Chapter Six:

Summary and Implications

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6.0 Introduction

India, on move, has its own wheels of science and technology. Fivefold growth in Literacy rate, sixteen fold rise in wheat output, forty eight fold growth in per capita power consumption, telephone connections shooting up from 1.1 million to 672 million and doctors from 0.5 per to 64 per lakh population are potential indicators of the strong base and growth of science and technology in India, in the last 63 years (TOI. 2010). In this context one can recall the observation of Kalam (2006), "Today India has become one of the strongest in the world in terms of scientific manpower in capability and maturity. Hence, we are in a position not only to understand the technologies that we may have to borrow, but also to create our own technologies with extensive scientific inputs of indigenous origin. Basically we have come a long way since our independence, from mere buyers of technology to those of who have made science and technology as an important contributor for national development and societal transformation. In a world where the powers are determined by their share of the world's knowledge, reflected by patents, papers and so on, the World Trade Organizations starts to play a crucial role in the economic development. It is important for India to put all her acts together to become a continuous innovator and creator of science and technology intensive products".

Development of any nation depends on its citizens, their intellectual property and social commitment. Science and technology is one of the key determinants of development. Science and Technology can develop to the fullest if capacity of every citizen is realized to the fullest. With changing world scenario it is imperative for any developing nation to adopt and adapt to the global outlook, scientific temperament and rational thinking. Mashelkar (2000) while addressing to the gathering at Indian Science Congress has summarized the progress comprehensively as follows: "Let me sum up by recalling the new panchsheel of the new millennium, which we should launch in the year 2000. It is simply; child centered education, woman centered family, human centered development; knowledge centered society and innovation centered India. These principles if put into practice, will help India to acquire a

scientific temper, edge towards a 'learning community', realize national dreams of being knowledge society and leave behind memories of underdevelopment."

Learning community and knowledge society demands efficient teaching community with proficiency in creating learning climate and rational human beings rather than stereotyped machinist products from school education. It is noted that teachers teach the way they are taught. In majority of the classrooms the teachers practice the methodologies they have experienced in past and that continues to next generation. This chain is to be broken and stereotyped production is to be restricted for creating innovation centered society. This becomes responsibility of teacher training institutions. Innovative methodologies, constructivist pedagogies and activity centered instruction are the suggested ways to achieve the panchsheels mentioned above.

Classroom observations while teaching the course, review of related literature and the interaction with the students and teacher educators re-assured that study related to science education has a vital scope. At pre-service level the student teachers can be trained effectively as they are fresh and open to new ideas. Accordingly, this study was proposed for pre-service teachers at the bachelor of Education level. Keeping in view of the time period available for investigation it was aimed to expose the student teachers to various types of Activities throughout the year with the help of Activity Based Science Teaching (ABST). It also studied the effectiveness in terms of the difference found in student teachers disciplinary knowledge, understanding of science teaching, experimental ability and attitude for science teaching. Further, it was presumed that this study results in the improvement of competencies of student teachers as science teachers.

6.1 Title of the study

"Development and Implementation of an Activity Based Science Teaching Programme for pre-service student teachers"

6.2 Objectives of the study

Objectives of the study are placed below:

1. To develop the Activity Based Science Teaching Programme (ABSTP) for the student-teachers.
2. To implement the developed programme on student teachers.
3. To study the effectiveness of the developed programme in terms of the differences in student teachers with respect to ;

- Content knowledge of science and technology.
- Experimental ability.
- Understanding about nature of science.
- Teaching qualities enhanced as science teacher.
- Understanding about science teaching.

4 To study the effectiveness of the developed programme in terms of

- Student teachers' opinion about each of the activities after the implementation.
- Student teachers responses at the end of the implementation of Activity Based Science Teaching Programme.

6.3 Hypotheses

In order to achieve the above stated objectives following null hypotheses were formulated to study the effectiveness of the developed ABSTP.

H01: There will be no significant difference between the mean achievement of the student teachers' in pre test and post test with respect to the treatment given through developed Activity Based Science Teaching Programme.

H02: There will be no significant difference between the mean score of experimental skills of the student teachers' in pre test and post test with respect to the treatment given through developed Activity Based Science Teaching Programme.

