Chapter Three:

Research Methodology

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3.0 Introduction

Research is an unfolding of what already exists in the field. It is a planned and systematic search for the truth. In order to carry out systemic investigation planning, designing and understanding about the field is imperative. Research Methodology acts as a light house for the researcher in the journey of ocean of knowledge. It gives direction to the research and confidence to the researcher for conducting the research. In this chapter attempt is made to discuss various aspects involved in the specification of problem and methodology.

3.1 Rationale

Science is a way of life. It is also a part and parcel of life. Thorough understanding and application of science eliminates the miseries of individuals and the community as well. Science is more than a body of facts, a collection of principles and a set of machines for measurement. It is a structured and directed way of asking and answering questions. Pedagogical triumph does not lie in teaching the pupils the facts of science but to ensure that these facts are taught in relation to the procedure of scientific inquiry. Mere knowledge based teaching of science cannot help to achieve the benefits of science. One of the major objectives of teaching science is not only to teach content, but also to develop scientific attitude. Understanding about the learnt concepts and carrying out new experiments resulting into new knowledge in science. The concepts and principles of science are developed through a series of activities and experiments. Training the students in scientific investigations and inquiry is the most important aspect of teaching science. If science is taught and learnt effectively, individuals' life will become meaningful, prosperous and productive. It will have a positive impact on the community. Science therefore, needs to be taught as a procedure of scientific inquiry. When the students are taught in desired manner, dream of creation of scientifically literate society is possible because students are the future citizens. It is essential that the future citizens learn science not as a memory or magic but rather as a disciplined form of human curiosity. This will gear up research and innovation in the field of pure and experimental sciences.

Research in some areas of pure theoretical science is promising and progressive. On the other hand, experimental science in India is at least a decade behind, in

comparison to leading research centers abroad. In general, India's recent successes have been largely in engineering, not in pure science, and that many government research institutions are far below international levels. In the report of Indian National Science Academy (2002) it has been reported that majority of the students lose their interest in science subject by the time they complete Grade X due to lack of knowledge in subject teacher or they do not find science classes interesting and meaningful. Teachers were unable to relate the science concepts with real life situation, causing de-motivation in pursuing further studies in science stream.

Indian National Science Academy (2002) has further noted that "Science education must evoke the natural curiosity of the child, the wonderment for nature. For this, the education and its tools should be fashioned to the environment in which the child lives. The child should be encouraged to find its own answers with textbooks being only a guide. Concepts must be introduced and field trips and outdoor activities to learn must be encouraged. At the school stage itself, there should be spotters to identify special talents for science and these must be further supported by providing incentives." For that systematic efforts are needed at school education to relate the scientific knowledge with their daily life.

In the reports of NCF (2000) and NCF (2005) great emphases has been given to relate the school experiences with child's age range and its real life environment to consolidate learning. Further, above reports observe; at school level the quantum of practical laboratory work, field work must be substantially increased. To aid learning by inquiry, more exploratory methods must be incorporated into the curriculum. A larger number of experiments, kits and multimedia teaching aids should be created using locally available materials as far as possible. Various activities must be designed in full harmony with the child's environment and from this environment more detailed concepts of scientific truth must be understood. This would not only sensitize the child to its environment and help to solve niggling problems at a later stage but also make the whole exercise of learning all the more interesting and invigorating. In order to make the teaching learning more interesting, teacher has to use the available resources to their optimum level, seek for the new alternatives to create interest among students for learning. Selection of suitable method can ensure learning and enhance understanding of the leaner.

The selection of method of teaching any subject is largely based on the objectives of teaching the subject, nature of the topic, level of learners and availability of resources.

In a given set up, then, the selection of method of teaching depends on the nature of the topic to be taught. All the methods are equally good if used effectively. The lecture method is the one, most commonly employed in the science classes, and even where lectures are followed by so called practical work, they do not develop a proper grasp of the subject matter or the necessary skill required for analyzing and solving problems on the basis of scientific principles and data, or the right attitude towards the process or spirit of scientific inquiry.

