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Chapter – I

INTRODUCTION

“There is a single light of science, and to brighten it anywhere is to brighten it everywhere.”
Isaac Asimov (January 2, 1920 – April 6, 1992)

“Through science, we can build not only a pipeline of future scientists, engineers, and doctors, but also create a society of well-informed leaders in business, law, and politics.” (Ann Lee-Karlon, Senior Vice President, Portfolio Management and Operations, Genentech -2013.)

Science has the capability to improve our lives. It is believed that the science of this 21st century will be more and more unified - global issues asking for answers from across the spectrum of knowledge and research, ideas and technologies integrated to provide global solutions. The 21st century is going to need various scientific solutions to a big range of issues, from global warming to food security, and from fighting crime to developing new medicines. Science is a fundamental feature of modern day society and understanding how science works and applying scientific methods to challenges in everyday life are key skills that we all need. How else can we decide whether to eat genetically modified food, assess how our lifestyle might be contributing to global warming, evaluate the real issues associated with cloning, or decide on the effectiveness of the latest fitness fad, and answer of all questions given by only scientifically literate personnel which is possible only through providing science education with an innovative approach of scientific literacy.

1.1 Concept of Literacy

Literacy is phase of human understandings, when he or she tries to relate the facts happening around with the knowledge acquired. It is an ability of a human being. For most of its history in English, the word ‘literate’ meant to be ‘familiar with literature’ or, more generally, ‘well educated, learned. (Education for All Global Monitoring Report, 2006).

Literacy has many forms like recognizing words, able to write symbols etc. At first sight ‘literacy’ seems to be a very simple term that everyone understands. But at the same time, literacy as a concept has appeared to be a complex and dynamic term, can be interpreted and defined in a multiple ways. It is always seen the people’s thinking about the meaning of to be literate or illiterate is influenced by academic research, institutional agendas, national context, cultural values and personal experiences. Literacy as a simple process of acquiring basic cognitive skills and using these skills to contribute in socio-economic development as well as developing the capacity for social awareness.
Some years back in past common people where not much exposed to science and technology even many of them not having interest in such things. In that era literacy is merely an ability to read and write, understands symbols, boards that’s it, which was enough for some people of society who wants to continue their routine life without much change.

Till man was not invented to write, the basic level of literacy is to observe the facts. But after the invention of writing the concept of literacy changed and, reading and writing were became basic levels of literacy. Even though writing was there, but the writing instruments, printing was not so developed, hence writing and reading was became the property of people who can afford it. As printing technology advanced more and more, ample amount of affordable writing material available in market, the definition of literacy is changed those who can read & write symbols, words were considered to be literate.

1.1.2 Literacy in Technological Context

But new idea of literacy is not only understanding but also implementation of decisions using literacy. Many self-help groups conduct literacy programs for childcare, sanitation etc. in villages, means they add a definite subject training along with traditional literacy programs.

If we see the history of literacy, there is always an impact of technological inventions. Now there is not mere language literacy but computer literacy, health literacy, chemo literacy and so many literacies have been introduced. This means that technological advances have affected to traditional definition of literacy. Now people are using cell phones, watches satellite TV programmes, can see news happening in New York at other part of the country. These all facts directly impact on change in thinking of human being. Literacy should be now such that person can now learn to use the simple technologies available in market.

In modern context literacy should have adequate level of communication so that one can express thoughts in literate society; this helps one to be a part of literate society.

1.1.3 Changing Concept of Literacy

“We no longer discuss the future of India. We say the future is India" said the Indian Commerce and Industry Minister at the conference organized by the US-India Business Council in 2004. He predicted that India would certainly have achieved 100% literacy, become a developed country; enjoy the same fundamentals as the United States by 2030.

This means that world looking towards India as an emerging world power. But to be a world power what our country should have so that it can able to lead other countries?. To be a powered country of future we need to have highest literacy rate. Literacy is a basic need and need to be fulfilled to be India as a super power.
Taking into account the growing complexity of our world, caused by the opening of national borders and by almost infinite electronic communication and the increasing speed of global ecological, economic and political changes, number one of the educational challenges of the next century seems to be: high flexibility, both in storing and using knowledge and in international communication. (NSSE, 1947, p. 20)

Since the late nineteenth century it was referred to the abilities to read and write text, while maintaining its broader meaning of being ‘knowledgeable or educated in a particular field or fields’. Thus, the original meaning of the English word ‘literacy’ is different from its translations in several other languages. Since the mid-twentieth century, scholars have dedicated considerable attention to defining literacy, and their work has had direct implications for approaches to practice and policy (Fransman, 2005).

Wide-ranging disciplines such as psychology, economics, linguistics, sociology, anthropology, philosophy and history have engaged in an ongoing and, at times, highly contested debate over the meaning and definition of the term ‘literacy’ and how it is related to the broader notions of education and knowledge. Taking into account these evolving debates, including the major traditions, critiques and approaches to literacy, there are four discrete realizations of literacy:

- literacy as an autonomous set of skills;
- literacy as applied, practiced and situated;
- literacy as a learning process;
- literacy as text.

These broad areas of enquiry accommodate almost all theoretical understandings of literacy. (Education for All Global Monitoring Report, 2006).

In 2002, the United Nations declared 2003-2012 the United Nations Literacy Decade. Resolution 56/116 acknowledged the place of literacy at the heart of lifelong learning, affirming that: ‘literacy is crucial to the acquisition, by every child, youth and adult, of essential life skills that enable them to address the challenges they can face in life, and represents an essential step in basic education, which is an indispensable means for effective participation in the societies and economies of the twenty-first century’ (United Nations, 2002b).

The Resolution also embraced the social dimension of literacy, recognizing that ‘creating literate environments and societies is essential for achieving the goals of eradicating poverty, reducing child mortality, curbing population growth, achieving gender equality and ensuring sustainable development, peace and democracy.’ UNESCO emphasizes the goal of universal literacy under the motto ‘Literacy as Freedom,’ reflecting the evolution of the conception of literacy: beyond its simple notion as the set of technical skills of reading, writing and calculating, to a plural notion encompassing the manifold meanings and dimensions of
these undeniably vital competencies. Such a view, responding to recent economic, political and social transformations, including globalization, and the advancement of information and communication technologies, recognizes that there are many practices of literacy embedded in different cultural processes, personal circumstances and collective structures (UNESCO, 2004b).

"Literacy skills for the twenty-first century are skills that enable participation in the new communities emerging within a networked society. They enable students to exploit new simulation tools, information appliances and social networks; they facilitate the exchange of information between diverse communities and the ability to move easily across different media platforms and social networks."

(Jenkins et al, 2006, p. 55)

1.1.4 Literacy and Education

All the explanation given above clearly means that literacy empowers human being to be on the same pedestal as the society in which he lives. In a world where information comes mostly through the written medium this is a rather crucial ability for anyone. Being literate is indispensable. But literacy is not the end of learning process but it drives one towards education. And hence being literate is not the same as being educated. Education is more of a process than an ability.

It's a loop: observe -> learn -> understand -> apply -> observe.

Literacy is a tool in this process; at least it is if your choice of education is academic: science, literature, history etc. Literacy is not the only way to be 'educated'. The difference between them is much like the difference between a tool and a process. Literacy will gives the ability to read a book. Education is enforces to understand what the author is trying to convey.

A direct effect of education is knowledge gain. Education give knowledge of the world around. It develops in man a perspective of looking at life. It helps to form opinions and develop a point of view. The information we are constantly bombarded with, cannot be converted into knowledge without the catalyst called education. Education makes man capable of interpreting things rightly and applying the gathered information in real life scenarios. (Oak, M. 2013)

"Our progress as a nation can be no swifter than our progress in education. The human mind is our fundamental resource." – (Kennedy, J., 1961)

Apart from three basic human needs, education is equally an important fourth basic need. For the progress of a nation, for the enrichment of society in general, education is important. A country's literate population is its asset. In today's competitive world, it won't be wise to neglect the importance of education for the development of society as a whole. Most countries have realized this. It has led to the development of many government-aided educational programs and government grants to schools and colleges. The motive behind this is
fostering education in society. The future of a nation is safe in the hands of the educated.

(Oak, M. 2013)

1.2 Role of Education: Future of Power

As quoted by Rajnekar, D. (2013) in the book India -2061: A look at the future of India, related to the power of education, both academics and the practitioners in social sciences accept the all powerful role that an education system can play in shaping the society and in a way contributing to Social change. In essence, education is futuristic in its very nature since it helps young minds realize their potential and in many ways prepares them to successfully face the real life that they are likely to face when they become adults.

Shaping society through an educational process is a long-term and relatively slow process - the effect of which might not be experienced by people within a generation or two. It requires a long-term vision on the part of a nation as well as willingness to address some fundamental issues.

According to his views “In essence, education is futuristic in its very nature since it helps young minds to realize their potential and in many ways prepares them to successfully face the real life that they are likely to face when they become adults..!”

To be India as a Future power, it is needed to concentrate on development of powers with respect of future development. Every power is based on the development of society in all respect which includes 1) Education 2) Health 3) Employment for which we need a skilled manpower, to have a skilled manpower we need to aware people about the benefits of education, to understand the benefits of education the people should be literate. Science and technology is the just upper layer of literacy level, here we should not forget that literacy should be increased in terms of science and technology. Ideally, any discussion about evolving an effective educational system should begin with a deeper and long-term analysis of the future of the society for which young people need to be prepared. This needs a group of multidisciplinary people who put their mind together and evolve a coherent picture of the future. The education system that we envisage needs to have a strong linkage to this picture of the future.