H03: There will be no significant difference between the mean score of nature of science scale of the student teachers' in pre test and post test with respect to the treatment given through developed Activity Based Science Teaching Programme.

H04: There will be no significant difference between the mean score on a quality of science scale of the student teachers' in pre test and post test with respect to the treatment given through developed Activity Based Science Teaching Programme.

* All the above mentioned hypotheses were tested at 0.01 level of confidence.

6.4 Operational Definition of the Terms

1 Effectiveness

Effectiveness for the present study was seen comprehensively as indicated below. This includes both quantitative and qualitative dimensions:

- The difference between mean achievement score of the student teachers in pre-test and post-test with respect to the treatment given through the developed programme.
- The difference between the mean score obtained by the students on understanding of nature of science in pre-test and post test with respect to the treatment given through the developed programme.
- The difference between the responses of the student teachers before and after treatment on understanding of science pedagogy.
- Students' feedback and rating about each of the activity and their opinion after the implementation of programme.

2 Activity Based Science Teaching

It is the process of instruction, wherein the students' multiple senses were involved and students actively involved in teaching-learning process. For the present study activity based science teaching includes exposure of student teachers to different activities, such as demonstration, small group discussions, situational problem solving and brainstorming. Further, it includes group activities like, field trip, project work, preparing science skit, formation of online group and using it for sharing and submitting assignments, practicing various teaching methods in school, visiting science laboratory for planning and preparing plan for multipurpose science laboratory. These activities were designed in line with the secondary school 'science and technology' curriculum and syllabus of 'teaching of science' at Department of Education, Faculty of Education and Psychology, The M S University of Baroda, Vadodara.

6.5.1 Delimitation of the study

Present study was delimited to the secondary teacher training institutions i.e. B.Ed. level.

6.5.2 Limitation of the study

The study was limited to acquaint, expose, motivate and practically experience ABST by the student teachers and also to use activity based science teaching at secondary level. However, present study was not intended to find its effectiveness in their real classroom teaching at secondary school level, which is envisaged as a long term objective when they become teachers.

6.6 Methodology

Methodology includes various elements like, design of the study, selection of sample, the conduct of study, tools development, data collection and statistical treatment. Details of these elements are presented in the following sections.

6.6.1 Design of the study

The research was aimed to develop an Activity Based Science Teaching Programme to prepare the student-teachers for teaching science at secondary level through the course "C 507: Teaching of Science" at B.Ed. Programme, Department of Education, The M. S. University of Baroda. Developed Activity based Science Teaching Programme was implemented on student teachers for one academic year in a natural setting with the available resources. A single group pre test treatment post test design was adopted for the study as mentioned below:

Pre-Test **(Mi)**	Treatment **(X)**	Post Test **(Mii)**	**Mii –Mi**
Mean of the Pre test	ABSTP	Mean of the Post Test	Effectiveness of ABSTP

6.6.2 Population

The student teachers with graduation / post–graduation in science of the B.Ed. Programme, Department of Education of academic year 2009-2010 of The Maharaja Sayajirao University of Baroda, Vadodara, comprised the population for present study.

6.6.3 Sample

The study was focused on developing an activity based science teaching programme for the student teachers through transecting the content of 'C 507: Teaching of Science' at B.Ed. level. Following criteria were detrimental and a critical need for the study, hence B.Ed. student-teachers opting science as one of the methods in Department of Education, FEP, The M S U of Baroda, Vadodara were selected with the following purpose as sample.

- Scope of continuous involvement and interaction with the student-teachers in the regular classes.
- Ease of conducting the various activities and freedom of interacting with students after the regular classes.
- Ease of evaluating the student-teachers for various activities.
- Facilities required such as LCD projector and computers with internet facilities as

one of the important activities.

- ❑ Ease of collecting the regular feedback and modifications in the classroom transactions.

For the requirement of the data for objective one, student teachers of the academic year 2007-2008 and 2008-2009 who were admitted for B.Ed. programme and opted for the course 'teaching of science' as one of the methods were considered as the sample. All the student teachers of the course: "C-507: Teaching of Science" of the B.Ed. Programme of the Department of Education of academic year 2009-2010 of The Maharaja Sayajirao University of Baroda, Vadodara were selected purposively for the present study. There were total forty five students in the group out of which four students have left during the academic session and finally there were forty one students, who were the actual sample for the entire experiment.

