vocabulary, however, is to detract from science as a process, to put learning for understanding in jeopardy, and to risk being misled about what students have learned.

1.7.2 **Science Teaching should Reflect Scientific Values**
Science is more than a body of knowledge and a way of accumulating and validating that knowledge. It is also a social activity that incorporates certain human values. Holding curiosity, creativity, imagination, and beauty in high esteem is certainly not confined to science, mathematics, and engineering—any
more than skepticism and distaste for dogmatism are. However, they are all highly characteristic of the scientific endeavor. In learning science, students should encounter such values as part of their experience, not as empty claims. This suggests that teachers should strive to do the following:

(a) Welcome Curiosity: Science, mathematics, and technology do not create curiosity. They accept it, foster it, incorporate it, reward it, and discipline it—and so does good science teaching. Thus, science teachers should encourage students to raise questions about the material being studied, help them learn to frame their questions clearly enough to begin to search for answers, suggest to them productive ways for finding answers, and reward those who raise and then pursue unusual but relevant questions. In the science classroom, wondering should be as highly valued as knowing.

(b) Reward Creativity: Scientists, mathematicians, and engineers prize the creative use of imagination. The science classroom ought to be a place where creativity and invention—as qualities distinct from academic excellence—are recognized and encouraged. Indeed, teachers can express their own creativity by inventing activities in which students' creativity and imagination will pay off.

(c) Encourage a Spirit of Healthy Questioning: Science, mathematics, and engineering prosper because of the institutionalized skepticism of their practitioners. Their central tenet is that one's evidence, logic, and claims will be questioned, and one's experiments will be subjected to replication. In science
classrooms, it should be the normal practice for teachers to raise such questions as: How do we know? What is the evidence? What is the argument that interprets the evidence? Are there alternative explanations or other ways of solving the problem that could be better? The aim should be to get students into the habit of posing such questions and framing answers.

(d) **Avoid Dogmatism**: Students should experience science as a process for extending understanding, not as unalterable truth. This means that teachers must take care not to convey the impression that they themselves or the textbooks are absolute authorities whose conclusions are always correct. By dealing with the credibility of scientific claims, the overturn of accepted scientific beliefs, and what to make out of disagreements among scientists, science teachers can help students to balance the necessity for accepting a great deal of science on faith against the importance of keeping an open mind.

(e) **Promote Aesthetic Responses**: Many people regard science as cold and uninteresting. However, a scientific understanding of, say, the formation of stars, the blue of the sky, or the construction of the human heart need not displace the romantic and spiritual meanings of such phenomena. Moreover, scientific knowledge makes additional aesthetic responses possible—such as to the diffracted pattern of street lights seen through a curtain, the pulse of life in a microscopic organism, the cantilevered sweep of a bridge, the efficiency of combustion in living cells, the history in a rock or a tree, an elegant mathematical proof. Teachers of science, mathematics, and technology should establish a learning environment in which students are able to broaden and deepen their
response to the beauty of ideas, methods, tools, structures, objects, and living organisms.

1.7.3 Science Teaching and Learning Anxieties

Teachers should recognize that for many students, the learning of mathematics and science involves feelings of severe anxiety and fear of failure. No doubt this results partly from what is taught and the way it is taught, and partly from attitudes picked up incidentally very early in schooling from parents and teachers who are themselves ill at ease with science and mathematics. Far from dismissing math and science anxiety as groundless, though, teachers should assure students that they understand the problem and will work with them to overcome it. Teachers can take such measures as the following:

(a) Build on Success: Teachers should make sure that students have some sense of success in learning science and mathematics, and they should deemphasize getting all the right answers as being the main criterion of success. After all, science itself, as Alfred North Whitehead said, is never quite right. Understanding anything is never absolute, and it takes many forms. Accordingly, teachers should strive to make all students—particularly the less-confident ones—aware of their progress and should encourage them to continue studying.

(b) Provide Abundant Experience in Using Tools: Many students are fearful of using laboratory instruments and other tools. This fear may result primarily from the lack of opportunity many of them have to become familiar with tools in safe circumstances. Girls in particular suffer from the mistaken notion that
boys are naturally more adept at using tools. Starting in the earliest grades, all students should gradually gain familiarity with tools and the proper use of tools. By the time they finish school, all students should have had supervised experience with common hand tools, soldering irons, electrical meters, drafting tools, optical and sound equipment, calculators, and computers.

