Chapter 1: Understanding the Context of the Study

I must begin with a good body of facts and not from a principle (in which I always suspect some fallacy) and then as much deduction as you please.

Charles Darwin (1809 - 1882)
- From ‘Letter to J. Fiske’

This chapter, concerning the context and the background, begins with sharing the source of the problem encountered by the researcher in the science classroom. The chapter further builds on the need for this study, how it was formulated, expectations from the study and related issues. The whole chapter has been divided into seven subsections. The first subsection is a descriptive introduction to the actual source of the problem. The second subsection describes some theoretical positions and some earlier researches to identify the need for this study and building up a rationale for the same. The third subsection formulates the problem and presents its statement. The fourth subsection spells out the focus of the study by stating the objectives so that expectations from the study could be further clarified. A brief of the methodology of the study in relation to the construction of tools, collection and analysis of data have been seeded in the fifth sub section. Any study, which is time and resources bound, has its own limitations and a researcher has to identify the constraints and delimit the work to be done. These delimitations of this study have been explicated in the sixth subsection.

1.1 Introduction

“Water is made up of hydrogen and oxygen. Fishes and other aquatic animals take oxygen from water. Therefore bubbles of hydrogen gas come out when they breathe. Thus, water is consumed from the reservoir and the level should come down.”

These were the words of a tenth grade learner, of the researcher’s class, who was very enthusiastic and confident about her views regarding the level of water in a reservoir having fishes and other aquatic animals. She explained the aquatic life
through the logic that she has developed by interconnecting various concepts of science that she has learned and observed so far. After three days of deliberations, discussions, and explorations an understanding was arrived upon that plants utilize the oxygen dissolved in water. When, three months later the same question was again raised by her and some other learners of the class, it was observed that the learners have reverted back to their initial explanation of the phenomenon mentioned above. Though, in their argument one may find a reflection of the concepts studied, observations taken, application of logic and reasoning to the problem, and making linkages with real-world situation, which are the most celebrated facets of science education, yet there is an obvious question mark on this generated explanation of the phenomena by the learners.

The Researcher had been teaching science to these learners for more than four years, since they were in class sixth. Even though these learners performed well in tests and classroom interactions, which reinforced the researcher’s belief in their conceptual understanding, but an in-depth probing revealed that their interaction with nature and their conceptual modelling to understand their world is not as simple and scientific as we, as teachers, believe and what the usual tests and discussions can reveal. It was also noted that only four science learners, who did not go back to the initial understanding, were the ones who had explored to find a solution to the problem by using various resources available to them.

“One important human response to the wonder and awe of nature from the earliest times has been to observe the physical and biological environment carefully, look for any meaningful patterns and relations, make and use new tools to interact with nature, and build conceptual models to understand the world. This human endeavour has led to modern science. Broadly speaking, the scientific method involves several interconnected steps: observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences, verification or falsification of theories through observations and controlled experiments, thus arriving at the principles, theories and laws governing the natural world. The laws of science are never viewed as fixed eternal truths. Even the most established and universal laws of science are always regarded as provisional,
subject to modification in the light of new observations, experiments and analyses” (National Council of Educational Research and Training, 2005).

(Worth, 1999) in ‘The Power of Children’s Thinking’ thinks of children as natural scientists and posits that, “They do what scientists do, but perhaps for some slightly different and less conscious reasons. They are anxious to understand the world just as adults are or one can say even better than them. There is a terribly interesting, but rather confusing, world full of stimuli all around them. Many adults, however, have learned to ignore some of that world rather than investigate it. Young children ignore very little” (Worth, 1999). The curiosity of children is many times evident in the questions that they ask. Since children are more curious and receptive than usual adults. Instead of idealised world of scientific theories, they weave. The web of their understanding from the exploration of messy world around them and this is with what a child enters the school.

Moreover when children start school and throughout their school years, they already have preformed ideas about how the natural world works. These ideas may come from within the instructional setting or from their experiences outside of school. Research has shown that teaching is unlikely to be effective unless teachers and curriculum materials take into account learners’ preconceptions” (Rosalind Driver, Squires, Rushworth, & Wood-Robinson, 1994).

