CHAPTER VII

OVERVIEW, FINDINGS, EDUCATIONAL IMPLICATIONS AND PERSPECTIVES FOR FUTURE RESEARCH

7.1 Introduction

Throughout history, intellectual, social, scientific, cultural and technological events at times, accumulated to produce a major turning point in human affairs. The introduction of agriculture, the industrial revolution, the use of computers, automation, bio-technology and genetic engineering, the revolution in information technology, the acceptance of mechanised farming and the use of satellites for weather forecasting mark such times. Again we find human beings challenged with a plethora of circumstances, events, and innovations in socio-scientific and socio-technical systems assures us that our future will not be like our past, no matter how we deal with them.

John Desmond wrote his book The Social Function of Science in the late 1930s intended to show that the proper relationship between science and society depended on the welfare of both. After seventy six years of the publication of that book it appears that the contemporary 'scientific and technological revolution' has been a part of what Bernard perceived. Today, there are two large fields of tasks, with the help of which the science of science particularly contribute effectively, to
influence the prospects of scientific progress: (i) Research in the scientific method and dynamic of science theories, and (ii) investigations of historic, organisational, economic, social, psychological and other aspects of scientific activity, with increasing attention being paid to ethical problems of science and social responsibility of scientists in our time, in particular their specific responsibility for the application of scientific research findings for exclusively human aims (Krober, 1991).

The scientific findings which are translated today, into general social practice, are, as a rule, results of relatively recent research, which are, moreover of a fundamental character, for example in the case of biotechnology or of the information and communication technologies. These scientific findings differ fundamentally from the educational level, society has attained so far. Thus, a wide range of professional groups and social strata is immediately confronted with the new science, new scientific values and totally different social responsibilities. Thomas Kuhn in the *Structure of Scientific Revolutions* (1970) has very aptly mentioned that through experimental and socio-cultural impacts new paradigm emerges and it leaves behind the old paradigm. Capra (1983) has observed that Descartes vision and Cartesian view of science has changed. The acceptance of the Cartesian view as absolute truth and Descartes' method as the only valid way to knowledge, has played and important role in bringing about current cultural imbalance. Cartesian view is linear, focused and analytic. This approach is likely to generate self centered activity. Today, there is a need of holistic view. The new vision of reality
is an ecological view in a sense which goes beyond the immediate concerns with environmental protection. This will prove meaningful only if it goes hand in hand with profound changes in values, beliefs and ethics.

A Conceptual and Empirical View of Understanding of Science and Scientific Temper

It is apparent that we get conceptual and functional aspects of understanding of Science and Scientific Temper. In this study the investigator has taken following meaning: Understanding of science is related to the preliminary knowledge of science concepts, science policy perspective and world view.

Scientific temper is a process of thinking to act objectively and rationally based upon available evidence at the time of making decision. Scientific temper is a state of mind, comprising, thoughts, action and conduct of an individual in a specific situation.

P. N. Huskar (1989) has observed that scientific methods and science itself are products of scientific temper. It represents ethos of science which encourages rationality, objectivity and intutive wisdom.

India has accepted Science as an integrated part of School Curricula. National Policy on Education 1986 (1992) has highlighted the need and inculcation of scientific temper through formal education. Similarly, A Study Report from Research Centre for Educational Innovation and Development, Tribhuvan University (1990) has observed 'Science education at school has to be given a new drive, a new direction. But this kind of innovative measure can come up effective only if the
school science curriculum aims to develop in the students scientific attitudes towards things in real life situations and simple specialised skills in observing the everyday phenomena as they occur around them.

Thus, India has accepted the development of understanding of science and scientific temper among students through formal education. In addition to it there are some Non Government Organisations actively engaged in developing scientific literacy. Media has also started meaningful programmes namely 'Turning Point' and 'Living on the Edge' to inculcate awareness of science and science related issues.

Conceptually, different meaningful efforts have been initiated. But empirical evidence appears to be sparse. The investigator could not locate any published study on the Public Understanding of Science. However, investigator could locate three studies, Mathur (1990), Sood (1992) and Kansakar (1996), on the Public Understanding of Science. Similarly, there was only one published study on Scientific Temper (Singh, 1990). However three other studies, Sharma (1991), Dubey, K. K. (1992) and Leela Pradhan (kansakar) 1996, on Scientific Temper have also found. It is clear that there is an urgent need of assessment of understanding of science and scientific temper.

The situation is not very encouraging in developed countries too. There are limited studies in these areas but ample work has been done on scientific attitude. In Biritain Lucas (1983), Miller (1983) and others have attempted some studies which are very limited.