The Education Commission (1964-66), critically observed and, which remains relevant, with concurrence to the comments of NCF that "In an average school, today instruction still conforms to a mechanical routine, and continues to be dominated by the old besetting evil of verbalism and therefore remains as dull and uninspiring as before." The report further remarks, "even where laboratory work is employed in science teaching, the approach is largely confirmatory and not investigatory so as to equip students in the techniques of acquiring knowledge by themselves." According to the report of the National Advisory Committee on 'Learning without Burden' (1992-93), "transmission of information rather than experimentation, exploration or observation characterizes the teaching learning process in most classrooms." Supporting the same view Kumar (2004), the Director of Homi Bhabha Centre for Science Education (HBSCE) stated, "It is unfortunate that the majority of schools across the country teach science in a boring and mechanical style allowing little room for original thinking and innovation. Most of the time of the science students spent on searching for correct answers rather than learning the process of getting the answer. This is a false interpretation of science teaching. Science is all about doing and learning even through mistakes. It's vital that interest in science is kindled and nurtured through the school years because it's from school system that our future scientists and technologists will emerge. We must catch them young."

Veerappa (1958) examined the position of science education in India and found that teaching science through herbertian plans, the lecture demonstration methods and essay type of questions in the examinations were the common trends. Researcher has suggested that concept based teaching and integrated approach has scope for science teaching in India which still holds true. Collette and Chiapetta (1984) noted that "Teachers of science have the challenging task of involving the students in scientific enterprise through science teaching. Science teaching should stress the different aspects of science such as a body of knowledge, as a method and as a way of

thinking." Above and following researches indicate that situation has not changed much in the field. Umashree (1999) found that 90% of the teachers in science classroom teach science as directed in the textbooks. In none of the classes under observation, problem solving or inquiry based teaching had been noticed. They simply follow the language given in the text and don't even simplify it. It is clear from the above discussion that teachers still continue to use the traditional chalk and talk method. On the other hand, Report of NCFSE (2005) emphasized that child should be a constructor of knowledge rather than mere reservoir of knowledge. This can be done through the active involvement of the learners in the teaching learning process.

The importance of teaching science through the active involvement of learners has been supported in the report of Secondary Education Commission (1964-66) when it noted "Demonstration experiments performed by the teachers should form an important and integral part of science teaching. It will not be sufficient to demonstrate the experiments but training them in performing the experiments effectively and efficiently. For creating scientists, at the secondary level students should be engaged in learning science as a composite discipline, in working with hands and tools to design more advanced technological modules". This can be ensured by providing experiential learning and involving them into various activities. National Council of Educational Research and Training NCERT (1986) in the guideline of curriculum transaction described that "Among the techniques of instruction which play an important role in the type of effective curriculum transaction involving activity based approach, the teacher has to be apt at: Planning of activities, Preparing the students for activities, Conducting and supervising activities and Conducting discussion for evaluating learning outcomes. Activities for evolving learning outcomes may be organized under the following three areas:

1. Operational / functional understanding of scientific principles / concepts
2. Competency to solve problems
3. Development of scientific attitude, interest and appreciation, such activities may include; teachers observations, situational problem solving, participation of the students, assignment of the project, short quizzes, paper and pencil test and students performance at work."

Teachers require due exposure to the ways and means of conducting various activities in science. This remains a prerequisite for providing various activities to students by the science teachers. This helps in an effort to bring reform in the teaching methods in

the classroom at secondary level and guideline for the teachers. Umashree (1999) reported that teachers still confirm themselves to the textbooks and hence implementation of NCERT recommendation could not get operational in classroom interactions because teachers did not have exposure for the same. One of the ways to understand something is to get ones hands on it and actually experiment with it. According to the report of India's first National Science Survey (NSS) (September 2005), "there is need for a change in our mode of teaching and learning as activity-based teaching provides simple yet dynamic tools for an effective classroom teaching. Science teaching in Indian schools needs a radical overhaul to stop students losing interest". For this, science educators and researchers in the field can provide guideline to the teachers by developing the programmes and strategies to implement.

Report of National Curriculum Framework (2005) emphasized constructivist approach and given due importance to revitalize the methodologies of learning. Constructivism includes cooperative learning, collaborative learning, active learning, experiential learning, problem based learning and hands on learning as its methodologies. This can be done by providing wide range of activities and experiences to the learners. Science by its nature has immense scope of using various activities in the science classroom, laboratory and out side. Activity based science teaching involves multiple senses of learner which helps to insure their involvement in the learning and leading them for self learning also. To implement these, MHRD (Ministry of Human Resource Development) has made recommendation to strengthen the quality of science teachers, their trainings, teaching methods, and the education infrastructure. Training the teachers at both in-service level and pre-service level for activity based teaching is mandatory. At in-service level Secondary teachers are expected to be trained every year for content cum methodology by the respective subject experts by respective State Council of Educational Research and Training, Institutes of Advanced Study of Education or Collages of Teacher Education. At pre service those who come to the teacher training institutions do not have such exposure. It is a proven fact that prevention is better than cure. Considering this recommendation and the arguments put forth in the subsequent lines, it has been thought that it is desirable to focus the present investigation on the student teachers of pre-service programme at the secondary stage.