When asked ‘What causes the phases of the moon? Why does season change?’ Learners do come up with some answers, even though they have not had any such discussions with elders, says (Weiler, 1998). He compiles a list of children’s Alternative Frameworks about science for the American Institute of Physics. For instance, many children insist that the moon produces its own light, and that Earth’s changing shadow causes the moon’s phases. And many believe summer is hot when Earth travels close to the sun, and winter is cold when Earth travels far away from the sun. Whereas, according to the scientific conception, the Moon reflects light from the Sun. Also, phases of the moon are its visible sunlit portions. About seasonal change, scientific conception says that the tilt of Earth’s axis causes it. In the northern hemisphere, the North Pole points away from the sun in winter and toward the sun in summer.
Though reasoning behind the easy ideas that children make, may not be as complex as a scientific attitude behind the observer cannot be challenged. “Some call these early ideas that children form as Alternative Frameworks; others label them naive conceptions, or alternative conceptions. Alternative Frameworks might also be referred to as preconceived notions, non-scientific beliefs, naive theories, mixed conceptions, or conceptual misunderstandings. Basically, in science these are cases in which something a person knows and believes does not match what is known to be scientifically correct. These terms identifying similar mismatches are used interchangeably in this study and are referred to as Alternative Frameworks” (Worth, 1999).

Karen Worth further argues that “a child is not going to give up his theory made by so much effort and observations just because an adult disapproves it or a single event challenges it. Children do not want to give up the concepts and theories they work so hard to make. They take their experiences and struggle to come up with understandings that work in their daily lives. They are not about to drop their ideas just because someone says so, or because an event disproves what they have come to believe. As anyone familiar with the history of science can attest, even adults have trouble changing theories that are well grounded in experience. If a child's theory works, if it has been productive and the child has worked hard to build that theory, he/she will not give it up unless he/she has a lot of new experiences that provide reasons to do so” (Worth, 1999).

1.2 Rationale and Need of the study

Alternative Frameworks have many serious concerns attached with their presence and something especially concerning about them is that we, at all stages of our development, continue to build further knowledge on our current understandings. This development of learning would be seriously impacted if there are Alternative Frameworks at their core (Black, 2006). [...] 22 of the 25 Harvard University faculty and graduating learners they interviewed -- including some with science majors -- had reverted to their childhood notions of the universe”.

This reverting back to Alternative Frameworks makes them especially relevant to be focused upon in science education. We can surely identify the urgency to
intervene, especially in the areas of Alternative Frameworks for our learners in the passive learning environments in the present schools and the inability to individualize these learning environments, work as constraints in this direction.

Various technologies have been employed in the past to deal with the constraints in the process of supporting learning and “With the advent of the personal computer, technology took on new roles for learning, including supporting learners to interact with responsive environments that support compelling active learning” (Pea et al., 1997). (Kubicek, 2005) further asserts, “New computer technologies are creating new opportunities for learners to engage in serious inquiry and to undertake aspects of inquiry that they could not do otherwise”. In fact, some of these technologies can actually help transform science “from canned labs and the passive memorization of content to a dynamic, hands-on, authentic process of investigation and discovery”.

If I had to reduce all of educational psychology to just one principle I would say this:

*The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly”*

(Ausubel, 1968)

This assertion by Ausubel becomes even more significant in the light of the research observations that learners revert back to these frameworks soon after writing ‘correct answers’ in the exams or later in their lives. This indicates that children’s Alternative Frameworks and building up new concepts on them should be attended to not just at their formation but also at proper stages of school experience.

Alternative Frameworks cannot be addressed by rote memorization, or examination pressure to vomit right answers, or by what is there in the book, but by a kind of school experience that is rich with spaces to assess their own conceptions and problems therein. The opportunity to evaluate different dimensions of their conceptions can pave the way to develop conceptions accepted by the scientific community, one of the broader aims of learning science.