As the Royal Society's report noted, whilst survey of public
attitudes to science have been plentiful, especially in the U. S. A., detailed investigations into the scientific knowledge which adults possess are sparse. Indeed a recommendation of the Royal Society's report was that research into ways of measuring public understanding of science and technology and of assessing the effects of improved understanding should be sponsored by research funding agencies (1985, p. 12).

Therefore, the investigator has studied this problem.

There is a need to study another aspect of the understanding of science. Knamiller (1984) has observed that the conventional science education programmes dominate the third world classroom. Al-Hidabi searched for relevant science education in Yemen schools through an examination of policy statements, text book content, classroom teaching and examination papers. He found that there was a very wide gap between the policy making level and the implementation level. There was very little reference to the social as well as national aspects of science relevance in science books and science teaching classrooms.

The explosion at Chernobyl that spread radioactive cloud across the Ukraine and Europe, poisoning crops spawning bizarre mutant like stock and exposing nearly 5 million people to dangerous fall out. How many people understand the devastating environmental implications happen by chernobyl style accidents? Perhaps very limited people can understand it.

The Bhopal Gas leak tragedy in 1984 was the world's worst
industrial disaster with far reaching consequences, compelled people to think that scientific literacy, understanding of science will help in piercing the consequences of our actions.

7.2 Statement of the Problem
The investigator has researched the following problem:
"A STUDY OF THE UNDERSTANDING OF SCIENCE AND SCIENTIFIC TEMPER OF HINDU AND MUSLIM STUDENTS"

7.3 Objectives of the Study
The study was planned to achieve the following objectives:

1. To determine the levels of understanding of science among Hindu and Muslim students.

2. To study the effect of type of school, class level, geographical locale and sex on levels of understanding of science.

3. To study the levels of scientific temper among the Hindu and Muslim students.

4. To study the effect of type of school, class level, geographical locale and sex on levels of scientific temper.

5. To determine the relationship between levels of scientific temper and understanding of science.

7.4 Hypotheses of the Study
In order to achieve the foregoing objectives, following hypotheses were formulated:

1. Theoretical mean of the total sample is not different than the obtained mean on the understanding of science scale.
2. Students from Hindu & Muslim religion are not different on the understanding of science scale and its dimensions.

3. Students of different groups are not different on scores of understanding of science scale and its dimensions due to class level differences.

4. Students of different classes are not different on the scores of the understanding of science scale and its dimensions.

5. Students from urban and rural schools are not different on the scores of the understanding of science scale and its dimensions.

6. Students from different types of school are not different on the scores of the understanding of science scale and its dimensions.

7. Theoretical mean of the total sample is not different than the obtained mean on the scientific temper scale.

8. Students from Hindu and Muslim religion are not different on the scientific temper scale and on its dimensions.

9. Students of different groups are not different on scores of scientific temper and its dimensions due to class level differences.

10. Students of different sexes are not different on the scores of scientific temper and its dimensions.

11. Students from urban and rural schools are not different on the scores of scientific temper scale and its dimensions.

12. Students from different types of schools are not different on the scores of the scientific temper scale and its dimensions.
13. There is no significant relationship between scores of scientific temper scale.

14. There is no significant effect of following on coefficient of correlation between scores of understanding of science and scientific temper:

I) Class level of students

II) Geographical location of students

III) Type of school of students

IV) Sex of students

7.5 Research Setting: Selection of The Sample

The sample of the study was selected from all the Government and Private secondary schools of Jhansi Region, comprising three Districts: Jhansi, Orai (Jalaun) and Lalitpur, by random sampling procedure. In other words, this sample is representative of the whole population. In this study students of both the sexes from different geographical locales have been selected randomly. Random selection is a process by which every element in the population has an equal chance of being chosen in the sample and the same was adopted for the present study.

The sample comprises Hindu and Muslim students studying in 9th and 10th classes. The total sample includes 1000 students and its distribution is as follow:
TABLE 3.1
SAMPLE DISTRIBUTION (N = 1000)

<table>
<thead>
<tr>
<th>Religion</th>
<th>Geographical Locale</th>
<th>Class</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hindu</td>
<td>Muslim</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>400</td>
<td>800</td>
<td>200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Urban</th>
<th>Rural</th>
<th>9th</th>
<th>10th</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>660</td>
<td>340</td>
<td>650</td>
<td>350</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Salient Features of the Sample:**

The investigator has selected sample in accordance to the need of the study. This study is meant to determine the levels of understanding of science and scientific temper among the students. This sample has following characteristics:

1. Students from two different religious background, namely Hindu and Muslim have been selected.
2. Students from different academic background have been selected.
3. One group of students (class 9th students) have studied science for nine years in school, which is a sufficient period to inculcate scientific temper.
4. This sample comprises both male and female to determine sex bias, if there is any, due to formal education.