In the report of National Curriculum Framework for Teacher Education (2009) it has been noted "the kind of teacher and teacher education we have envisaged calls upon

us to look at teacher education as a holistic enterprise involving actions of different kinds and from multiple fronts aimed at the development of total teacher knowledge and understanding, repertoire of skills, positive attitudes, habits, values and the capacity to reflect. We need teachers who organize learner centered, activity based, participatory learning experiences, play projects, discussion, dialogue, observation, visits and learn to reflect on their own practice." Teacher education institution and their role is crucial in realizing the above.

Department of Education, Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda, Vadodara is the one of the pioneer institutions for teacher training. It was established in 1935 and known as Secondary Teachers' Training Collage (Part of Baroda Collage) and later on became one of the departments in Faculty of Education and Psychology. It prepares the teachers for the secondary and higher secondary schools. At present it offers fourteen different method courses covering various subjects of secondary and higher secondary. Teaching of science is offered as one of the method courses with exclusive focus on the training of student teachers for teaching 'science and technology' subject at secondary level. The course provides training of various pedagogical practices in transecting the content of the subject science and technology. It assumes that student teachers have acquired adequate content knowledge of their respective discipline hence disciplinary inputs are not provided. The course content is rich enough to design the learning experiences with various emerging learning theories and strategies such as cooperative learning, experiential learning, hands on learning, active learning and inquiry based learning and field based learning. 'Science and technology' subject and the course content of 'teaching of science' both have great scope of using the constructivist learning tactics in the classroom by integrating them properly. Science teaching should ensure understanding of science as a concept, as a discipline and as a way of learning. A programme would be possible in this regards which has scope of incorporating the activities suggested by NCERT (1986) and NCFTE (2009) training the student-teachers through this course Teaching of Science for training them to be an effective would be science teachers.

In a nutshell, 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.

3.2 Research questions

From the few studies available on science teaching, it is observed that majority of the studies were conducted to know the status of science teaching, but experimental studies were very few. It is necessary to investigate and find the possibility of implementing the recommendations of NCERT (1986) and NCF (2005) and NCFTE (2009) while training the student teachers at B.Ed. level. Following questions guided the researcher, for further investigation.

- Is there any scope of preparing Activity Based Science Teaching Programme (ABSTP) for pre-service students at secondary level?
- Is it possible to implement the developed ABSTP in the given situation?
- What are the steps and activities, in sequence, to design ABSTP?
- What will be the consequences of implementation of the ABSTP?

3.3 Title of the Study

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

3.4 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 their implementation.
- ❑ Student teachers responses at the end of the implementation of ABSTP.

3.5 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 in the mean achievement score of the student teachers in pre-test and post test with respect to the treatment given through developed ABSTP.

H02: There will be no significant difference in the mean score of performance test of the student teachers in pre-test and post test on experimental skills with respect to the treatment given through developed ABSTP.

H03: There will be no significant difference in the mean score of the student teachers in pre-test and post test on understanding about nature of science with respect to the treatment given through developed ABSTP.

H04: There will be no significant difference in the mean score of the student teachers in pre-test and post test on qualities possessed by them with respect to the treatment given through developed ABSTP.

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

3.6 Operationalization of the terms

For the purpose of present study following terms are operationalized.

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.

- Student teachers' 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 included 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.

3.7 Delimitation of the study

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

3.8 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.

3.9 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.