1.2.1 Present Education System in India

It is often mentioned that India has had a rich tradition of an “educational system” and in the ancient era, it was a source of knowledge to the world. Most education philosophers, while discussing the purpose of education have stressed on three aspects of education - happiness in life, developing an independent responsible thinker and providing necessary skills to survive in life. It is also a uniformly accepted view that education is probably the only non-violent medium for social change.
However, the current educational system followed in a majority of our schools is more than 150 years old. The British context in which the system was evolved has become obsolete long ago. It is based on archaic notions such as “child is an empty vessel and needs to be filled with knowledge”, “education happens only in the school”, “some children are clever and some are not”, “all children have to learn the same subject within a fixed period of time” etc. Whereas learning experiments and neurological research has established radically different realities such as “all children have similar potential to learn”, “children learn at varying pace”, “children have varying preferences on what they want to learn more”, “children are able to significantly contribute to their learning” etc. Lack of synergy in the educational objectives among various stakeholders is a serious problem. Teachers, parents, education functionaries, children themselves and society in general - have fairly conflicting view of the purpose, process and delivery of education.

After 65 years of Independence, our educational system has miserably failed to deliver quality education that achieves the goals set in the constitutional and policy framework. India is clearly a nation that is “receiver of knowledge” than “creator of knowledge”. Since our education is merely focused on “cramming” or “rote memorization”, our children are weak in independent thinking, analysis, application of their knowledge and in challenging existing paradigms.

Today we have IITs, IISc, CDAC-who contributed to build the PARAM 10000 super computer, ISRO sent a space shuttle to Mars. But does the people in bottom level of society knows about these events? It’s simple answer is NO. This knowledge is limited to specific layer of people of society.

India is the country having large number of villages than the towns and cities. Literacy should reach from the up to bottom level of society in rural area. The basic facilities need to be provided to increase the literacy rate in rural area at first preference.

“Teaching global literacy today gives students an intellectual foundation they’ll be able to build on in the years to come.”

In India literacy is only limited to know how to read the letters, symbols, do own signature. Even in advertise published by government is shown as person doing signature on a form and feeling proud about himself. Literacy is far beyond of it. It not only deals with knowing but also an understanding.

As stated in a training manual of literacy – ‘Literacy is not only reading words, set of symbols and sounds but an act of critical understanding of the situation in the world.”

The above statement means being literate is not the end, but one should be able to extends the efforts to problem solving and taking quality decisions in critical times of life.
When certain efforts are made to understand, act, relate the facts in structural way is called education in simple words. Literacy is very basic level of understanding, literacy provides a path but education tells how to walk this means literacy has a direct relation with education. Such literate society in the country expects product of well developed human potential from the system of education.

1.2.2 Expectation of Literate Society from Education

According to Prof. Amryta Sen (1998) “Human development, as an approach, is concerned with what I take to be the basic development idea: namely, advancing the richness of human life, rather than the richness of the economy in which human beings live, which is only a part of it.”

The development is a choice of people to have better healthy life or it’s a ongoing process which helps people to have better healthy life.

Hence it means that development of society is not only meaning the economic development but also other so many developments which help human being lead their life calmly.

Education plays a vital role in development of society in many ways. Being educated, person can rely on his knowledge to take complex decisions; he can guide others who are not much competitive to carry complex tasks. Education helps society to think of process of development and its path. Society expects some of the following things from education in context of development of man.

1) Leadership
2) Develop Others
3) Provide economic strength
4) Survive with healthy and calm life

Every society always needs a leader to drive the society together towards development. Leader should have ability to handle the conflicts in non partial manner. He should consistently exhibit a high standard of integrity and ethical behavior. He should be able to communicate effectively and most important thing is he must be able to take timely and excellent decisions.

Educated person also has a mentality to develop others, inspire people to have good quality education, provoke people to think about their development.

The society having most educated people always has good economic strength as well as ethical values. These societies are always having high quality of human values. These all factors mentioned above always provide calm and healthy life. Linkage between expectation of society from education and developed human being is as shown below.
Society always seeks many things from education so that the processes of development will be continual. Hence education system should be such that it can able to suffice the needs of society.

Education system should change according to the change in the environment of society. (http://www.designshare.com, optimal learning environments societal expectations learning-goals and the role of school designers)

1.3 Importance of Science in Human life

Science is necessity in growing the economy and finding new solutions to old problems and dilemmas. However history is now entering a period where the great discoveries mostly cannot be made without some sort of financial backing for the equipment and research time. This means that there is a real chance for major nations losing ground in the sciences if they do not make the conscientious effort to invest in research and development. President of America Mr. Obama made a telling point in saying that innovation was the key to “winning the future.” In an increasingly competitive global market it is the country that can harness innovation and technology that will be the most successful economically. The possibilities and new markets created by science and invention are eternal. (http://www.universetoday.com, Importance of science)

1.3.1 Science Education

Science is the knowledge related with our life. What we see, observe, feel, experience is all included in this. Hence as human culture changes, thinking changes the concepts in science also changes. Science is based on thoughts, experiences hence always new concepts, ideas are added. One person said “Science is a graveyard of old ideas”.

The purpose of science education is not so simple to produce the next generation of scientist. Today we all are facing issues on a global scale that are fundamentally technical, like change in climate conditions, energy resources, food production, genetic information and many more and as such demand basic scientific literacy throughout our population so that wise decisions can be reached about how to address them. (Weiman, Carl 2012)
1.3.2 Science education in India: Pre-independence period

In the 19th and 20th centuries most of the Indian princely states were under the rule of British Empire. The British administrators during the 19th century did not take adequate measures to help develop science and technology in India and instead focused more on arts and humanities. Till 1899 only the University of Bombay offered a separate degree in sciences. In 1899 B.Sc. and M.Sc. courses were also supported by the University of Calcutta. By the late 19th century India had lagged behind in science and technology and related education. However, the nobility and aristocracy in India largely continued to encourage the development of sciences and technical education, both traditional and western.

India’s first Prime Minister Jawaharlal Nehru realized the importance of science for economic growth and social developments. Addressing to National Institute of Science, in Nehru Stated “Who indeed can afford to ignore science today? At every turn, we have to seek its aid and the whole fabric of the world is of its making”.

Sir C. V. Raman, India’s most eminent scientist said “There is only one solution for India’s economic problems and that is science, more science and still more science”.

1.3.3 Science education in India: Post-Independence Period

In post independence period of India, one generation of modern educated people was formed, who had a vision on education system of India. They realized the importance of science and technology only can lead us to eco-social growth. The main purpose of science education in this period was the socio-economic growth for sustainability. As a developing country India has to conquer new horizons of science and technology. To pursue this vision the science education was need to be strengthen, hence National Commission on Education assess the current education system and modify it if needed as stated above.

As Kristie Grover (2013), Executive Director, BIOCOM Institute said “An educated science workforce strengthens our economy, reduces healthcare costs, and most importantly saves lives. So the question should be why science doesn’t play more of an important role in our society. Science education is the foundation needed for innovation and ultimately commercialization. Unfortunately, life science companies are realizing that new hires lack the necessary skills to be successful in such complex and interdisciplinary work environments. This is what we are addressing at the science Institute because we know that in order to unlock the potential of the science and technology pipeline, individuals need to be provided with constantly evolving resources that are based on industry’s needs. Ultimately the end game of any education is a career and not just a job.”

1.3.4 The constitutional provisions for science education

The 7th Schedule of Indian constitution puts the responsibility for determination of standards in the institutions of higher learning and research on the central government.
1) Establishment of University Grant Commission (UGC-1953) and All India Council for Technical Education (AICTE-1945) by the acts of parliament to administer the functions of higher education in science and technology.

2) The Parliament approved a Technology Policy in 1968 which states that research and development together with Science and Technology education and training of a high order will be provided pride of place. It emphasizes on the linkage of educational institutions, Research and Development establishments, industrial sector and government.

3) The constitutional amendment of 1976 places education including science and technology is the concurrent responsibility of central and state government.

4) Establishment of Ministry of Human Resource Development. This Department consists of -
   a) Secondary & Higher Education
   b) Elementary Education & Literacy
   c) Woman and Child Development

Science education academics have broad purposes for school science education. The same expectation have been quoted in report of Prime Minister’s Chief Science Advisors Sir Peter Glickman in (“Looking Ahead: Science Education for the Twenty-First Century, A report from the Prime Minister’s Chief Science Advisor”) focusing on purpose of science education as stated follows –

Following are the purposes for science education-

1) Preparing students for a career in science

2) Equipping students with practical knowledge of how things work

3) Building student’s science literacy

4) Developing student’s skills in scientific thinking and their knowledge of science as part of their intellectual enculturation.

1.3.5 Purposes of Science Education

1. Preparing Students for a Career in Science

The rationale is studying science will increase student’s awareness of STEM (Science, Technology, Engineering and Mathematics) careers and stimulate their interest in them, and that the science knowledge they gain will give them a necessary foundation for the advanced study needed to qualify for such careers. From this perspective, science education at school is, in effect, a pre-professional course of study where associated assessments function as a gate-keeper reserving entry to the STEM
professions for the most successful students.

A science education designed to prepare students for STEM careers emphasizes the basic components of accepted scientific knowledge.