Table 6.1: Description of the sample

Sr. No	Objective	Academic Year	Sample size
1	Development of ABSTP	2007-2008	35
2		2008-2009	45
3	Implementation and Effectiveness of ABSTP	2009-2010	41

6.6.4 Tools and Techniques of Data Collection

To obtain the required data for research following tools and techniques were used.

- ❑ Achievement test
- ❑ Activity Evaluation Sheet
- ❑ Criteria for the analysis of the course C 507
- ❑ Curriculum of the subject science and technology at secondary level.
- ❑ Feedback Sessions
- ❑ Feedback sheet
- ❑ Field Diary
- ❑ Field Notes and Anecdotes
- ❑ Nature of Science Scale
- ❑ Observations
- ❑ Photography
- ❑ Programme Evaluation Sheet
- ❑ Rating Scale
- ❑ Science Pedagogy Questionnaire

- Science Teachers Quality Scale
- Small Group Discussions
- Videography

6.6.5 Data collection

Considering the nature of study data were collected in two phases:

Phase I: Development of Activity Based Science Teaching Programme

In the first phase a rigorous exercise of developing the Activity Based Science Teaching Programme (ABSTP) for student teachers of the course C 507: Teaching of Science was carried out. Following steps were followed to achieve the same.

1. Analysis of the Course C 507: Teaching of Science at Department of Education was carried out to have a comprehensive understanding of the course and its components. The analysis of the syllabus was carried out using the following criteria.
   - Nature of content
   - Scope of incorporating activity/activities
   - Scope of integrating it with secondary curriculum

   This course intends to develop various pedagogical competencies among student teachers to enable them to be effective teacher at secondary level hence; an understanding about secondary science curriculum is also required to design the activities for them.
2. An analysis of curriculum of 'Science and Technology' subject at secondary level was done to develop a comprehensive understanding about the subject matter which the student-teachers have to use as a medium to achieve long term objectives of teaching of science. Criteria followed while analyzing the content were as follows;
   - Basic concepts covered
   - Possible activities which can be done by science teachers
   - Scope of integrating the possible activities in teaching to the student teachers through course 'Teaching of Science'
3. Considering the syllabus of the course 'Teaching of Science' and curriculum at secondary level possible activities were identified.
4. An initial outline of the possible activities was prepared and implemented on the student teachers during the academic year 2007-2008. At the end of the year a

group discussion was carried out to know responses of student teachers on each of the activities and its suitability for them. Feedback was collected from student teachers in a written form (Annexure VII) about the activities which are possible to be carried out for each of the units of the course 'Teaching of Science'.

5. The Initial draft of the Activity Based Science Teaching programme (Table 4.1) was prepared and sent to the experts (list of experts; Annexure X) for their suggestions and feedback. Suggestions provided by student teachers of academic year 2007-2008 and the experts were incorporated and it was implemented on the student teachers during the academic year 2008-2009 to study the possibilities of implementation of each of the activities through the course 'C 507 Teaching of Science'. At the end of the year student teachers feedback was collected for each of the activities and its effect on them through group discussion and feedback sheet (Annexure VII)
6. Based on the student-teachers feedback and researcher's observation during the tryout of ABSTP addition/modification/omission of activities was made.
7. A final Activity Based Science Teaching Programme was prepared keeping in mind the ease of administration, time factor and the tentative schedule of the B.Ed. programme during the academic year 2009-2010. The programme covered various activities to provide inputs for enhancing their knowledge, understanding and application of the learnt science knowledge to enable them to be effective in teaching science with various activities.

Phase II: Implementation of ABSTP and study of its effectiveness

The developed ABSTP was implemented from June 2009 to April 2010 on the student teachers who opted for 'Teaching of Science' as one of the methods of teaching during the academic year 2009-2010. Pre-test was conducted on student teachers before the implementation of the ABSTP. Intention here was to know their prior knowledge and understanding about the various aspects covered in the ABSTP before undergoing a treatment in the form of ABSTP. Programme was implemented as per the finalized schedule, the details of which are provided in Chapter IV (Table 4.2). At the end post test was conducted by using the same set of tools.