**7.6 Research Design**

There were five independent variables, each has two levels. Therefore, the research design for this study has been factorial design. The five independent variables has been as follows:
1. Type of Religion : Hindu and Muslim
2. Class level : 9th and 10th
3. Type of School : Government Schools and Private Schools
4. Geographical locale : Urban and Rural
5. Sex : Male and Female

The dependent variables of the present investigation has been:

1. Understanding of Science and its Dimensions
2. Scientific Temper and its Dimensions

**Procedure for Analysis :**

Data has been computerised and following calculations were made:

1. Mean and Standard Deviation
2. Critical Ratio test for significant difference between means
3. Coefficient of correlation

With the help of above statistical treatments, inter group comparison and relationships has been tested.

**7.7 Instruments**

The investigator has adapted two instruments, constructed and validated by Leela Pradhan (Kansakar), 1996. These are:

1. The Understanding of Science Scale
2. Scientific Temper Scale
1. Understanding of Science Scale comprises three dimensions namely,
   I. Concepts of Science
   II. Science Policy perspective
   III. Science Value Perspective

   There are 40 items in this scale of which 20 items deals with Concepts of Science, 15 items Science Policy Perspective and 5 items for Science Value Perspective.

2. The Scientific Temper Scale comprises four dimensions namely:
   I. Value Perspective
   II. Aversion to superstitions
   III. A set of attitudes
   IV. A world view perspective

   There are 30 items of which 16 items deals with Value Perspective, 6 items Aversion to Superstitions, 4 items a set of attitudes and 4 items - A world view perspective.

7.8 Findings Related to Understanding of Science

Investigator has tried to find out the levels of understanding of science among the students of Hindu and Muslim. The findings are as follows:

1. The total sample of students of Hindu and Muslim (N=1000) has favourable understanding of science. It was also inferred that the total sample has favourable understanding of science concepts, science policy perspective. Incidentally, understanding
of science among students was not highly favourable on dimension value judgement.

2. It was found that Hindu students (N=600) possess significantly higher understanding of science than the Muslim students (N=400). Hindu students had significantly higher understanding of science concepts, science policy perspective and value judgement dimensions.

3. It was indicated that students from 9th class donot significantly differ from students of 10th class on their understanding of science and its dimensions accept science concepts, in which 10th class students possess more favourable understanding.

4. Similarly, male and female students do not differ significantly on their understanding of science. But there is significant difference between male and female students on dimensions: science policy and value judgement. The male students possess more understanding on above mentioned dimensions than female students.

5. It was revealed that students from schools situated in urban possess higher understanding of science than the students from schools situated in rural. it is true on the three dimensions of this scale also.

6. It was indicated that the students studying in private schools has higher understanding of science than students from Government schools. It was also revealed that:
(a) The Hindu students from private schools possess higher understanding of science accept dimension III- Value Judgement in which there is no significant difference between Hindu students of Govt. and Private schools.

(b) The Muslim students from private schools were not different from the students of Government schools concerning their understanding of science accept on dimension I- Science Concepts and dimensions III- Value judgement. Where, there is significant difference between Muslim students from Govt. and Private schools. The private school students possess more favourable understanding on these dimensions.

7. There is significant difference between 9th and 10th class students of Hindu in their understanding of science. 10th class students possess higher understanding of science on all the dimension except dimension III- Value Judgement where there is no significant difference between 9th and 10th class Hindu students. But their counterparts that is Muslim were not significantly different in their understanding of science. But there is significant difference on dimensions of understanding of science. The 10th class Muslim students possess favourable science concepts, science policy and value judgement than the 9th class Muslim students.

8. It was indicated that the 9th and 10th class students of Hindu and Muslim differ on their understanding of science and
students of Hindu possess much more favourable understanding of science.

9. It was indicated that male and female students of Hindu and Muslim independently do not differ significantly concerning their understanding of science.

10. It was indicated that male Hindu and Muslim students as well as female Hindu and Muslim students significantly differ in understanding of science. Male and female students of Hindu possess much more favourable understanding of science.