1) **Equipping students with practical knowledge of how things work**

Providing people with practical knowledge of how things work – the natural world, everyday devices and machines, and their own bodies – has long been a key purpose of school science education. Teaching for this purpose involves a focus on basic science concepts and principles as they apply in the everyday world of things they need and care about. This approach is designed not to prepare people for science-related careers but to give them everyday life skills and information that will allow them to make better choices.

2) **Building student’s scientific literacy**

A scientifically literate population is essential to sustain a healthy society, for only if the non-expert population has at least some understanding of the underlying science can the issues be aired in public and discussed in relation to wider, non-scientific concerns.

Teaching for scientific literacy would focus on the nature of scientific knowledge including what makes science ‘scientific’, how science knowledge develops and how scientists think and work. Critical and ethical thinking, skills in constructing scientific argument and problem-solving would all be emphasized, and because students would do this through in depth exploration of particular issues, they would also learn some key science concepts.

3) **Developing student’s skills in scientific thinking and their knowledge of science as part of their intellectual enculturation**

Scientific thinking as a goal: teaching for this purpose does not generally focus explicitly on developing thinking skills. Students are supposed to pick these up implicitly through exposure to the structures of scientific knowledge, and by emulating the thinking modeled by their teachers who, it is assumed, think like working scientists.

These four purposes are all very different from our traditional one. Each has different origins, and each requires a different kind of learning programme if it is to be met. However, school science curricula, now and in the past, have, at least in theory, been required to serve all of these purposes. This has resulted in programmes with rather muddled mixtures of purposes, and limited success in achieving them.

Looking towards world’s economic development, development in science and technology plays a big role in development of developed countries. Those countries which are still underdeveloped or developing, if we see their education system, it is lagging behind in the area of science and technology.
In the above context worldwide expected goals of science education given by Bybee, Trowbridge, 1999, (NACOL, 2008) are as follows:

1.3.6 Goals of Science Education – In the Context of the World

To enhance scientific literacy is worldwide goal of science education, further to this, there are following goals of science education.

1. To enhance students to think critically and deeply about natural phenomena happening in surrounding environment.
2. To apply various methods to enable students to understand hypothesis, laws of nature discovered/invented by scientists.
3. To encourage students to apply their constructive ideas for development of community.
4. To excite and enthuse children with a sense of awe and wonder at the natural world.
5. To develop an appreciation of how science has contributed to the historical and cultural development of the society.
6. To give practical experience of how scientists make observations of the natural world, come up with hypotheses and do experiments to obtain evidence to support or disprove these hypothesis.
7. To cause children to understand the importance of evidence when making decisions and to be able to judge whether the claims of the media, advertisers, politicians, journalists, etc, are evidence-based and reliable.
8. To give pupils enough evidence-based knowledge to be able to make informed personal judgments in order to lead healthy, safe, comfortable and environmentally sustainable lives.
9. To develop awareness of the conclusions of important scientific theories in a concrete and accessible way.

India has to march along with the world, NCERT (2005) put forth the goals of science education as follows:

1.3.7 Goals of Science Education – In the Context of India

1. To know the facts and principles of science and its applications, consistent with the stage of cognitive development,
2. To acquire the skills and understand the methods and processes that lead to generation and validation of scientific knowledge,
3. To develop a historical and developmental perspective of science and to enable her to view science as a social enterprise,
4. To relate to the environment (natural environment, artifacts and people), local as well as global, and appreciate the issues at the interface of science, technology and society,

5. To acquire the requisite theoretical knowledge and practical technological skills to enter the world of work,

6. To nurture the natural curiosity, aesthetic sense and creativity in science and technology,

7. To imbibe the values of honesty, integrity, cooperation, concern for life and preservation of environment, and

8. To cultivate ‘scientific temper’- objectivity, critical thinking and freedom from fear and prejudice.

To cultivate the scientific temper, development of scientific literacy and scientific process skills are essential. However till today our present education system is not succeed in such scientific thinking by achieving the above goal, reasons may be because the direction of science education which we have chosen. Due to this misdirection number of challenges has been hinder before science education.

1.3.8 Challenges in Science Education

People in society have to be aware of science is not only a subject but as a part of their day to day life. Lack of science literacy in society enforces the following challenges in science education –

a) Shortage of Qualified Science Teachers

b) Language as a Barrier

c) Lacking of interest of students in science

d) Carrier aspiration

e) Connecting science with other subjects

f) Required Infrastructure

a) Shortage of Qualified Science Teachers

Teachers are the yield of the developed society. Since the 1980's, secondary school pre-service teacher education has focused on pedagogy with the assumption students already possess strong content knowledge. However, with teacher shortages in critical areas such as science and mathematics, pre-service teacher graduates are often hired by school systems to teach subjects in which they are not domain experts. Recent legislation in the form of No Child Left Behind is requiring teachers to be highly qualified and therefore teacher educators must prepare pre-service teachers to be just that. Teachers cannot effectively educate students on subjects they themselves aren't comfortable with or confident in (Ball, 1990).
Borko (1996) reported that most teachers' content knowledge comes from what they absorbed from their disciplinary fields, while their pedagogy and understanding of communication comes from the field of education. If future teachers are misinformed or have poor understanding of specific concepts, it is quite likely they will perpetuate these naive conceptions to their students (Boyce, 1995). Leonard A. Annetta, Sharon Dotger (2006). Same challenge in science education has reported by Malik (2012).

b) Language as a Barrier

The language of science is English. This is because many of the English speaking countries contribute much more in science. The medium of the science education is English. Hence it is very difficult for the non-English speaking countries to translate the science concepts into native language. In India student learn science in native language till the end on secondary education but after it the medium of science become English which many students feels very difficult and don’t want to pursue further to study science.

Here the language literacy can help to understand the science concepts for non-English medium students. Prof. Rao, C. N. (2013) mentioned this challenge in one of his speech after awarding Bharat Ratna.

c) Lacking of Interest of Students in Science

Many student starts to take science education in great enthusiasm but due to some factors they lack interest in science education. These factors may be inadequate infrastructure, teacher’s inability to teach science in understandable manner, adopting teaching science in traditional way as language. Many times teachers don’t bother about what student actually wants to learn from science, whether they understand the concepts are not. Science is driven by examples from day to day life hence it’s very essential to conduct experiments, hands on experience, study tours.

d) Carrier Aspiration

In India when child starts to go to school, parents and teachers play an important role in the selection of courses as well as in deciding career options. Regarding career aspirations, over 40% of the students, whether in classes VI to VIII or XI and XII, wanted to become either an engineer or a doctor (Shukla, 2005, Malik, 2012). The literate parents already decide which carrier their child should pursue in future. The upper brilliant layer of student always pursue carrier in professional and high earning streams like Medical, Engineering etc. Those who can’t afford the high cost of professional education and those whose brilliancy is at mid or low level mostly turn to choose the education field as profession. Even government education trusts don’t bother about the need of teachers, their salaries, status in society.
Now many institutes hire teachers by taking bribes from student teachers. To get employed as teacher, people need to pay to schools, colleges, trusts.

As far as the Science education and curricula are concerned, there is a common perception that Science is difficult and that courses often focus on knowledge and facts rather than on understanding. This is further aggravated by the fact that science teachers are not well trained and not motivated enough to attract the young mind to science. This, in turn, is a consequence of the general observation that teaching jobs are much less attractive than other professions.

e) Connecting Science with Other Subjects

Innovative educators have always made connections between science and other topics. Some science fiction provides a good starting point. Whether it involves reaching back to Jules Verne, or exploring more contemporary authors like the (late) Philip K. Dick, or Neal Stephenson, science fiction has always triggered some great “what if?” moments in our minds. Expanding beyond science fiction, the fine arts provide alternate pathways to thinking about science — and many scientific phenomena are esthetically pleasing by themselves!

Today, for some very solid reasons, we are hearing more and more about the need for STEM skills (Science, Technology, Engineering, and Math.) Unfortunately, much of the work in this area treats these four topics as stovepipes, functioning independently from each other. I think this is a mistake. As Kristina Johnson, from Johns Hopkins University has said, “Today the problems are more complex than they were in the 1950’s, and more global. They’ll require a new educated workforce, one that is more open, collaborative, and cross-disciplinary.” Students should be provided opportunities for cross-disciplinary work before graduating from high school.

f) Required Infrastructure

As we stated earlier science is knowledge driven by examples, it needs to carry out experiments. But if there is no proper infrastructure then how to teach science?. Hence to have a better infrastructure to teach a science is a major challenge in India especially in rural areas.

The trusts who invest money to start the school doesn’t bother to establish full fledge infrastructure needed for science education. If proper infrastructure is not available then student need to imagine the miracles of science, which itself is very tedious task. (Thornburg, David D., 2009)

To face these challenges first important thing is strengthening science education, the following means can be used to strengthen science education;

1.3.9 Strengthening Science Education

1. Changing school level teacher’s learning
2. Public Engagement with Science
3. Changing Nature of schooling  
4. Changing Approach of Pedagogy  
5. Re-framing Curriculum

1) Changing school level teacher’s learning

Teacher is a single resource for student. If teachers are much expert, trained in science education then only they can impart knowledge according to requirement of students. But it is very unfortunate fact that science teachers in India do not have enough opportunity to upgrade or enhance their science knowledge, even not introduced to new science teaching methods. Hence when these teachers are at student teacher phase new enhanced science teaching methods has to be introduced in their curriculum. The methods and science teaching skills should be such that even complex scientific phenomenon should explain to students in very simple way. It is a skill of teachers to generate interests among the students in science.