Phase III: Effectiveness of the developed ABSTP Effectiveness of the ABSTP was seen in terms of the difference in the mean scores obtained by student teachers during pre test and post test tools. The effectiveness of the programme was also judged by

collecting the relevant and adequate evidences in the process of trying it out on group of student teachers. At the end of every activity student teachers' responses on worthiness and importance of the activity for science teachers and rating for each of the activity on a five point scale was collected with the help of Activity Evaluation Sheet (Annexure VI). To get comprehensive feedback about the ABSTP, Programme Evaluation Sheet was given to the student teachers at the end of implementation of ABSTP. To study the effectiveness of ABSTP on student teachers during the process, anecdotes were maintained and researcher observed and recorded the changes in the students while undergoing the treatment over a period of time either by video recording/photography and/or field diary.

A **Programme Evaluation Sheet** was given to the students after the presentation. They were asked to give their fair and objective responses about the ABSTP as specified in the PES. To evaluate the process of the implementation of ABSTP and effectiveness of each of the activity individually **Activity Evaluation Sheet** was given to the students immediately after the implementation of each of the activities. During the process, when the performance based group activities were conducted, video recording and field diary was used to record the observations.

6.6.6 Data analysis

The very specific nature of research carried out called for an amalgamated set of response recordings. Different tools, used in the study and as discussed above, deserve a varying statistical treatment for analysis. Accordingly, the researcher employed the relevant statistical procedures and details of which are as follows.

Data collected in the first phase for the development of the ABSTP through Feedback Sheet were analyzed using content analysis. Quantitative information collected through Achievement test, Nature of Science Scale, Science teachers Quality Scale and Rating scale was analyzed quantitatively by using 't' test. Data obtained by Science pedagogy questionnaire and Programme evaluation sheet was analyzed using frequency and percentage and content analysis technique. Data obtained through observation, discussions, feedback sessions, video-recording was analyzed using qualitative content analysis. Data obtained as a part of ongoing analysis of the activities through AES was analyzed by (a) using frequency and percentage analysis for close ended items (b) Qualitative content analysis for open ended items.

6.7 Major findings

- The first objective of the research being development of an ABST programme, the researcher developed various group and individual activities, indoor as well as outdoor activities and small group discussions in the course C-507 Teaching of Science through use of science concepts at secondary level. The designed activities provide testimony to the fact that it is possible to provide learning experiences based on constructivist, experiential, collaborative, co-operative and ICT embedded learning technique to the student teachers through ABST programme.
- The developed Activity Based Science Teaching programme was implemented on a group of forty student teachers as per the decided time duration and periods specified from 29.06.2009 to 12.03.2010. The total time required for the implementation was 2,605 minutes (43.40 hours) in the classroom transactions i.e. fifty seven periods of forty five minutes each of which does not include the field work and the preparation time taken by the student teachers for activities such as internet surfing for group formation, laboratory visits, visit to District Science Centre, Dharampur, Community Science Centre, Baroda and other such outdoor visits.
- The developed Activity Based Science Teaching Programme was found to be effective in terms of:
  - The mean achievement score of student teachers was found to be higher in post test (31.5) as compared to the pre test (26.15). The t-value was 9.9799 which was significant at 0.01 level of confidence, which indicated that the student teachers' developed clarity on science concepts after the implementation of ABSTP.
  - The mean score of the experimental skills of student teachers' was found to be higher in post test (123.10) as compared to the pre test (99.85). The t-value was 5.1496, which was significant at 0.01 level of confidence, which indicated that the student teachers' experimental skills got enhanced after the implementation of ABSTP.
  - The mean score of student teachers on the nature of science scale was found to be higher in post test (176.7) as compared to the pre test (168.7). The t-value was 4.1396, which was significant at 0.01 level of confidence which

indicated that the student teachers' understanding about the nature of science was enhanced after the implementation of ABSTP.