3.9.1. Design of the study

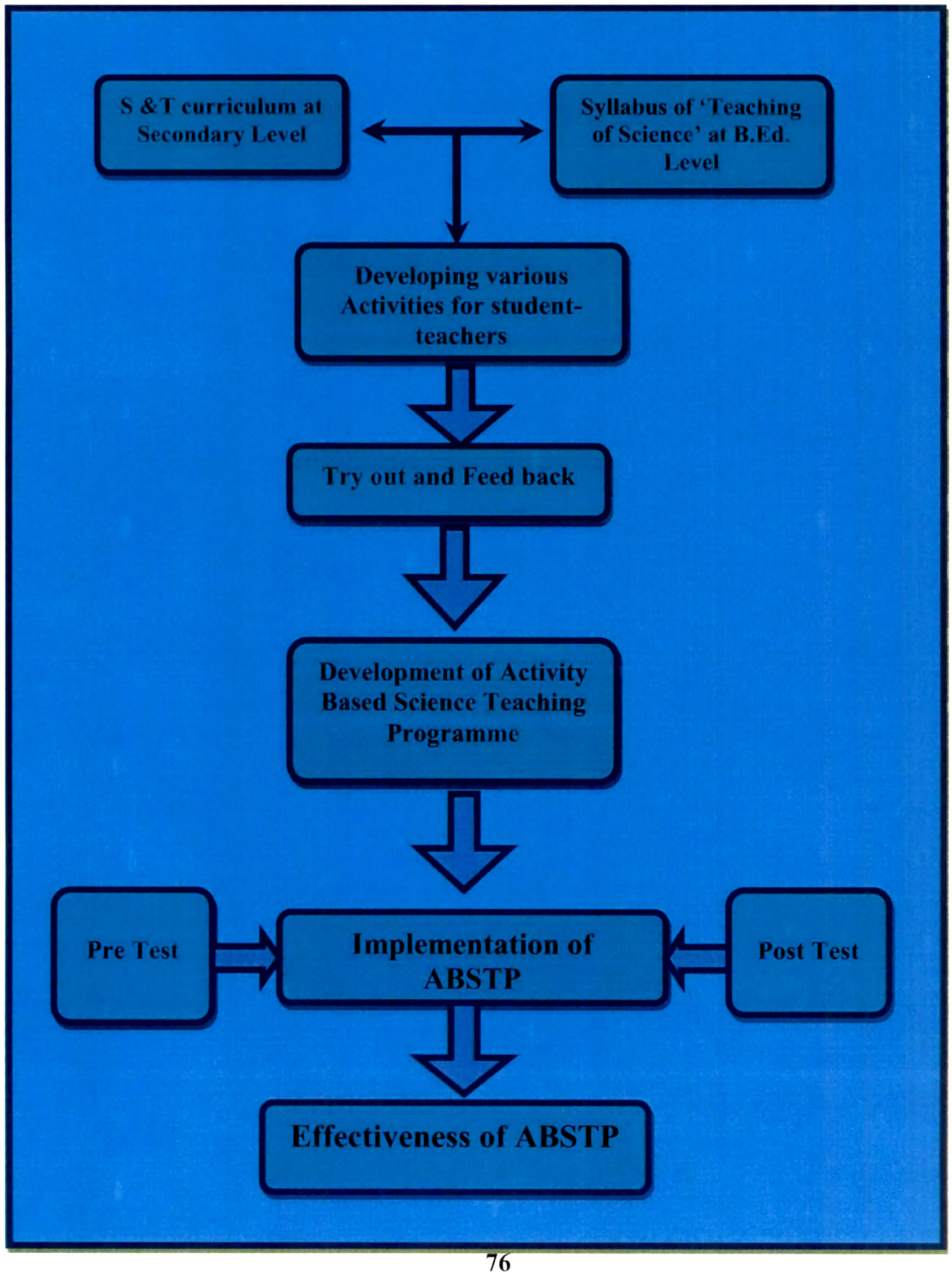
The research was aimed to develop an Activity Based Science Teaching Programme to prepare the student-teachers for teaching science at secondary level through the course "C 507: Teaching of Science" at B.Ed. Programme, Department of Education, The M. S. University of Baroda. Developed Activity based 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

Diagrammatic depiction of the research design is placed below (Figure 3.1).

Figure 3.1: Diagrammatic representation of Research design of the study



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.

3.9.2 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.

3.9.3 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, Faculty of Education and Psychology, The Maharaja Sayajirao University 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 3.1: 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

3.9.4 Data required for the study

To develop ABSTP, syllabus of the course teaching of science and curriculum of secondary science were required.

In order to implement the developed ABSTP to the sample during the academic year 2009-2010, academic calendar and schedule of B.Ed. Programme along with time table for academic year 2009-2010 were required to plan the implementation of the programme.

The programme was implemented on forty one student teachers of the year 2009-2010; accordingly, following data were required from them. The same was collected using various tools.