11. It was indicated that the students from urban and rural schools differ in their understanding of science. This is true for the students from both Hindu and Muslim. The students from urban schools possess much higher understanding of science. But students from rural schools of Hindu and Muslim do not differ in their understanding of science. Students from urban schools of Hindu and Muslim differ in their understanding of science. The urban Hindu students possess higher understanding of science.

12. Students from Government schools of Hindu and Muslim differ on their understanding of science. This is also true to students of private schools. Hindu students from Government and Private schools possess higher understanding of science.
7.9 Findings Related to Scientific Temper

The investigator has tried to measure Scientific Temper of the students of Hindu and Muslim. The findings are as follows:

1. The total sample (N=1000) has above average scientific temper. The sample has positive and favourable value perspective, it has aversion to superstitions, favourable attitude towards science and has constructive world view about science and its role in developing a balanced world.

2. It was indicated that the students of Hindu reflect higher level of scientific temper than the students of Muslim. These two groups significantly differ on different dimensions of scientific temper, that is, Value Perspective, Aversion to Superstition, Attitude towards science and a World View Perspective.

3. This study has reflected that 10th class students possess much more favourable scientific temper in comparison to 9th class students. It was also indicated that 10th class students possess higher level of value perspective, attitude towards science and a world view perspective.

4. It was indicated that there is no difference in the level of scientific temper due to sex differences. But there was significant difference between male and female students on a world view perspective and a set of attitudes. Male students' thinking was on the higher side.
5. It was revealed that the students from the schools situated in urban areas has much higher level of scientific temper than the students from schools of rural areas. This is true on the all four dimensions of Scientific Temper Scale.

6. It was indicated that the students from private schools possess higher level of scientific temper than the students from Government Schools.

7. It was inferred that the 9th class students of Hindu possess higher level of scientific temper than the 9th class students of Muslim. But there is no significant difference in a world view perspective of 9th class Hindu and Muslim students.

8. It was observed that the 10th class students of Hindu has high level of scientific temper than the 10th class students of Muslim. But there was no difference in these two groups on dimension IV- A world View Perspective.

9. It was observed that the male students of Hindu has higher level of scientific temper than the male students of Muslim.

10. It was revealed that there is no significant difference in the level of scientific temper of female Hindu and Muslim students.

11. It was observed that there is no difference in the level of scientific temper of rural Hindu and Muslim students. But there was significant difference between rural Hindu and Muslim students on all the dimensions of Scientific Temper Scale.
12. It was revealed that the urban Hindu and Muslim students significantly differ in their level of scientific temper. The urban Hindu students possess higher scientific temper. It was also revealed that there was no significant difference between Hindu and Muslim urban students regarding aversion to superstitions.

13. It was indicated that there is no significant difference between Government school Hindu and Muslim students on level of scientific temper. However, there is significant difference on dimension II - aversion to superstitions. The Government school Hindu students possess more aversion to superstitions.

14. It was observed that private school Muslim students possess more scientific temper than Private schools Hindu students. But there was no difference between two groups on a world view perspective of scientific temper.

15. It was revealed that 9th class and 10th class, Hindu and Muslim students significantly differ independently in their level of Scientific Temper. 10th class Hindu and Muslim students possess higher scientific temper than their 9th class counterparts.

16. It was indicated that there is no difference in the level of scientific temper due to sex difference. Hindu male and female students as well as Muslim male and female students possess same level of scientific temper independently.
17. It was revealed that rural and urban Hindu students are significantly differ on their level of scientific temper. Urban Hindu students possess higher scientific temper. Similarly rural and urban Muslim students differ on their level of scientific temper.

18. It was indicated that Hindu students from Government and Private schools differ in their scientific temper Hindu students from Private school possess higher scientific temper. Similarly Muslim students from Government and Private schools differ in their level of scientific temper. Private school Muslim students possess higher level of scientific temper.

7.10 Findings Related to Relationship Between Understanding of Science and Scientific Temper

1. There is significant relationship between understanding of science and scientific temper. It was revealed that scientific temper has significant correlation with concepts of science, science policy perspective and science value perspectives. Similarly, there was significant relationship between dimensions of scientific temper and understanding of science.

2. This study has revealed that the total sample of Hindu students have significant relationship between understanding of science and scientific temper. It is true in the case of Muslim students too.
3. This study has revealed that the total sample of 9th class and 10th class students has significant correlation between understanding of science and scientific temper.

4. There has been no effect of sex on relationship between understanding of science and scientific temper. The relationship between the two was significant.

5. There has been no effect of students of schools situated in urban and rural geographical locales on the relationship between understanding of science and scientific temper.