- The mean score of student teachers on the scale for 'Qualities of science teachers' was found to be higher in post test (409.75) as compared to the pre test (379.47). The t-value was 3.2038, which was significant at 0.01 level of confidence, which indicated that the student teachers' found improvement in their qualities as a teacher in general and science teacher in particular after the implementation of ABSTP.

- With regard to the development of different skills and qualities as a result of engaging in science it was found that there was enhancement of their understanding of the benefits of scientific activities since in the pretest they could list only as many as thirty eight various qualities and skills while in the post test they could list out fifty eight various skills and qualities which can be developed by science. List of the same is appended. (Annexure XXI)
- In response to the question 'what are the different ways through which one can learn science?' it was found that there was more clarity regarding the various ways of learning science after the implementation of ABSTP since the student teachers could report fifty four different ways of learning science as compared to thirty two different ways mentioned in the pre-test. List of the same is appended. (Annexure XXII)
- The different activities included in the ABSTP could be categorized in two major categories viz. activities with least teacher support and activities with teacher's support. The former includes both outdoor as well as indoor while the latter has only indoor activities. With regard to the feedback of the students on these different activities it can be said that the student teachers' rating for the different activities was in decreasing order when it came from outdoor and indoor activities with least teacher support like visit District Science Centre-Dharampur, Community Science Centre at vadodara, Role-play on status of science clubs in schools of vadodara, Demonstration of concepts of Science, Making of science toys from waste material, film show on Global warming, development of the design for ideal science laboratory and value inculcation through concepts of science to indoor activities with teacher's support like discussion on qualities of science teachers, objectives of science teaching, self

evaluation of the experimental skills, enlisting TLMs in science, Brainstorming on methods and models of teaching and their execution and evaluation technique for science.

- With regard to the student teachers' evaluation of their actual learning outcomes as a result of the ABSTP, the student teachers responded in terms of the increase in content clarity, knowledge gained, awareness, sensitization, skill development, attitude development, innovative thinking, decision making, brain storming and planning ability.
- The activities like demonstrations and video recording of demonstrations improved their science process skills, the visit to science centers and different schools to study the status of science clubs developed in them clarity of scientific concepts and also improved knowledge on scientific concepts and experiments, it also helped them to understand the importance of science centers in teaching of scientific concepts, helped them through providing them opportunity for organization and planning of such educational tours, gave a picture of the status of science clubs and sensitized them on the role of teacher.
- The activities like discussion on qualities of science teachers, objectives of science teaching, preparation of ideal science laboratory, enlisting of science TLM, brainstorming on methods and models of teaching, evaluation tool and technique for science developed in them awareness regarding the role of teacher, decision making on the usage of appropriate method and model for teaching of scientific concepts, acumen in planning science laboratory and sensitization in the role of teacher in general and science teacher in particular.
- The activities like value inculcation through scientific concepts, film on global warming and preparation of toys based on scientific concepts with the help of the waste material available at home changed their attitude towards science teaching, sensitized them on the role of teacher in development of healthy environment and brought in them a behavioral change reflected through the oath that the students took to minimize the use of plastics and establish a science club that carries out activities for promoting such activities apart from enriching the scientific skills and knowledge.
- The formation of online group and sharing of assignments as well as its evaluation was one of the most liked activities of ABSTP as per student teachers

responses. Fourteen out of forty (35%) student teachers responded that for the first time they knew about the possibility of using online groups for academic purpose. Ten (25%) of the student teachers were not having their E-mail addresses when they joined the course. Eight (20%) of them felt very happy to report that due to this they were made to create and actually using it actively for knowledge sharing helped them. Six (15%) of them responded that they were using internet for information gathering earlier and this activity made them to share the gained information to others which was very beneficial to them during their teaching phase. Eight (20%) of them learnt to prepare documents and submit it online. Nineteen (47.5%) of them felt that it was an initiation towards the paperless society by making them submit the assignments online. They could realize that it was an attempt for academic networking forever.

- It was found that out of eighteen activities the most effective activity was the demonstration of the science concepts-II with the highest rating 4.75, whereas the least effective activity was preparation of objectives of science teaching with the rating of 3.325 and rest of activities were rated in between the two values as indicated in the table 4.23, the activity methods of teaching and its execution recorded 4.2 rating by the student teachers which is the median value of the all the rating. None of the activity was rated as poor and very poor in effectiveness.
- Most of the activities having rating higher than 4.2 were the unconventional, group based or field based activities. Most of the activities with less than 4.2 rating were group work in the classrooms followed by individual work which had teacher support or instructions in the process of implementation.