1 Academic profile of students: Qualifications, subject specialization during graduation and post graduation if any, teaching experience if any, medium of instruction during their schooling

2 Achievement score before and after the treatment

3 Performance test score before and after the treatment

4 Score of Nature of Science Scale before and after the treatment

5 Score of Science Teachers Qualities Scale before and after the treatment

6 Feed back of the student teachers after each of the activities

7 Email address of student teachers to formulate the group on yahoo groups to create academic network of student teachers

3.9.5 Sources of Data

Data for the study were collected from the following sources.

Information regarding secondary school science and technology curriculum was sought from the Gujarat State board of school textbook. In order to develop insight about the syllabus of teaching of science at B.Ed. programme in other universities the B.Ed. syllabus of universities of the state of Gujarat was collected by the researcher either from website of the university or by contacting the Head of the Department of Education of university in person. Researcher has collected information about the ten

different universities of Gujarat and curriculum of secondary teacher education was downloaded from the NCTE website.

Information, regarding the various activities to prepare the science teachers, was collected from practicing teachers, prospective teachers and teacher educators through personal interviews at various stages of the study. Science teacher educators at Regional Institute of Education (RIE), Bhopal and RIE Bhuvaneshvar were consulted for developing activities for B.Ed. students. Information about professional science teachers training was collected by consulting experts providing training to the practicing science teachers at national and international level. (Lists of experts appended in Annexure XIII)

Student teachers of the academic years 20007-2008 and 2008-2009 were the main source for the development of the programme. The information about the implementation and effectiveness of the developed programme was collected by the student teachers of the academic year 2009-2010.

Convener 'B.Ed. programme' was source of information regarding the academic calendar of B.Ed. programme for academic year 2009-2010. Convener of the course 'C 507: Teaching of science' was also source of providing the information about course structure and transaction of the course in last ten years in Department of Education, Maharaja Sayajirao University of Baroda, Vadodara to develop a comprehensive understanding about the course.

3.9.6 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
- ❑ 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

3.9.7 Development of tools

ABSTP aimed to enable student teachers to develop understanding about teaching science with alternative ways and acquire various abilities and skills required for teaching science. It is imperative to check their prior knowledge on various aspect of science learning before undergoing the implementation. Considering the above, a set of tools was developed containing various tests which verify student teachers knowledge in various aspects mentioned below in table 3.2.

Table 3.2: List of tools

Sr. No	Test	Dimension of science learning to be checked
1	Achievement Test	Knowledge understanding and ability to apply the science concepts of secondary level
2	Science Pedagogy Questionnaire	Understanding about teaching science at secondary level
3	Nature of Science Scale	Understanding about Science as a discipline and related concepts.
4	Rating Scale	Experimental skills
5	Science Teachers' Quality scale	Expected Qualities in science teachers

1. Achievement Test(AT)

As indicated above, this test was prepared to check student teachers clarity in the concepts from science and technology curriculum at secondary level. Student teachers opting science as one of their methods of teaching have at least a bachelors degree in science and are going to teach science and technology subject at secondary school level. Their knowledge about the content of science plays a vital role during their practice teaching in school even though at Department of Education, The Maharaja Sayajirao University of Baroda student teachers are neither taught nor are they evaluated on content of science. Hence, it becomes imperative to check their content knowledge. The Achievement test contained items which had questions from real life situations aiming at measuring understanding and application of the acquired knowledge of science in daily life. Achievement test had fifty multiple choice items related to the concepts of science taken from secondary science and technology. Initial outline of the achievement test was prepared based on the tests developed at Alberta University (1998) for assessing K12 school students in science subject

specifically grade 7 and grade 9. It possessed ability to assess science cognition and process skills of the students at particular grade. The similar pattern was taken up to design the Achievement Test for student teachers. The first draft having thirty items was prepared. After consulting the experts in the field of science teaching, their suggestions were incorporated. Twenty new items were added to cover wider range of the concepts from secondary school science and technology curriculum. It was implemented on the student teachers of science method during academic year 2008-2009 and their suggestions were collected. On the basis of analysis of the answers, few easy and some very difficult items were omitted and few new items were added. The final draft containing fifty Multiple Choice Items was prepared (Annexure I). It contained items on content of Physics, Chemistry and Biology concepts at knowledge, understanding and application level. Subject wise distribution of items is presented below. Number of items per subject varied based on coverage of the concepts at secondary science and technology curriculum.