There should be teacher’s refresher courses in science, which should conduct periodically. Similar problem has referred by Thyagrajan, Manoharan mentioned in the citation of Mahadevan, G (2011)

2) Public Engagement with Science

The increasingly technological nature of contemporary society, and the increasing need to manage resources and the effects of development carefully, places new imperatives on the way the public needs to engage with and respond to science and its products. Controversies involving conflicting views between science experts, or government and science expertise, such as with regard to climate change, stem cell research, inoculation, and a range of environmental issues around energy or conservation and management, imply an increasingly important role for science education in preparing future citizens to engage with these personal and public science-based issues.

3) Changing Nature of Schooling

The knowledge explosion significantly challenges the traditional model of the teacher as expert knower who delivers significant and stable science concepts to dependent students. It also implies the need to focus more seriously on learning and the capacity to learn as a major aim of a science education rather than continuing to accept knowledge acquisition as the single prevailing metaphor. This is not to say, of course, that knowledge acquisition is not fundamentally important. However, changes in the way, knowledge is accessed have led more generally to pressures to reconsider the nature of schooling.

4) Changing Approach of Pedagogy

As stated earlier teacher is the prime source of information for students, its a skill of teacher to impart the science knowledge to the bottom level of society. Hence there should be change in approach in science teaching.
(a) **Conceptual Change** - Conceptual change (CC) approaches to teaching science typically involve an exploration of and challenging of students’ prior ideas, establishment of the science ideas, extension of these ideas to a range of phenomena, and explicit evaluation of the new perspective (Hubber, Engaging the science learner 2005).

(b) **‘5Es’ Approach** – This involves five stages in a unit designed to establish a science idea: engage, explore, explain, elaborate, evaluate.

Research studies into teaching strategies to support this CC approach have reported some success (Hubber & Tytler, 2004). However CC approaches have been increasingly questioned on the basis of a comprehensive amount of research demonstrating difficulties in changing students’ naive ideas to more scientific conceptions (Duit & Treagust, 1998).

5) **Re-framing Curriculum**

a) Curriculum should create interest among students using new technologies like using tablets.

b) Use of open ended projects related to real life issues e.g. green house effect, global warming.

c) The curriculum should be united such all units are relevant to student life e.g. unit on science and art. Unit on sugar industry which involves partnership with local industry.

d) Including science of sport in curriculum - Interpret the intent of syllabus and less dependency on text books.

e) Including carrier oriented topics

f) Teaching science using debates, discussions should be emphasized.

g) Developing skills to carry out in house researches like making report on effect of water pollution in certain area.

h) Open up curriculum more so school can design their own courses which deal with new developments in science or carrier oriented course.

(Ideas generated in teacher forums at the ACER conference, 2006)

If one has to use these means for strengthening science education, the first step towards it to develop scientific literacy and essential science process skills among young children right from the level of early school education.

1.4 **Scientific Literacy**

Many researcher worldwide argue that a key goal of science education is scientific literacy (see, e.g., Laugksch, 1991). UNESCO has mooted the goal of science education is scientific and technological
literacy for all i.e. every citizen need to be ware of trends in science, cope with technology in everyday life and be able to take concealed position on science related issues of social importance. Scientific literacy can be expressed as science literacy or science and technology literacy (Keskin, 2008). The usual reason proffered is the increasing impact of science and technology on everyday life. Science now impacts on virtually every citizen in some way and many scientific issues are now highly political in nature (Gauld, 2005). Examples include debates over the fluoridation of municipal water, vaccination programs, and the production and consumption of GM or GE foodstuffs (Coll & Taylor, 2008). So that the increased emphasis on preparing scientifically literate citizenry is reflected in national science education reforms (American Association for the Advancement of Science (AAAS), 1989 & 1993); national science education standards (National Council of Research, (NRC), 1996); national educational policies (McEneaney, 2003; Ministry of Education, 1996) and national science curricula (Jenkins, 1990; Holman, 1997; BouJaoude, 2002). Bybee and Fuchs (2006) also state that through science, the public can learn not only how to make informed decisions about the use of science and technology, but also to assess the applicability and effects of scientific discoveries and technologies on society as they emerge.

Scientific literacy (SL) is a broad and important term in national educational systems worldwide. However, Scientific literacy involves individuals can understand scientific facts and scientific inquiry process, and an awareness of the relationships among science, technology, and society (Bauer, 1992; NRC, 1996). Scientifically literate persons are those who has scientific knowledge, scientific inquiry skills, and abilities to make thoughtful decisions about socio-scientific issues (Jenkins, 1990; Laugksch, 2000a). Such individuals appreciate the value of science and technology and understand their limitations (Wilkinson, 1999).

Raising the scientific literacy of students is identified by many authors as a goal of contemporary science education (AAAS, 1989; BSCS, 1993; Bybee, 1995; Demastes & Wandersee, 1992; Goodrum, Hackling, & Rennie, 2001). So that Science education must meet the challenge of improving SL among students who are also future citizens (Roberts, 1983; Maarschalk, 1988). In particular, science teachers have an important role in educating students to become more scientifically literate. Beyond science education reforms and teachers, science teaching materials should promote the development of scientific literacy among students by providing a balanced representation of the many aspects of SL (Chabalengula et. al. 2008).

Many definitions have been put forward for scientific literacy since 1958 some of them as given below

1.4.1 Definitions of Scientific Literacy

1. Scientific literacy encompasses written, numerical, and digital literacy as they pertain to understanding science, its methodology, observations, and theories. (Wikipedia)
2. **Scientific literacy** is relation between general knowledge about science and its applicability to the social environment. (Paul DeHart Hurd, 1958)

3. **The scientifically literate** individual would be one who, “knows something about the role of science in society and appreciates the culture conditions under which science survives, and knows the conceptual inventions and investigative procedures” (NSTA, 1964)

4. **Scientific literacy** as an accumulation of knowledge and skills required to understand science as presented by electronic and print media. (Charles, Koelsche, 1965)

5. **Scientifically literate** individual should: understand interrelationships between science and society, understand the methods and processes of science, have a knowledge of fundamental science concepts or conceptual schemes, and understand the relationships between science and the humanities or look upon science as a part of the humanities. (Pella ,1967)

6. **The scientifically literate** individual as one who uses science knowledge, skills, and dispositions in making day-to-day decisions, who understands the relationships between science and technology and their relationship to society including historical, interpersonal, and economic dimensions. (NSTA, 1971)

7. **Scientifically literate** citizenry understands some of the knowledge library of science, knows some of the limitations and potentials of the contents of the library, knows how and when to apply the knowledge theory, knows where the contents of the library came from, and knows the regulatory principles involved in knowledge production and use. (Pella, 1976)

8. **The scientifically literate** person is one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; and uses scientific knowledge in scientific ways of thinking for individual and social purposes.(AAAS, 1990)

9. The capability to function with understanding and confidence, and at appropriate levels, in ways that bring about empowerment in the made world and in the world of scientific and technological ideas(UNESCO, 1993)
10. Developing the ability to creatively utilize sound science knowledge in everyday life or in a career, to solve problems, make decisions and hence improve the quality of life.” (Holbrook and Rannikmae, 1997)

11. The capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and helps to make decisions about the natural world and the changes made to it through human activity. (OECD, 1998)

All these definitions of scientific literacy focus on Scientific literacy is process of acquiring knowledge about scientific facts, phenomenon happening around. It is not only ability to read and write but having sense about the scientific facts around like global warming, depletion of ozone layer etc. Scientific literacy means that a person can ask, find, or determine answers to questions derived from interest and curiosity about everyday life experiences. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately.

1.4.2 Scientific Literacy – Two Views

While agreement on the meaning of scientific literacy, beyond the metaphorical use, is much less universal, there seems to be two major camps, or points of view:

a) Those that advocate a central role for the knowledge of science; and

b) Those who see scientific literacy referring to a society usefulness.

The first camp seems to be very prevalent among science teachers today. It builds on the notion that there are ‘fundamental ideas’ in science that are essential and that there is content of science which is a crucial component of scientific literacy. It has been described as a short term view (Maienschein, 1998) of knowing science and even labeled as “science literacy” to distinguish it from a longer term view of “scientific literacy”. The term science literacy, however, is not common, and for the most part, it seems to be a play on words.

The second camp encompasses the longer term view and sees scientific literacy as a requirement to be able to adapt to the challenges of a rapidly changing world. This focus sees scientific literacy align with the development of life skills (Rychen & Salganik, 2003). It recognizes the need for reasoning skills in a social context, and above all, this view recognizes that scientific literacy is for all, having little to do with science teaching solely focusing on a career in science, or providing only an academic science background for specialization in science. In fact, it is contended that the second view refutes the need for two types of school
science courses – one for general education and another for specialists – and recognizes that a specialist course is simply an extension of the former with an increase of “time on task” - that is, more science lessons, which will give time for more in-depth investigation.

Bybee (1997) proposed a comprehensive hierarchical model still very much driven by the discipline of Science, a more central position can be taken in which subject competence is important, but is propagated by general competences within education, and this is strongly supported by Project 2061 (AAAS, 1993). A further intermediary view for scientific literacy sees the general aim as being oriented towards societal requirements, to learn how to deal with social issues and to make rationally founded decisions. Shamos (1995), however, doubts whether any definition of scientific literacy, which includes both wide and deep content knowledge and process competence, is possible. He sees scientific literacy far more in terms of promoting competent consumers of science with the ability to gain knowledge from experts as and when appropriate.