(c) **Support the Roles of Girls and Minorities in Science**: Because the scientific and engineering professions have been predominantly male and white, female and minority students could easily get the impression that these fields are beyond them or are otherwise unsuited to them. This debilitating perception—all too often reinforced by the environment outside the school—will persist unless teachers actively work to turn it around. Teachers should select learning materials that illustrate the contributions of women and minorities, bring in role models, and make it clear to female and minority students that they are expected to study the same subjects at the same level as everyone else and to perform as well.

(d) **Emphasize Group Learning**: A group approach has motivational value apart from the need to use team learning (as noted earlier) to promote an understanding of how science and engineering work. Overemphasis on competition among students for high grades distorts what ought to be the prime motive for studying science: to find things out. Competition among students in the science classroom may also result in many of them developing a dislike of science and losing their confidence in their ability to learn science. Group approaches, the norm in science, have many advantages in education; for
instance, they help youngsters see that everyone can contribute to the attainment of common goals and that progress does not depend on everyone’s having the same abilities.

1.7.4 Science Teaching Beyond the School

Children learn from their parents, siblings, other relatives, peers, and adult authority figures, as well as from teachers. They learn from movies, television, radio, records, trade books and magazines, and home computers, and from going to museums and zoos, parties, club meetings, rock concerts, and sports events, as well as from schoolbooks and the school environment in general. Science teachers should exploit the rich resources of the larger community and involve parents and other concerned adults in useful ways. It is also important for teachers to recognize that some of what their students learn informally is wrong, incomplete, poorly understood, or misunderstood, but that formal education can help students to restructure that knowledge and acquire new knowledge.

1.7.5 Teaching and Learning Science Requires Time

In learning science, students need time for exploring, for making observations, for taking wrong turns, for testing ideas, for doing things over again; time for building things, calibrating instruments, collecting things, constructing physical and mathematical models for testing ideas; time for learning whatever mathematics, technology, and science they may need to deal with the questions at hand; time for asking around, reading, and arguing; time for wrestling with unfamiliar and counterintuitive ideas and for coming to see the advantage in thinking in a different way. Moreover, any topic in science, mathematics, or
technology that is taught only in a single lesson or unit is unlikely to leave a trace by the end of schooling. To take hold and mature, concepts must not just be presented to students from time to time but must be offered to them periodically in different contexts and at increasing levels of sophistication.

1.8 STATEMENT OF THE TOPIC

Statement of the present topic is “AN INVESTIGATION TO IDENTIFY THE LEARNING DIFFICULTIES IN SCIENCE AMONG THE SECONDARY SCHOOL STUDENTS”.

1.9 NEED AND SIGNIFICANCE OF THE STUDY

It is clearly observed that there are students with various levels of learning difficulties in a normal classroom. This results in some kind of learning difficulties among students in science. These difficulties may be general i.e., in all academic achievements or in specific areas, such as reading, writing, arithmetic, communication and expression skills. At present in our classrooms there is no systematic survey of these learning difficulties. Even when teacher come across with this kind of areas in any case neither the teacher is aware of these learning difficulties nor have any account of intervention programs.

The present research is to make an attempt for systematic assessment of learning difficulties in science to help the secondary school teachers in
identifying the difficulties and help the students to overcome the same, which explain the significance on the present study.

1.10 OBJECTIVES

1. To identify the learning difficulties in science among secondary school students.

2. To compare the responses of the teachers about learning difficulties in science among secondary schools students with reference to gender, management of the school, locality, qualification and experience.

3. To suggest measures to overcome learning difficulties in science.

4. To suggest measures to prevent learning difficulties in science.

1.11 HYPOTHESES

1. There is no significant difference between male and female teachers with regard to their responses about learning difficulties in science among the secondary school students.

2. There is no significant difference between government and private school teachers with regard to their responses about learning difficulties in science among the secondary school students.
3. There is no significant difference between rural and urban teachers with regard to their responses about learning difficulties in science among the secondary school students.

4. There is no significant difference between the teachers with UG and PG qualifications (academic qualification) with regard to their responses about learning difficulties in science among the secondary school students.

5. There is no significant difference between the teachers with B.Ed. and M.Ed. qualifications (Professional qualification) with regard to their responses about learning difficulties in science among the secondary school students.

6. There is no significant difference between below 10 years experience and above 10 years experience teachers with regard to their responses about learning difficulties in science among the secondary school students.

1.12 LIMITATIONS OF THE STUDY

1. The study is limited to Mahabubnagar and Ranga Reddy districts of Andhra Pradesh.

2. The study is confined to secondary school teachers’ responses only.
3. The study is limited to government and private unaided schools with regard to management of schools covered.

4. The study is confined to Learning Difficulties in general science (physical and biological) subject only.

5. The sample is drawn from urban and rural areas only.