Table 3.3: Distribution of items of AT as per the subjects

Subject	Item Number	Total items
Physics	01,06,07,11,12,19,24,26,28,30,31,34,35,37,38,41, 42, 44, 45, 46, 50.	21
Chemistry	02,04,14,15,16,17,18,21,25,29,32,36.	12
Biology	03,05,08,09,10,13,20,22,23,27,33, 39,40,43,47,48,49.	17

2. Science Pedagogy Questionnaire (SPQ)

It intended to check student teachers understanding about science teaching in school and different alternatives for science teaching at school level. It consisted of the items related to different aspects like, student teachers basic understanding about science as a discipline, their understanding about teaching science, past experiences, and methods of teaching science. A draft was prepared and given to the experts (Appended in annexure X) and suggestions were incorporated. Few items related to concepts of science teaching were added wherein they have to respond as they have to teach the content at a given grade. Final SPQ (Annexure II) contained fourteen open ended items.

3. Nature of Science Scale (NSS)

NSS was developed to know student teachers understanding about the nature of science, products of science and processes of science.

Table 3.4: Component wise distribution of the items

Sr. No	Component	Statement No.	Total items
1	Scientific attitude	02,03,09,10,12,13,17,23,34, 36, 38, 41, 45, 47, 49, 50	16
2	Scientific Facts	21, 35, 37	03
3	Scientific laws	04,05,39,40	04
4	Scientific Theories	06,07,08,42,43,44,48	07
5	Scientific Concepts	11, 46	02
6	Hypothesis	01, 14, 28	03
7	Product and process of science	15, 16, 18, 19, 20, 22,24, 25, 26, 27, 29, 30,31, 32, 33	15
		50	50

This test was prepared based on the items developed in a test 'what do you think about nature of science' for grade 12 by Enger, S. and Yager, R. (2001). "*Assessing Students understanding in science":* Crowin press. There were twenty statements in the original test for grade twelve which only focused on components mentioned in Serial Number two to six mentioned in the table 3.4. Developed NSS contained 50 statements (Annexure IV).Student teachers were expected to rate each of the statements on a five point rating scale.

4. Rating Scale (RS)

Rating scale was used to rate the performance of student teachers on predefined criteria. Student teachers performance was rated by a group of teacher educators on pre defined criteria to arrive at a score. Ten different criteria were decided based on the researchers' past experiences and review of literature in the initial draft. They were made explicit for the specifications and ease of evaluation. (Appended in annexure three part one)

1	Selection of the concept	2	Selecting the activity
3	Proportionality	4	Accuracy
5	Arrangement	6	Logical flow
7	Concept clarity	8	Presentation skills
9	Practicability	10	Worthwhileness

Above criteria were referred to the experts from various fields such as field of science teaching, evaluation and measurement and practicing secondary school science teachers. Based on the suggestions from the experts, criteria were modified and scaled down to five. Final rating scale (Annexure III part two) was prepared based on the following predefined criteria.

I) **Selecting the activity:** Whether the selected activities is in accordance with the topic selected from secondary science text book and suitability of the activity to explain the concept selected by the student teachers?

II) **Proportionality:** Whether it is the suitability of proportion of the equipment or materials and solutions used for the selected concept. Appropriateness of shape, size, volume of the apparatus etc. opted?

III) **Accuracy:** The way students handle the apparatus/materials /solutions whether it is with due care or accuracy? Cleanliness maintained while performing the activity and dealing with materials?

IV) **Arrangement:** While performing the activity how the student is arranging the apparatus and materials whether it is visible to all the students or not?

V) **Presentation skill:** It includes the Logical flow and sequence of the oral presentation and performance, way of presenting, clarity of concept and confidence which one is having while performing the activity.

Each criterion was given weightage of 10 marks and each student teacher was given marks out of 50 for five criteria.

5. Science Teachers' Quality Scale (STQS)

STQ scale was prepared as one of the activities of the programme in the initial stage, based on student teachers understanding about an ideal science teacher and qualities expected to be there in him/her. This test was having list of fifty attributes in two parts viz. Common attributes (thirty) and specific attributes of science teachers (twenty). Student teachers were expected to rate themselves on each of the attributes on a ten point rating scale. (Annexure V)

All the above mentioned tools **1-5 (Annexure I to V)** were used as a set of tools for pre-test and post test.