There is no dearth of books and texts on building conceptions in science. However, we do realise at some point or the other in our lives that studying from texts is a complex process. The main goal of learning from texts is to work out the core information contained in the texts, to trim down it to its main ideas, to understand it,
and to mix it with the learners’ existing body of prior knowledge. In addition to this, learners should be able to retrieve the information quickly and without effort at the right time and at the right place. It is thus a very demanding task and it is not surprising therefore, that so many high school, college and even university learners report learning difficulties. When we are dealing with Alternative Frameworks in science we need to take note of this argument.

In the present times, though taking assistance from computer as a technological tool of mediation may give us one way to deal with the problem, but “Education in particular has suffered as often the last application area for advanced technologies. It has typically taken 15 years for computer tools to make their way into classrooms from their advent in military or industrial settings” (Pea et al., 1997).

Even after fifteen years, when computer tools enter into classrooms, its applications are limited. Transmitting instruction was one of the earlier approaches in the technology that was used to transmit instruction in “a more engaging fashion and a larger numbers of learners. Distance education inherits this tradition when it uses phone lines, satellite links, and microwave to transmit static knowledge to wider audiences, with minimal opportunities for highly interactive conversations with instructors or learners” (Pea et al., 1997). This might be the case because the behaviourist paradigm supplied the framework for development of educational software. Thus reinforcement of concepts, drilled and practice or artificial development type of issues dominated, with the advent of alternatives to behaviourist paradigm such as cognitivism of constructivism different sorts of framework started to seep in. “[...]constructivist software should allow for ‘cognitive authenticity’ by promoting opportunities for learners to express personal ideas and opinions and articulate ideas, experiment with ideas, engage in complex environments which are representative of interesting and motivating tasks and receive opportunities for intrinsic feedback” (Kearney & Treagust, 2001).

But this sort of software intervention needs to be tested for its efficacy in the school system. (Carroll, 2000) has pointed out that “highly interactive technologies can make it possible to support both learners and learning in recursive processes of exploration that are non-linear and congruent with natural motivation and learning processes. To support these complex non-linear processes, it is necessary to ‘think
outside the box’ of traditional education with its focus on knowledge conservation rather than knowledge production”.

The criticism of traditional education and the passive multimedia uses in education go hand in hand. Both seem to be linear and de-motivating and devoid of accepting the complexities of meaning making process/ model construction by the learner.

(Kearney & Treagust, 2001) summarises the criticism of passive multimedia use in education as is raised by (Madian, 1995), (Yeo, Loss, Zadnik, Harrison & Treagust, 1998), (Ben-Zvi and Hofstein, 1996) (all quoted in (Kearney & Treagust, 2001)), and the limited influence and impact of constructivist research findings on the practice of science education as put forth by (Ben-Zvi and Hofstein, 1996) (quoted in (Kearney & Treagust, 2001))

In contrast with passive multimedia use in education (Bell, 2005) summarizes that “interactive computer simulations can be designed to reify otherwise abstract concepts and objects; they can allow learners to personally explore the dynamics and interactive relationships associated with the modelled physical system through virtual investigation”. From a more contemporary perspective, it may be considered pedagogically sound that learners directly manipulate variables, observe the consequences of their actions, and interpret and give meaning to the symbols and representations in the simulation that correspond to underlying concepts, principles and facts of the physical and natural world.

In the light of the above arguments there is a need to explore the place of Computer Assisted Learning in addressing Alternative Frameworks in science. Envisaging a program that can work for general population yet satisfy individual learners’ needs is a challenge in front of science education enthusiasts. Non mindful interaction of learners with computer based materials has also been observed in many cases. Thus the program developed needs to be sufficiently effective to ensure active and mindful engagement of the learner for addressing alternative framework in science. However, for this to take place, we first need to establish whether these programmes are needed and useful, and whether requirements of both the teachers’ and learners’ contexts can be satisfied by such programmes, so that further designing can be taken up based upon certain identified characteristics. In this direction, as the
first step, the exploration of efficacy is being taken up in this study.