6. It was revealed that there has been no effect on students from Private and Government schools on the relationship between understanding of science and scientific temper.

7.11 Educational Implications

India has accepted planned national development, and, in the order of priorities, education has been accorded a high priority as an integral part of country's national developmental process. Consequently, the number of literates has increased tremendously, enrolment at the primary school level has been encouraging, the infra structure for schooling has been provided to a great extent and trained teachers have been hired to implement the national education policy. Since education is a dynamic, continuous process, it needs further efforts to provide relevance and quality. In particular, efforts would be made to raise the standards of science and mathematics.
India has started Science for All and all students study science compulsorily up to secondary level. At the primary level students learn science as environmental study, which provides relevance to science education. Yet much remains to be done. Aruna Narlikar (1989) has reviewed a film Global Warming and focused on the allied causes of environmental degradation. Environmental challenges such as acid rain, depleted ozone layer, deforestation and global warming are threatening the very survival of the human race.

Therefore, an awareness about these environmental hazards has become essential for public.

Secondly, India has been conventional societies which faithfully believe in old beliefs and miracles happening in the community. A genuine faith in conventional beliefs and in miracles means living on hope for all the time. The drinking of milk by the Ganesh idols in India, Nepal, Dhaka, London, U. S. A. and other places on September 21, 1995 has presented a picture of miracle-promoting credulity and straining credibility. This miracle was taken as a miracle, strengthening the conventional faith of supernatural powers in people and taking scientists' explanation phony. The rationalist who refuses to accept miracles, was reduced to minority.

These two pointers - science related environmental issues and faith in traditional beliefs necessitates scientifically literate citizens, who understand science and use scientific temper for quality living. It has far reaching educational implications.
This investigation leads further about the problems of population control, controlling industrial disasters and diseases such as plague and malaria. Hopefully, scientific knowledge will provide sound base for developing scientific thinking and values of science. An educational programme demands changes in (i) Goals of Science education, (ii) Science curriculum, (iii) Teaching-learning interaction processes and (iv) Assessment of formal and non-formal science education programmes.

It leads to rethinking about the contemporary challenges of life and living, as evidenced by our ecological, health and energy problems.

Goals of science education should lead to understanding of science and development of scientific temper. The goals of science education given by Hodson and Reid (1988) are appropriate and useful in developing a brief list:

* General awareness of science concepts.
* Application of science problem solving skills to everyday situation.
* Independence of thought and self-confidence.
* Perseverance and tenacity in the face of difficulties.
* Intellectual curiosity.
* Tolerance of the views of others.
* Willingness to predict, speculate, and take 'intellectual risks'.
* Openmindedness.
* Self criticism.
* Honesty and integrity in carrying out and reporting, experimental work.
* Informed and healthy scepticism based on the limitations of science.
* Suspended Judgement.
* Recognising the role of science in shaping society.

Science Curriculum

A common science curriculum needs appropriate content which is relevant, adequate, accurate and contemporary. It should be related to real life situations. It should be philosophically and psychologically sound (Hodson, 1985). Such a coherent scientific curriculum should contain following (Reid, Hodson, 1985):

2. Application of Knowledge.
4. Problem solving and interaction with technology.
5. Economic, ethical, social and political issues in science.
6. Philosophical and sociological considerations.

Teaching Learning Interactions and Assessment:

The new curriculum have enormous implications for teaching and learning methods and assessment procedures and science teachers' attitude. learning should be learner centered and a variety of learning
routes should be explored to meet the needs of different abilities of students. The notion of mastery learning carries with it a clear specification of minimum levels of expected attainment and criterion referenced assessment. It needs a well designed assessment and evaluation strategy, capable of continuously monitoring the progress of each individual.

7.12 Future Research Perspectives

This area is full of rich and varied future research. India is full of diversities both in educational and social context which forms the base of research. This area is directly related to philosophical and sociological science education aspects. Some of topics for future research may be as follows:

1. A study of the impact of non-formal sources of learning science on understanding of science and scientific temper.

2. A study of the public understanding of science in different geographical locales.

3. A study of mass media impact on the public understanding of science.

4. A study of science concepts, such as, energy, environment and genetic engineering.

5. A study of students ideas on nutrition.

7. A study of science for the masses: Goals and Achievements.
9. A study of Environmental Awareness among different groups of People.
10. A study of science concepts and Values among different groups of people.
12. A study of Science concepts, such as, Kidney Transplant, Industrial Waste and Nuclear Power.
14. A study of methods strategy and programmes for inculcating Understanding of Science and Scientific Temper among different groups of peoples and students.

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