Activity Evaluation Sheet (AES)

Activity evaluation sheet was prepared to get feedback from the student teachers at the stage of implementation of each of the activities of ABSTP. It comprised of open ended and close ended questions. In the open ended items they were expected to provide their opinions about the activity, its importance for science teachers, its effect on them. While for close ended items student teachers were expected to rate themselves on five point scale on some statement related to effect of that activity on them. The Activity evaluation sheet was prepared keeping in mind all the possible outcomes of each of the activities used for all the activities. (Annexure VI)

Feedback Sheet (FS)

A feedback Sheet (Annexure VII) was prepared to collect the feedback from the student teachers of the academic years 2007-2008 and 2008-2009 about the implemented activities on them and colleting their suggestions about the activities and implementation.

Programme Evaluation Sheet (PES)

Programme evaluation sheet was prepared to study the actual outcome in the students at the end of the programme. It consisted of a list of every activity in front of which student teachers had to write the actual learning outcomes/behavioral changes which have taken place in them as a result of the implementation of the programme. There were twenty activities listed in the PES. Rating of each of the activities was done by student teachers on a five point rating scale. (Annexure VIII)

Information Sheet

Information Sheet (Annexure IX) was prepared to collect information from student teachers such as qualifications, subject specialization during graduation and/or post graduation, teaching experience, medium of instruction during their schooling and email addresses.

Field Diary

Specific observations and reflections of the student teachers during the period of development and implementation of ABSTP were recorded in the field diary.

Video Graphy and Photography

Video recording and photography was done to capture the glimpses of the process of implementation of the activities, feedback sessions, small group discussions and individual presentations. Video recordings of the students performance during the performance based test was done and shown to the student teachers for identifying the process skills executed in any demonstration/activity.

Following techniques were used to collect the data from the student teachers.

Small Group Discussions (SGD)

Small Group discussion was used in many activities to provide them opportunity to interact in small group, gather divergent ideas on a definite topic/idea and arrived at a common understanding and present it in front of other groups. Number of students in a group varied from five to eight as per the nature of activity.

Observation

While the implementation of the programme was going on researcher has observed the classes as participant observer to capture behavioral changes which have taken place if any. To check and study the changes in the experimental skills, extent of participation in group, working in small group activities observations were made and records were maintained for necessary subsequent analysis.

Feedback Sessions

In the process of development of the programme feedback sessions were conducted to collect student teacher's views, ideas, and reflections, suggestions, regarding the activities, its implementations and its importance.

3.9.8 Data collection

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

Phase I: Development of the ABSTP

For the purpose of developing the Activity Based Science Teaching Programme, outline of the course teaching of science at B.Ed. programme from ten different universities was collected. The collected syllabus was analyzed in terms of certain criteria. Prior permission of the Dean, Faculty of Education and Psychology and Head, Department of Education was taken in June 2007 before selecting the sample from the Department of Education, The Maharaja Sayajirao University of Baroda, Vadodara as sample for the study.

Data regarding the teaching methods adopted in the transactions of the course Teaching of Science since year 1998. Convener of the same course was contacted, and required information was collected, and activities were designed accordingly. The tentative outline of the activities were prepared and implemented. Data from the students of the academic year 2007-2008 were collected in March 2008 for activities implemented on them and ideas for new activities for different units. The tool used for this was Feed Back sheet. Group Discussion was carried out on the same day to know their responses, which were not covered in the feedback sheet such as their experiences, feelings and change in behaviors or attitudes during the implementation of the activities.

Data regarding the activities were collected from the student teachers of the academic year 2008-2009 after implementation of the activity based science teaching programme for further implementation and finalizing the activities for it. Focused

Group Discussion was conducted for collecting responses from the student teachers regarding the ABSTP.

Phase II: Implementation of ABSTP and study its effectiveness.