1.3 Statement of the Problem

In the light of the arguments presented in previous subsection, the study is titled

*Exploring the Efficacy of Computer Assisted Learning in Addressing Alternative Frameworks Among Learners of Science*

1.4 Objectives

The study has focused on the following objectives:

1. To explore teaching learning contexts in science classrooms with respect to
   a. Teachers' natural dispositions towards formation and addressing of the Alternative Frameworks
   b. Possible sites of formation of alternative frameworks among learners in science
2. To understand science teachers’ perception about Alternative Frameworks
3. To understand science teachers’ perception about the use of Computer Assisted Learning program in addressing Alternative Frameworks among learners in science.
4. To identify the characteristics of desirable computer-assisted learning program as per the perceptions of science teachers.
5. To evaluate features of some of the computer-assisted learning programs in science on the basis of
   a. Understanding that has been developed about the teaching learning context in science classrooms.
   b. Perceptions of science teachers
6. To suggest implications for Science Education.

1.5 Methodology of the Study

In order to explore possible sites of formation of Alternative Frameworks among school learners, the queries that come to their mind and how they address those queries have been studied along with the figures, diagrams and terms that they use.
For recognizing and analyzing teachers’ natural dispositions towards formation and addressing Alternative Frameworks among learners in science a self assessment schedule has been used. It had to be filled up after transaction of every lesson in science by the teachers.

A questionnaire was filled up by the science learners to be analyzed and reflected upon by their teachers as well as by the researcher. This analysis and reflection were used for attempting an exploration of teaching learning contexts in science learning.

A questionnaire was given to science teachers and the responses were analysed to explore the science teachers’ understanding of Computer Assisted Learning and to understand teachers’ perception of Alternative Frameworks. The same questionnaire given to the science teachers was also used to ascertain competence of science teachers and learners for using Computer Assisted Learning in their classrooms through developing an understanding about their comfort. Another objective was to enlist the characteristics desirable in Computer Assisted Learning program as per the perception of the science teachers. In order to evaluate features of some of the available Computer Assisted Learning programs, analysis of teacher’ perceptions were used.

1.6 Limitations and Delimitations

Limitations:
In this study, prospective science teachers pursuing the B.Ed. programme are the sample and have been considered as Science Teachers.

Delimitations:
Teachers are the prospective teachers of two B.Ed. colleges in Delhi.
Science learners are from different schools in Delhi.
Only two computer interventions one from NCERT and another from University of Colorado have been analysed.
The study has focussed on identifying the possible sites of Alternative Frameworks and not profiling the Alternative Frameworks.
Concerns and consideration in reference to the limitations and delimitations:

1. Prospective science teachers are the sample and have been considered as Science Teachers:

   The number of years of experience gives opportunities to have more insight into Alternative Frameworks of science learners. However, since the focus of study was not on profiling the Alternative Frameworks. In order to minimize any such impact, the questionnaire was given to prospective learners at the end of their session, after their School Life Experience program. Their reflections and analysis was collected during the later part of their B. Ed. Program.

   In relation with computers, the nature of skill-sets of young and experienced teachers may be significantly different. So this might have a significant impact on the results of the study related to comfort and competence of teachers in handling Computer Assisted Learning related tasks.

2. Teachers were the prospective teachers of two B.Ed. colleges in Delhi. Teachers from Delhi, other parts of the country and the world have different exposures and contexts and therefore the result might be impacted by the same.

3. Science learners were from different schools in Delhi.

   Since the prospective teachers teach in various types of schools during their School Life Experience Program, therefore this might be representative of some diversity in the learners’ contexts. But this sample cannot be taken as a probability or random sample.

   Science learners from Delhi and other parts of the country and the world have different exposures and contexts and therefore the result might be impacted by the same.

4. Only two Computer Interventions from NCERT and University of Colorado have been analysed.

   The nature of the two programs is very different. One has interactive features, while the other is in instructional mode. So the evaluation is not exhaustive but exploratory and descriptive.

5. Focus on possible sites of Alternative Frameworks
This chapter brings forth the context, need, significance, limitations and delimitations for the study undertaken. The nature of the reviewed literature, the directions for tools that might be needed and their structures, expected outcome of the study etc have been delineated in this chapter. This chapter also helped the researcher in projecting further chapters in two directions viz. one related to Alternative Frameworks and another related to the computer assisted learning. Inherent inseparability of the review of related literature from the theoretical framework needed in the context of the study has also been pointed out.