6.8 Implications of the study

In the reports of Indian National Science Academy (2005) it has been suggested that in order to revitalizing the system of science education in India there is a need for national model of science education and for that activities must be designed in full harmony with the child' environment. About teacher training it was suggested that school teacher training programs should be increased all over the country and opportunity should be provided to the teachers to experience the excitements while learning science through inquiry. This would help teachers to imbibe the same excitement in their students and raise their level of teaching. Similar concern was expressed in the report of NCFTE (2009) for preparing the humane teacher who can

be a participatory learner with the student rather than dictator. Present study was an attempt in this direction. Following implications can be drawn from the study.

- In teacher preparation institution use of activity based teaching is possible and can be designed for all subjects making teacher training institutes torchbearer of the changes in the school education.
- Present study paves the ways to the teacher educators for using the various learning methodologies in their classrooms so as to prepare humane teachers.
- Group activities and outdoor activities have more scope to provide comprehensive understanding to the future teachers about the type of environment expected of them when they become teacher.
- Discussion is also proved to be very important method of teaching and learning if carried out properly.
- Even at professional development level inputs for basic disciplinary knowledge remains pre requisite and should be mandatory.
- Role of community science centers is crucial and equally important in developing interest in learner at any level.

6.9 Suggestions for further studies

Present study of Activity Based Science Teaching programmes at B.Ed. level was a developmental cum experimental study. The focus of the study was to develop an activity based science teaching programme for B.Ed. student teachers of science discipline and implementing the same in the natural setting for one academic year without controlling any variables. It further studied the effectiveness of the developed ABSTP in terms of its effect on pre decided criteria. This study focused on pedagogical inputs in a given time frame and has scope to transect in the real classroom situations. The insight and experiences gained by the researchers gave a deeper understanding and few questions which can be further investigated. Those who want to sail in the area of classroom researches, science teaching or want to work on teacher training can look in to the following areas for further research

- This study was an experimental study carried out with the many activities and studied its effect on student teachers achievement, understanding, experimental skills, understanding about nature of science, enhancement of qualities as a science teacher, and scientific attitude. Instead A study without any experimental design

only focusing the processes of the implementation and their reactions responses and feeling during the implementation can be studied.

- Researcher felt that the real effect could be seen when teachers are implementing in secondary grades what they learnt. Hence a study with the multistage sampling having student teachers and students at secondary level wherein effectiveness will be studied on the bases of students' responses after student teachers taught in the classroom with the activities they studied. This will provide a clear picture of the real field and amount of training transected in the classrooms
- Researcher has conducted experiment on forty student teachers and adopted pre experimental design. A study with a control and experimental group can be taken up with the science student teachers and effect and differences can be further studied.
- Each of the outdoor activities mentioned in the research are worth to be taken up for the in depth exploratory research either at B.Ed. level or at secondary school level to study their effect on target group and realizing the academic importance of the activities.
- The study has incorporated various activities for the pedagogical training of science student teachers. A comprehensive study can be taken up for training all student teachers in pedagogical practices by modifying selected activities.
- A teacher training module can be prepared for in service training of science teachers at secondary level.

6.10 Conclusion

"Two roads divulged in the woods and I--
I took the one less travelled by,
And that has made all the difference"

- Robert Frost

The researcher when embarked upon the study found it really challenging to work in the area of ABSTP at teacher education level. However, coming to the end of it gives a feeling of great satisfaction not for having proved the t-values to be significant but for all the difference made to the student teachers, their insight in teaching, refinement on science process skills, sensitization on environmental issues and status of science teaching at schools and their future role, understanding of the nature of science, development of scientific temper and above all enthusiasm of a teacher and the

commitment to improve the status of science teaching at schools. This and many such promising programs at teacher education level seem to the researcher a '*The End*' of the chalk and talk methods and the beginning of a new dawn of Activity Based Science Teaching.