1.4.3 Types and Levels of Scientific Literacy

To evaluate the aspects of a scientific literacy, various types and level of scientific literacy are proposed s.

Shen (1975), suggested three types of scientific literacy i.e. 1) Practical scientific literacy 2) Civic Scientific literacy 3) Cultural scientific literacy. Shamos, (1995) suggested three levels of scientific literacy i.e. 1) Cultural scientific literacy 2) Functional scientific literacy and 3) True scientific literacy and Bybee (1997) suggested four levels of scientific literacy.

Bybee (1997) and the BSCS (1993) suggested a comprehensive theoretical scale that is more suitable for the assessment of scientific literacy during science studies at school, since its hierarchy can be easily transferred to instructional purposes. The following pyramid shows the level structure suggested by Bybee.

![Fig. 1.2: Levels of Scientific Literacy](image-url)
Nominal Scientific Literacy - Students at least understand the concept of science but not fully aware of it.

Functional Scientific Literacy - Students describe the science concepts but there are still some limitations in full understanding.

Conceptual Scientific Literacy - Students develop some understanding of the major conceptual schemes of a discipline and relate those schemes to their general understanding of science. Procedural abilities and understanding of the processes of scientific inquiry and technological design are also included in this level of literacy.

Multidimensional Scientific Literacy - This perspective of scientific literacy incorporates an understanding of science that extends beyond the concepts of scientific disciplines and procedures of scientific investigation. It includes philosophical, historical, and social dimensions of science and technology. Here students develop some understanding and appreciation of science and technology regarding its relationship to their daily lives. More specifically, they begin to make connections within scientific disciplines, and between science, technology, and the larger issues challenging society.

1.4.4 Measures of Scientific Literacy

The levels of scientific literacy and the corresponding measures of behaviors related to the particular levels are explained below.

Table No. 1.1

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<thead>
<tr>
<th>Levels of Scientific Literacy</th>
<th>Related Behaviors Indicator</th>
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| A) Nominal Level              | • Identifies terms, questions as scientific.  
                                 | • Demonstrates misconceptions.  
                                 | • Have naive explanations.  
                                 | • Shows minimal understanding.  |
| B) Functional Level           | • Can use scientific vocabulary in a particular activity or for a specific need, i.e., defining a term on a test.  
                                 | • Can read a newspaper article and define a scientific term used. Uses scientific vocabulary but without a broader conceptual understanding in relation to the discipline.  
                                 | • Able to memorize and restate lists of vocabulary.  
<pre><code>                             | • Can successfully memorize and restate text book vocabulary and ideas but without demonstrating a broader or in depth conceptual understanding.  |
</code></pre>
<table>
<thead>
<tr>
<th>Levels of Scientific Literacy</th>
<th>Related Behaviors Indicator</th>
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| C) Conceptual Level | • Understand the nature of scientific theories and the role of continuous testing and retesting that occasionally results in the discarding of new and old theories.  
• Realize that scientific knowledge has a temporary status and should not be accepted as unquestionable truth.  
• View scientists as studying a world in which they are a part and as such their work is not objective or value free.  
• Views science as progressing through continuing research and critical questioning.  
• Views science as dynamic and ongoing, not a static accumulation of information. |
| D) Multidimensional Level | • Have some knowledge of the history of scientific ideas.  
• Display an understanding of the aims and limitations of scientific processes. Understands new scientific knowledge is produced as a result of creativity and imagination coupled with scientific method.  
• Displays an awareness of the concept of observations being made from a personal perspective built up by prior knowledge, beliefs and theories.  
• Shows an awareness of the role science takes in their personal life and society generally.  
• Incorporates the philosophical, historical and social dimensions of the discipline into the analysis, interpretation and evaluation of scientific knowledge.  
• Makes connections within the discipline and with larger social problems and endeavors.  
• Demonstrate the competence and confidence to make informed decisions relating to scientific ideas. |

For enhancing the scientific literacy levels students need to develop scientific process skills. Science process skills are the tools used by the students to investigate, understand the scientific phenomenon happens around them. Individuals who can follow and internalize knowledge and technology will always be one step ahead in their lives. These individuals are generally those who know how to learn, how to think logically and creatively, and have decision making and problem solving abilities, in sum, they are science literate individuals (National Research Council, 1997).

Bringing up science literate individuals requires certain skills need to be developed, hence the scientific process skills are important.

### 1.5 Scientific Process Skills

Science process occurs naturally, spontaneously in our minds. By logically breaking down the steps in our thinking, we can use science process to find out how to answer our questions about how the world works. Science process is not just useful in science, but in any situation that requires critical thinking. Science process skills include observing
qualities, measuring quantities, sorting/classifying, inferring, predicting, experimenting, and communicating.

1.5.1 Emergence of Scientific Process Skills

AAAS first launched the project name “Science A Process Approach” (SAPA) during 1960 to 1968, the project is a pioneer for most of the countries and it emphasized the process of science through different approaches of teaching science such as inquiry approach, discovery approach, investigatory approach through which students can engage in scientific method and acquire knowledge and skills.

In India after 1960 various committees establish to strengthen the science education in the school. Many project carried out to improve science teaching at state levels and national levels.

NCERT is the national level body undertaken many project which includes providing science kits, improving laboratory facility, training science teachers, providing science equipments to schools, developed manual for science teachers. On the other side various commissions including recent document NCF (2005) also recommended that science teaching was made compulsory in school education and development of science process skills is one of the objectives of science teaching. (Ramesh, M. & Patel, R. C., 2013).

1.5.2 Concept of Scientific Process Skills

Today in area of teaching science to students, scientific methods, scientific and critical thinking are the main terms used to describe scientific skills. Science process skills are special skills that simplify learning science, activate students, develop students’ sense of responsibility in their own learning, increase the permanency of learning, as well as teach them the research methods (Korkmaz, 1997; Karamustafaoğlu, 2003 cited in Karamustafaoğlu, 2011). According to Padilla’s (1990) science process skills are “transferable abilities, appropriate to many science disciplines, and reflective of the behavior of scientists.” He classified the process skills into two they are basic and integrated skills. Basic science processing involves: observing, question raising, measuring, communicating, classifying, predicting and inferring, Integrated science process skills require controlling variables, defining terms operationally, formulating hypotheses, interpreting data, experimenting, and formulating models. ‘Science Process Skills’ is term used widely to describe all the properties need to enhance science knowledge. Science - A Process Approach (SAPA, 1980), grouped process skills into two types-basic and integrated process skills. The basic (simpler) process skills provide a foundation for learning the integrated (more complex) skills. These skills are listed and described below.

1.5.3 The Basic Science Process Skills - These are simple process skills.
1) **Observing**

   Definition – Using your senses to learn about objects around. Observe by seeing, smelling.

   Example – Seeing wood catch fire, hearing the cracking of burning of fire; smelling the smoke.

2) **Classifying**

   Definition – Putting objects into groups. All objects in a group are like in some way.

   Example – Grouping leaves according to shape, size, color, texture or type of edges; placing organisms in a similar (or common) relationship between people or groups.

3) **Inferring**

   Definition – Using what is observed to explain what has happened.

   Example – Concluding that it has rained in the morning because the side walk is wet; concluding that it is January, Mumbai has higher temperature than Kolhapur.

4) **Communication**

   Definition – Telling what one know by speaking, writing, drawing picture or graphs.

   Example – Giving an oral or written report, drawing a diagram; or developing a flow chart about one food chain with in a larger food web.

5) **Measuring**

   Definition – Finding out the size volume, mass, weigh; or temperature of an object. It is also finding out how long it takes for an event to happen.

   The object or event is compared to a unit of measure.

   Example – Using a meter stick to find out how tall a tree is; finding the mass of rock with a spring balance; using watch to find out how long it takes for an ice cube to melt; using thermometer to find out how hot water is.

6) **Using Numbers**

   Definition – Includes ordering, counting, adding, subtracting, multiplying and dividing numbers. It also includes number line and graphing.

   Example – Putting objects in order according to their masses, beginning with least amount of mass; calculating the mechanical advantage of a machine. Plotting a graph of temperature against time.

7) **Predicting**

   Definition – Proposing possible outcomes of an event or experiment. Predictions are based on earlier observations and inferences.
Example – Stating that blue litmus paper will turn red when dipped in lemon juice; stating how long it will take for a cup of water to freeze if it is placed in a freezer.

1.5.4 Integrated Science Process Skills

1) Defining operationally

Definition – Stating how to measure a variable in an experiment.
Example – Stating that bean growth will be measured in centimeters per week.

2) Interpreting Data

Definition - Explaining the measuring of information that has been collected.
Example - Reading a graph about use of fossil fuels and concluding that more industries use coal than natural gas; studying daily weather tables and concluding that cities along coast get more rainfall than those in deserts. Reading a table (or pie charts) about nutritional values of different foods.

3) Controlling Variables

Definition – Making sure that all factors in an experiment stay the same except the one which is manipulated
Example – Carrying out an experiment so that only the size of a boat’s sail could affect the amount of time needed to cover a certain distance.
Changing the amount of salt in a recipe the second time one prepares it but keeping all other ingredients, temperature, cooking time the same.

4) Experimenting

Definition – Being able to conduct an experiment, including asking an appropriate question, stating a hypothesis, identifying and controlling variables, operationally defining those variables, designing a “fair” experiment, conducting the experiment, and interpreting the results of the experiment.
Example – The entire process of conducting the experiment on the affect of organic matter on the growth of bean plants.