- B.Ed. programme for the academic year 2009-2010 started from 18th June, 2009.
- Permission from the Head, Department of Education was taken in June 2009 for the actual implementation of the ABSTP during the year 2009-2010.
- Academic calendar and schedule of B.Ed. for academic year 2009-2010 were collected from the convener of B.Ed. to prepare the schedule of implementation of the programme.
- A schedule was prepared for the implementation of ABSTP. Teaching for the method courses started from 27th June 2010.
- The developed ABSTP was implemented as per the schedule (Table 4.2) from June 2009 to April 2010 for the period of one academic year on student teachers opted Teaching of Science Course at B.Ed. programme at Department of Education, Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda.
- Academic information viz. Qualifications, subject specialization during graduation and post graduation if any, teaching experience if any, medium of instruction during their schooling and email addresses of every student teacher was collected through information sheet on 29th of June 2009.
- A set of tools for Pre test were administered on student teachers in month of July 2009 as described in proceeding lines.
- Science Pedagogy Questionnaire, Nature of Science Scale was administered on student teachers on 4th July 2009, Saturday from 01.15 p.m. to 2.30 p.m. by the researcher personally. Both the tools were given to the student teachers in the session and instructions were given to them. They were informed to answer independently and enquire with the researcher for any doubt/query. They were given freedom for responding open ended questions in any of the languages they feel comfortable out of the three languages i.e. English, Gujarati and Hindi which researcher can successfully understand. There was no maximum time limit for completing the test but all the students could complete the tests in maximum of seventy five minutes.
- Achievement Test was administered on the student teachers on the same day from 3.00 p.m. to 5.00 p.m. Student teachers were given the tool and instructions.

Student teachers were asked to answer as directed in the first page of the tool. Interestingly, time taken by student teachers varied from 40 to 120 minutes.

- Science Teachers' Qualities Scale was administered on student teachers on 20th July 2010 between 01.30 to 2.00 p.m. by the researcher. The tool was distributed and student teachers were provided necessary instructions and asked to rate themselves on given qualities. Maximum time taken by the student teachers was about twenty minutes.
- **Performance based Test** was conducted to measure the experimental skills of student teachers on the predefined criteria on 21st July 2009 from 8.30 a.m. to 01.00 p.m. Student teachers were given instructions on 3rd July 2009 about the Performance Based Test. They were asked to select a concept from science and technology curriculum from secondary grades and prepared a demonstration which can simplify or clarify the concept for students of secondary school level. They were given freedom in selecting the topic and selecting the activity of their choice from the specified curriculum. Student teachers were asked to procure the material/ apparatus/ instruments/solutions whichever is required for the demonstration. Researcher has taken permission from the Head and Dean for the technical assistance required from the faculty for video recording. The session actually begun at 8.45 a.m. on 21st July 2009 after all required arrangements. Each student had performed demonstration in front of the peer group and a group of five teacher educators. Rating of student teachers performance was done by each of the teacher educators individually with the help of a Rating Scale. At the end of the session a discussion was conducted. Feedback was given to the students by group of teachers on their performance. Student teachers had shared their views and reflections on the performances of others and their experience while performing in front of the group. Whole session was video-recorded.

The same set of tools was implemented on the student teachers at the end of the academic year, following same procedure, on pre decided schedule as Post Test.

- **Performance Test** was conducted on student teachers on 16th February, 2010 from morning 8.30 a.m. to 12.00 noon to collect the information about the experimental skills executed by the student teachers. This was followed by the discussion. Student teachers had responded on the changes they felt in themselves as compared to the pre test session. Same group of teachers had evaluated the student teachers performance and provided feed back at the end.

Rating scale was used to rate their performance. Video recording of the same was done.

- **Science Pedagogy Questionnaire** was used to check the understanding of student teachers about science teaching.
- **Nature of Science Scale** was used to collect the data reading their understanding about nature of science and attitude towards science.

Both the tools were administered on student teachers on 3rd of April 2010, Saturday from 01.15 p.m. to 2.30 p.m. by the researcher personally. Both the tools were given to the student teachers in the same session and instructions were given to them. They were informed to answer independently and inquire with the researcher for any doubt. They were given freedom for responding open ended answers in any of the languages they feel comfortable out of the three languages i.e. English, Gujarati and Hindi which are accepted languages by the Department of Education for answering the examination. There was no time limit for completing the test but all the students could complete the tests in seventy five minutes.

- Data related to student teachers' content knowledge of secondary level an **Achievement Test** was administered on the student teachers on the same day from 2.45.p.m. to 4.30 p.m. Student teachers were given the tool and necessary instructions. They were asked to answer as directed in the first page of the tool. Time taken by student teachers varied from 40 to 90 minutes.
- **Science Teachers' Qualities scale** was administered on sample on 05th July 2010 between 01.15 to 1.30 p.m. by the researcher to collect the data regarding the teaching qualities acquired by student teachers as science teachers.
- Data related to the student teachers responses about the ABSTP and actual behavior changes taken in them were collected through a **Programme Evaluation Sheet**. 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 rating of each of the activities and on student teachers' responses were collected for each of the activities. For this **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.

3.10 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. Details about the data analysis and interpretation are provided in the proceeding chapter.