5) Formulating Models

Definition – Creating a mental or physical model of a process or event.
Examples – The model of how the processes of evaporation and condensation interrelate in the water cycle.

6) Formulating hypotheses

Definition – Stating the expected outcome of an experiment.
Example – The greater the amount of organic matter added to the soil, the greater the bean growth.

A reasonable portion of the science curriculum should emphasize science process skills according to the National Science Teachers Association. In general, the research literature indicates that when science process skills are a specific planned outcome of a science program, those skills can be learned by students. This was true with the SAPA and SCIS and other process skill studies cited in this review as well as with many other studies not cited.

Teachers need to select curricula, which emphasize science process skills. In addition they need to capitalize on opportunities in the activities normally done in the classroom. While not an easy solution to implement, it remains the best available at this time because of the lack of emphasis of process skills in most commercial materials.

1.5.5 Importance of Scientific Process Skills

Science process skills are the base for the concepts formulation, in the period of the school education, for students it is important to understand basics of science. Only memorization of basic concepts is useless and no scope to develop scientific literacy. Science is learned basically by observing and verifying the phenomenon hence process approach provide much scope to use their mind and hands through which students can get useful experience.

Scharmann (1989) points out that science process skills promote significant increase in subject understanding and science content knowledge, arguing that science content and science process skills should be taught together as they complement each other. Developing scientific literacy among the students is one of the objectives of science teaching in schools, process approach of science learning can persuade scientific literacy. Process skills involves interest, thoughts and action that make the learner to motivate intrinsically, understand the scientific concept clearly and acquire the skills proficiently therefore cognitive, affective and psychomotor domains of an individual are strengthened. (Ramesh, M. and Patel, R. C., 2013)

Therefore for enhancing scientific literacy and scientific process skills researcher need some specific teaching strategies. Before explaining these specific teaching strategies concept of teaching strategy necessarily to be elaborated.

1.6 Teaching Strategy

Strategy is term used for finding a way to achieve the goal. In day to day life individuals always come across strategies for winning the situations, strategies for winning in elections etc. When discussing regarding teaching strategy, it means teachers have some goals in front of them and to achieve this, the strategies are made. Teaching Strategies are dependent on many objects like on what type of environment the teacher is in, the understanding level of student, environment of the student, infrastructure availed and many more. There will not same
strategy of teaching worldwide because strategies are different according to situation.

Teaching strategy is a plan or a program that is extensively used to ensure that a certain message or lesson is passed from the teacher to the student. Teaching strategies include the approaches that a teacher may take to actively engage students in learning. Effective teaching strategies meet all learning styles and development needs of the learners.

1.6.1 Teaching Strategies for Science

There are various strategy used for teaching science. Teaching strategies determine the approach of a teacher may take to achieve learning objectives. Teaching strategies are used by teachers to create learning environments and to specify the nature of the activity in which the teacher and learner will be involved during the lesson. What children learn depends not only on what they are taught but also how they are taught, their development level, and their interests and experiences.

These beliefs require much closer attention to be paid to the methods chosen for presenting material. Following strategies are mostly used by many science teachers in actual classroom.

<table>
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<tr>
<th>Direct Instruction Strategies</th>
<th>Indirect Instruction Strategies</th>
<th>Experimental Learning Strategies</th>
<th>Independent Study Strategies</th>
<th>Interactive Instruction Strategies</th>
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<tr>
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<td>Reading for Meaning</td>
<td>Conducting Experiments</td>
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<td>Role Playing Panels</td>
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<td>Inquiry</td>
<td>Simulations</td>
<td>Journals</td>
<td>Brainstorming</td>
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<tr>
<td>Drill &amp; Practice</td>
<td>Reflective Discussion</td>
<td>Games</td>
<td>Reports</td>
<td>Peer Partner</td>
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<tr>
<td>Compare &amp; Contrast</td>
<td>Writing to Inform</td>
<td>Story Telling</td>
<td>Learning Activity</td>
<td>Learning</td>
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<tr>
<td>Didactic</td>
<td>Concept Formation</td>
<td>Field Observations</td>
<td>Packages</td>
<td>Discussion</td>
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<tr>
<td>Questions</td>
<td>Concept Mapping</td>
<td>Role Playing</td>
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<tr>
<td>Demonstrations</td>
<td>Concept Attainment</td>
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<td>Building</td>
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For making the effective teaching strategies the instructor himself should have some properties. He or she should have a prominent knowledge of the subject, body language, good presentation styles, use of effective media, skill to answer questions and answering them.
1.7 Present States of Science Teaching

According to indiaeducation.net (2012-13), looking towards the quality and scope of Science education in India, the non-uniformity in the system is quite visible. This may be due to various causes. One major cause is the socio-economic difference between rural and urban India. However, the state as well the union governments are in a constant endeavor to fill this gap and to provide every citizen of the country quality as well as affordable science education.

Higher education, particularly in science discipline is offered by universities and colleges located in various parts of the country. Majority of universities in India train a large number of graduate students. Due to issues like infrastructure, proper quality control of faculty, a majority of the students find it difficult to fine-tune themselves with the complexities of science education at this level. Weak understanding of the concepts results in Incompetence. The curriculum is robust in structure – but is very difficult in implementation. To overcome this situation, the government has been implementing various recommendations made by H.R.D Ministry and other organizations like National Knowledge Commission.

Similarly, research activities in Science discipline have not yet gained much distinction. The government has established several research centers all over the country for carrying out research activities in a particular field. Also, universities throughout the country have been assigned with various projects to perform research work.

Creating enthusiasm among students to learn science is the most widespread activity in India being carried out at present. The government is popularizing the discipline by means of popular science articles, organizing lectures, through various scholarship schemes and through the establishment of science centers like TIFR, VIGAN MANDIR etc. Efforts in this direction have come from both individuals and from institutions. There are several organizations and institutions both public and private trying to change the scene of science education in India. Many teachers training programs are carried out to update them with current knowledge of science.

1.8 Need of Enhancement of Scientific Literacy and Scientific Process Skills among Student Teacher

Advances in Science and Technology have profoundly influenced the way we live. The marvelous strides made in Medicine and diagnostics, Transport and Aviation, Satellites and Communication, Computing, Internet and so on are just few examples of the existence of science in our daily lives. Besides, it is an established fact that scientific and technological advancement leads to economic prosperity and, therefore, no nation can afford to remain scientifically or technologically backward. Science and technology is field were rapid development happens. Students read, listen and see this development and ask questions to their teachers. They have spirit of enquiry and enthusiasm for life that needs to be encouraged in every way. Children at the primary
school are having tender mind. They are completely immature and their concepts about science are very limited. Hence there is always a scope for development of science teaching and learning. Children are always curious towards the phenomenon happens around them. They ask questions regarding the facts that they observe and they want correct answer to relate them with their life. But most of primary school teachers are ill prepared or not aware of current scientific development. For that purpose many teachers training programs are carried out to update them with current knowledge of science. But even though after many efforts, teachers yet not much competent. The main cause behind this is they are trained for how to teach the curriculum only, why to teach this or what strategies need use to teach science or what type of science process skills are need for teaching science is never taken care. Hence still India is lagging behind in science education as compare to developed countries.

The children in India underperform in science achievement when compared to students in other countries, but the raw ideas about science phenomena they bring with them to kindergarten frequently survive unchanged through high school and even college. As this information compels us to question our approach to science teaching, simultaneously, standards for student learning in science are rapidly expanding. It is currently understood that, in order for students to be considered “fully proficient in science” (Duschl, Schweingruber, & Shouse, 2007). They must be able to

a) know, use, and interpret scientific explanations;

b) generate and evaluate scientific evidence and explanations;

c) understand the nature and development of scientific knowledge;

d) participate productively in scientific practices and discourse (Duschl et al., 2007).

There is a growing understanding of the role that early childhood education can play in building scientific literacy. Infinitely curious about the world around them, children constantly observe and explore, take in new information, and generate their own ideas about how the thing in the world works. It is now widely known that cognitive stimulation in the early years is critical for brain development and that young children have cognitive capacities far beyond what was previously believed (Shonkoff & Phillips, 2000).

Unfortunately, many early primary teachers are unprepared to promote scientific literacy and scientific process skills in their classrooms. The way science was presented to them as students, a static collection of facts to be transmitted by the teacher and memorized by students does not translate to teaching young children. So many studies consistently indicate that elementary school teachers are not adequately prepared to teach science (Hoffiman & Stage, 1983; Steen, 1991; Worthy, 1989). Jarrett (1998) writes that there are many things a teacher needs to know in order to teach science effectively: science content, processes used by scientists,
and good organizational management. Teachers need to be able to identify and remedy misconceptions, manage the operations of learning and exploration centers in their classrooms, and knowledgeably lead follow-up discussions to children's discovery. Elementary teachers in general have been found to possess a generally low level of conceptual and factual science knowledge as well as in adequate skills in the content area of science (Stevens & Wenner, 1996), and general agreement exists that a lack of such background in science knowledge significantly contributes to hesitancy in teaching science and possibly to an inability to deliver effective science instruction in classroom setting. So that two areas appear to be important for pre-service teachers; a) science understanding and b) pedagogical practice.

A number of question have been raised related to the above two areas are as follows

1. What are the problems in science teaching in India with respect to scientific literacy and scientific process skill?

2. What are the qualities the science teacher should acquaint to be a good science teacher?

3. How should the student teacher trained to be a good science teacher?

4. How can one generate confidence that student teacher can teach science in positive way?

5. What is the present level of scientific literacy of science student teachers?

6. What are the hurdles in developing scientific literacy among student teachers?

7. What are the possibilities to enhance scientific literacy among student teacher?

8. What measures can be taken to enhance scientific literacy in the existing situation?

9. Which and how are the strategies can be used to enhance scientific literacy?

10. Which are scientific process skills required to enhance scientific literacy?

11. How are these scientific process skills needed to develop among student teachers?

12. What measures can be adopted so that science can be taken out off text and student should expose to hands on activities?

Above questions impel researcher to choose the following problem for research.
1.9 Statement of the Problem

Development of Teaching Strategies for Enhancing Scientific Literacy and Scientific Process Skills among Student Teachers.

1.10 Definitions of Technical Terms

1) Teaching strategies
   Conceptual Definition
   Teaching strategy is a carefully prepared plan involving a sequence of steps designed to achieve a given goal.
   Operational Definition
   Teaching strategies prepared by the researcher, which are useful for enhancing scientific literacy and scientific process skills among student teachers.

2) Scientific Literacy
   Conceptual Definition
   For scientific literacy measurements following scientific literacy levels are taken in to account:
   1) Nominal Scientific Literacy Level (NSLL)
   2) Functional Scientific Literacy Level (FSLL)
   3) Conceptual Scientific Literacy Level (CSLL)
   4) Multidimensional Scientific Literacy Level (MSLL)

   Bybee (1997)

   Operational Definition
   In present study the above conceptual definition is used as operational definition.

3) Scientific Process Skills
   Conceptual Definition
   The science process skills are defined as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientist’s. These skills are listed below.
   1. Observation,
   2. Inference
   3. Measurement
   4. Communicating,
   5. Classification,
   6. Predicting

   (SAPA, 1980)
Operational Definition

In present study for acquisition of scientific literacy level above fundamental scientific process skills are taken into account:

4) Student Teachers

Conceptual Definition

A college student pursuing a degree or diploma in education who teaches in a classroom under the supervision of an experienced, certified teacher educator.

(The free Dictionary, 2013)

Operational Definition

For the present study students admitted in the D. T. Ed. colleges are considered as student teachers.

5) Development

Conceptual Definition

The act or the process of developing where develop means to evolve to a higher or more useful stage.

(New Webster's Dictionary, 2000)

Operational Definition

For the purpose of this study development, means preparation of teaching strategies based on basic concepts in general science textbooks of 6th, 7th, and 8th standards used in the Marathi medium school and trying out their effectiveness, in relation with scientific literacy and scientific process skill.

1.11 Objectives of the Study

1. To finalize the components of scientific literacy with respect to levels of scientific literacy essential for acquisition of science at upper elementary level.

2. To finalize the components of scientific process skills essential for acquisition of science at upper elementary level.

3. To analyze science content at upper elementary level in the context of scientific process skills and scientific literacy.

4. To develop the teaching strategies for the pre-service student teachers at the elementary level to enhance their scientific literacy.

5. To develop the teaching strategies for the pre-service student teachers at the elementary level to enhance the performance level of process skills.

6. To implement the sets of teaching strategies on the pre-service student teachers through training.
7. To evaluate the effectiveness of teaching strategies employed to enhance scientific literacy level.

8. To evaluate the effectiveness of teaching strategies employed to enhance the performance level of process skills.

9. To examine relation between gender and effectiveness of the teaching strategies for the scientific literacy and scientific process skills.

10. To examine relation between faculty of student teachers and effectiveness of the teaching strategies for the scientific literacy and scientific process skills.

1.12 Assumptions

1. Scientific literacy is one of the objectives of the science education.

2. Scientific literacy and scientific process skills are essential for acquisition of information in science.

3. It is possible to develop the scientific literacy and scientific process skills among student teachers.

4. Scientific literacy and scientific process skills are necessary to acquire for teaching science at the upper elementary level.

5. Student teachers are familiar with basic scientific terms and basic processing skills.

1.13 Research Hypotheses of the Study

1. RH₁ – The developed teaching strategies will be effective for enhancing the scientific literacy level in physics among student teachers.

2. RH₂ – The developed teaching strategies will be effective for enhancing the scientific literacy level in chemistry among student teachers.

3. RH₃ – The developed teaching strategies will be effective for enhancing the scientific literacy level in biology among student teachers.

4. RH₄ – The developed teaching strategies will be effective for enhancing the multidimensional scientific literacy level in biology among student teachers.

5. RH₅ – The developed teaching strategies will be effective for enhancing the scientific process skills in physics among student teachers.

6. RH₆ – The developed teaching strategies are effective for enhancing the scientific process skills in chemistry among student teachers.
7. The developed teaching strategies will be effective for enhancing the scientific process skills in biology among student teachers.

Each the above Research Hypotheses is divided in null Hypotheses for testing as follows:

1.14 Null Hypotheses Related to Scientific Literacy Levels

1.14.1 Null Hypotheses Related to Scientific Literacy Levels in Physics

1.14.1.1 Null Hypotheses Related to Nominal Scientific Literacy Levels in Physics

1. There is no significant difference between the means of nominal scientific literacy level in Physics in pretest scores of experimental group and control group of D. T. Ed. student teachers.

2. There is no significant difference between the means of nominal scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

3. There is no significant difference between the means of nominal scientific literacy level in Physics without treatment of teaching strategies on D. T. Ed. student teachers in control group.

4. There is no significant difference between the means of nominal scientific literacy level in Physics in posttest scores of experimental group and control group of D. T. Ed. student teachers.

5. There is no significant difference between the means of nominal scientific literacy level in Physics in pretest scores of boys and girls of experimental group of D. T. Ed. student teachers.

6. There is no significant difference between the means of nominal scientific literacy level in Physics in posttest scores of boys and girls of experimental group of D. T. Ed. student teachers.

7. There is no significant difference between the means of nominal scientific literacy level in Physics in pretest scores of boys and girls of control group of D. T. Ed. student teachers.

8. There is no significant difference between the means of nominal scientific literacy level in Physics in posttest scores of boys and girls of control group of D. T. Ed. student teachers.
9. There is no significant difference between the means of nominal scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

10. There is no significant difference between the means of nominal scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in control group.

11. There is no significant difference between the means of nominal scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

12. There is no significant difference between the means of nominal scientific literacy level in Physics without treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in control group.

13. There is no significant difference between the means of nominal scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

14. There is no significant difference between the means of nominal scientific literacy level in Physics without treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in control group.

1.14.1.2 Null Hypotheses Related to Functional Scientific Literacy Levels in Physics

15. There is no significant difference between the means of functional scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

16. There is no significant difference between the means of functional scientific literacy level in Physics in pretest scores of boys and girls of experimental group of D. T. Ed. student teachers.

17. There is no significant difference between the means of functional scientific literacy level in Physics in posttest scores of boys and girls of experimental group of D. T. Ed. student teachers.

18. There is no significant difference between the means of functional scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.
19. There is no significant difference between the means of functional scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

20. There is no significant difference between the means of functional scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

1.14.1.3 Null Hypotheses Related to Conceptual Scientific Literacy Levels in Physics

21. There is no significant difference between the means of conceptual scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

22. There is no significant difference between the means of conceptual scientific literacy level in Physics in pretest scores of boys and girls of experimental group of D. T. Ed. student teachers.

23. There is no significant difference between the means of conceptual scientific literacy level in Physics in posttest scores of boys and girls of experimental group of D. T. Ed. student teachers.

24. There is no significant difference between the means of conceptual scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

25. There is no significant difference between the means of conceptual scientific literacy level in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

26. There is no significant difference between the means of conceptual level of scientific literacy in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.
1.14.2 Null Hypotheses Related to Scientific Literacy Levels in Chemistry

1.14.2.1 Null Hypotheses Related to Nominal Scientific Literacy Levels in Chemistry

1. There is no significant difference between the means of nominal scientific literacy level in Chemistry in pretest scores of experimental group and control of D. T. Ed. student teachers.

2. There is no significant difference between the means of nominal scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

3. There is no significant difference between the means of nominal scientific literacy level in Chemistry without treatment of teaching strategies on D. T. Ed. student teachers in control group.

4. There is no significant difference between the means of nominal scientific literacy level in Chemistry in post test scores of experimental group and control of D. T. Ed. student teachers.

5. There is no significant difference between the means of nominal scientific literacy level in Chemistry in pre test scores of boys and girls of experimental group of D. T. Ed. student teachers.

6. There is no significant difference between the means of nominal scientific literacy level in Chemistry in post test scores of boys and girls of experimental group of D. T. Ed. student teachers.

7. There is no significant difference between the means of nominal scientific literacy level in Chemistry in pretest scores of boys and girls of control group of D. T. Ed. student teachers.

8. There is no significant difference between the means of nominal scientific literacy level in Chemistry in posttest scores of boys and girls of control group of D. T. Ed. student teachers.

9. There is no significant difference between the means of nominal scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.
10. There is no significant difference between the means of nominal scientific literacy level in Chemistry before and after treatment of scientific literacy program on D. T. Ed. student teachers admitted from the faculty of Arts in control group.

11. There is no significant difference between the means of nominal scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

12. There is no significant difference between the means of nominal scientific literacy level in Chemistry without treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in control group.

13. There is no significant difference between the means of nominal scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

14. There is no significant difference between the means of nominal scientific literacy level in Chemistry without treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in control group.

1.14.2.2 Null Hypotheses Related to Functional Scientific Literacy Levels in Chemistry

15. There is no significant difference between the means of functional scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

16. There is no significant difference between the means of functional scientific literacy level in Chemistry in pre test scores of boys and girls of experimental group of D. T. Ed. student teachers.

17. There is no significant difference between the means of functional scientific literacy level in Chemistry in post test scores of boys and girls of experimental group of D. T. Ed. student teachers.

18. There is no significant difference between the means of functional scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.
19. There is no significant difference between the means of functional scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

20. There is no significant difference between the means of functional scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

1.14.2.3 Null Hypotheses Related to Conceptual Scientific Literacy Levels in Chemistry

21. There is no significant difference between the means of conceptual scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

22. There is no significant difference between the means of conceptual scientific literacy level in Chemistry in pretest scores of boys and girls of experimental group of D. T. Ed. student teachers.

23. There is no significant difference between the means of conceptual scientific literacy level in Chemistry in posttest scores of boys and girls of experimental group of D. T. Ed. student teachers.

24. There is no significant difference between the means of conceptual scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

25. There is no significant difference between the means of conceptual scientific literacy level in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

26. There is no significant difference between the means of conceptual level of scientific literacy in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.
1.14.3 Null Hypotheses Related to Scientific Literacy Level in Biology

1.14.3.1 Null Hypotheses Related to Nominal Scientific Literacy Level in Biology

1. There is no significant difference between the means of nominal scientific literacy level in Biology in pretest scores of experimental group and control of D. T. Ed. student teachers.

2. There is no significant difference between the means of nominal scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

3. There is no significant difference between the means of nominal scientific literacy level in Biology without treatment of teaching strategies on D. T. Ed. student teachers in control group.

4. There is no significant difference between the means of nominal scientific literacy level in Biology in post test scores of experimental group and control of D. T. Ed. student teachers.

5. There is no significant difference between the means of nominal scientific literacy level in Biology in pre test scores of boys and girls of experimental group of D. T. Ed. student teachers.

6. There is no significant difference between the means of nominal scientific literacy level in Biology in post test scores of boys and girls of experimental group of D. T. Ed. student teachers.

7. There is no significant difference between the means of nominal scientific literacy level in Biology in pretest scores of boys and girls of control group of D. T. Ed. student teachers.

8. There is no significant difference between the means of nominal scientific literacy level in Biology in posttest scores of boys and girls of control group of D. T. Ed. student teachers.

9. There is no significant difference between the means of nominal scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

10. There is no significant difference between the means of nominal scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in control group.
11. There is no significant difference between the means of nominal scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

12. There is no significant difference between the means of nominal scientific literacy level in Biology without treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in control group.

13. There is no significant difference between the means of nominal scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

14. There is no significant difference between the means of nominal scientific literacy level in Biology without treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in control group.

1.14.3.2 Null Hypotheses Related to Functional Scientific Literacy Levels in Biology

15. There is no significant difference between the means of functional scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

16. There is no significant difference between the means of functional scientific literacy level in Biology in pretest scores of boys and girls of experimental group of D. T. Ed. student teachers.

17. There is no significant difference between the means of functional scientific literacy level in Biology in posttest scores of boys and girls of experimental group of D. T. Ed. student teachers.

18. There is no significant difference between the means of functional scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

19. There is no significant difference between the means of functional scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. Student teachers admitted from the faculty of Commerce in experimental group.
20. There is no significant difference between the means of functional scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

1.14.3.3 Null Hypotheses Related to Conceptual Scientific Literacy Levels in Biology

21. There is no significant difference between the means of conceptual scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

22. There is no significant difference between the means of conceptual scientific literacy level in Biology in pre test scores of boys and girls of experimental group of D. T. Ed. student teachers.

23. There is no significant difference between the means of conceptual scientific literacy level in Biology in post test scores of boys and girls of experimental group of D. T. Ed. student teachers.

24. There is no significant difference between the means of conceptual scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

25. There is no significant difference between the means of conceptual scientific literacy level in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

26. There is no significant difference between the means of conceptual level of scientific literacy in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

1.14.4 Null Hypotheses Related to Multidimensional Literacy

1. There is no significant difference between the means of multidimensional of scientific literacy before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

2. There is no significant difference between the means of multidimensional of scientific literacy in pretest scores of boys and girls of experimental group of D. T. Ed. student teachers.
3. There is no significant difference between the means of multidimensional of scientific literacy in posttest scores of boys and girls of experimental group of D. T. Ed. student teachers.

4. There is no significant difference between the means of multidimensional of scientific literacy before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

5. There is no significant difference between the means of multidimensional of scientific literacy before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

6. There is no significant difference between the means of multidimensional of scientific literacy before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

1.15 Null Hypotheses Related to Science Process Skills

1.15.1 Null Hypotheses Related to Science Process Skills in Physics

1. There is no significant difference between the means of science process skills in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

2. There is no significant difference between the means of science process skills in Physics in pre test scores of boys and girls of experimental group of D. T. Ed. student teachers.

3. There is no significant difference between the means of science process skills in Physics in post test scores of boys and girls of experimental group of D. T. Ed. student teachers.

4. There is no significant difference between the means of science process skills in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

5. There is no significant difference between the means of science process skills in Physics before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.
6. There is no significant difference between the means of science process skills in Physics before and after treatment of scientific literacy program on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

**1.15.2 Null Hypotheses Related to Science Process Skills in Chemistry**

1. There is no significant difference between the means of science process skills in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

2. There is no significant difference between the means of science process skills in Chemistry in pre test scores of boys and girls of experimental group of D. T. Ed. student teachers.

3. There is no significant difference between the means of science process skills in Chemistry in post test scores of boys and girls of experimental group of D. T. Ed. student teachers.

4. There is no significant difference between the means of science process skills in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

5. There is no significant difference between the means of science process skills in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

6. There is no significant difference between the means of science process skills in Chemistry before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

**1.15.3 Null Hypotheses Related to Science Process Skills in Biology**

7. There is no significant difference between the means of science process skills in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers in experimental group.

8. There is no significant difference between the means of science process skills in Biology in pre test scores of boys and girls of experimental group of D. T. Ed. student teachers.
9. There is no significant difference between the means of science process skills in Biology in post test scores of boys and girls of experimental group of D. T. Ed. student teachers.

10. There is no significant difference between the means of science process skills in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Arts in experimental group.

11. There is no significant difference between the means of science process skills in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Commerce in experimental group.

12. There is no significant difference between the means of science process skills in Biology before and after treatment of teaching strategies on D. T. Ed. student teachers admitted from the faculty of Science in experimental group.

1.16 Limitations, Delimitations and Scope of the Study

1.16.1 Delimitations of the Study

1. The study is limited to two D. T. Ed. colleges, which is from Kolhapur district.

2. The study is limited to those 2\textsuperscript{nd} year D. T. Ed student teacher admitted in academic year 2012-1013.

3. The study is limited to Marathi medium D. T. Ed. Colleges.

4. The study is limited to Science content of upper elementary level for the academic year 2011-12.

5. Research is limited to the contents, which are based on science textbooks published by ‘BALBHARATHI’ at upper elementary level.

6. Research is limited to the student teachers of Marathi medium teacher education institution.

7. Research is limited to only upper primary level.

8. Research is limited to the Kolhapur district.

9. The development of teaching strategies includes designing, developing and evaluating stages. The evaluating stage includes large scale try-out of the system. However, the study is confined to experimental try-out on only two Colleges of education. The results of the evaluation of developed teaching strategies will be limited to these colleges only.
1.16.2 Limitations of the Study

1. The number of students from science faculty in control group and experimental group were 13 and 19 respectively. Due to centralized admission process in D. T. Ed. Which may be affected the sampling error, this was removed statistically by applying co-variance.

2. The admission of D. T. Ed. Course in Maharashtra is conducted according to merit list based on 12\textsuperscript{th} standard marks. The first slot of merit list in allotted to DIET and remaining students are allotted for other D. T. Ed. Colleges.

3. The number of girl students admitted in D. T. Ed. Course was more than boys.

4. Scores earned at 12\textsuperscript{th} standard by girls is more than boys from science faculty.

1.16.3 Scope of the Study

The results of this study may be generalized to all pre-service teacher education at elementary level.

1.17 Significance of the Study

No research of with objectives stated in this study has been undertaken in India as far as the knowledge of the researcher goes and there is need to conduct such research to enhance the scientific literacy level of pre-service student teachers.

The study will enhance the scientific literacy level of pre-service student teachers. The set of teaching strategies developed through this research can be used during pre-service teacher training courses with the help of D. Ed./B. Ed./M. Ed. colleges to enhance the scientific literacy level and scientific process skills. The set of teaching strategies developed through this research can be used during in-service teacher training programmes with the help of teacher education institutions.

1.18 Scheme of Chapterisation

Chapter I : Introduction
Chapter II : Review of Related Literature and Research
Chapter III : Plan and Procedure
Chapter IV : Development of Teaching Strategy
Chapter V : Analysis and Interpretation of Data
Chapter VI : Summary

Thus, in this chapter, researcher has introduced the present study with consideration of theoretical background, rationale, need and significance of the study including the aspects of study. In the next chapter researcher has given review of related literature and researches dealing with present study.