Chapter Five:

Findings and Discussion

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5.0 Introduction

This chapter in a nutshell presents the heart of the research i.e. the major findings and the discussion wherein the researcher is free to open her heart out, presenting not just the findings but also the context, the probable reasons for it, the process, the feedback and expressions of the sample group in the process of implementation which otherwise the scientific paradigm does not provide a scope of. So discussion gives a scope to the researcher to break the shackles and freely flow through the different aspects of research from the researcher's eye keeping in view the previous researches in the area as also the potential researches to follow.

5.1 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 were 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 were 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 were 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 were 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.

5.2 Discussion

Seeing may be believing, but what you see depends upon how you look and how you look depends upon the scientific temper that you have. This probably could be the reason why the first prime minister of India, Pt. Jawaharlal Nehru wanted India to be more scientific in thinking so as to break the shackles of casteism, communalism and economic crisis the worries then as much as they are today. In these sixty four years of independence, India has achieved technological advancements and has been self reliant to a large extent but have we been scientific in our outlook, our thoughts and reasons? Have we been free of the shackles of caste and religion based politics? Is each Indian economically self sufficient? If not I feel we have failed to realize the dream of our first prime minister. Yes, a dream, a dream that could not be nurtured by the system of education in general and teachers in particular. The burden of these and many more such questions held high on the researcher invigorating to work in the area of science education leading to the development of scientific temper.

The report of National Curriculum Framework for school Education (2000) emphasizes the important purpose of science and technology teaching at secondary stage reveals that it is to familiarize the learner with various dimensions of scientific literacy. These would include understanding the nature of science; ability to properly apply appropriate scientific concepts and their technological applications; capacity to understand values that underlie science and technology, willingness to understand and appreciate the joint enterprise of science, technology and society; ability to develop rich and satisfied views of the universe and to continue science and technology education throughout life and development of certain manipulative skills which are required in day to day life situations. This calls for a revisit to the school education and more so to the inputs provided to the teachers in teacher education institutes. The researcher thus began with an assumption that ABST at pre-service level would certainly lead to ABST in school education ensuing the development of scientific temper. This is endorsed by Boyd (2007) who explored the relation between teachers' learning in science and the way they teach science and found that teachers transferred only what they sought from the course. Present study was an attempt to prepare the student teachers to meet the demands of the contemporary school education and

society. This piece of discussion largely focuses on the findings with regard to the effectiveness of the developed ABSTP.

"It isn't that they can't see the solution; it is that they don't see the problem."

- G. K. Chesterton

Science is not about seeking the solutions but seeking the problems and understanding their origin and causes and the moment we see that, a solution appears. Having perused the problem in science education through the research based empirical evidences the researcher developed a program at secondary teacher education level for the course 'Teaching of science' in the Bachelor of Education program of the M S University of Baroda. It included various activities to enhance the content knowledge of science, understanding of pedagogy, qualities of a science teacher, and understanding of the nature of science, science process skills, and interest in teaching science resulting in the development of scientific inquiry and activity based science teaching in future. The same has been the expectations of NCFTE (2009) from any teacher education programme.

With regard to the developed program, its quality and it being overall rated above average, the researcher feels this to be the contribution of the previous batches of students who actively participated in the refinement of the activities which otherwise were raw. This was like the audience giving a feedback on the upcoming movie before the actual release of the movie thus assisting the director in refining the scenes before its final screening. The schedule of different activities, time for each and time for scheduling them all during the different phases of the B.Ed. program were actually discussed upon and finalized with the student teachers making the implementation of the program smoother and better. However, the number of students, their qualifications, whether graduates or post graduates, whether from physics, chemistry, mathematics or botany zoology, their interest in participation, the number of working days, the number of periods available, the departmental schedule and the readiness of the students at that point of time and the cooperation of the other colleagues; in a nutshell the implementation and effectiveness of the entire intervention program has to be understood in this context.

Although all the activities planned in the ABSTP were rated above average, the unconventional and field based activities were the most preferred and rated above the median 4.2. The most liked activity as per the rating was the demonstration of science

concepts. This could be attributed to the futuristic potential of the activity in establishing the clarity of the scientific concepts, refining the science process skills and providing a scope for easily teaching a concept. Field activities like visit to community science centre-Vadodara, DSC-Dharampur, visiting the science laboratory in different schools also fetched higher rating from student teachers. This is due to the ample scope provided by these activities for self learning, co-operative learning and constructive learning. The same has been reported in the study on field based teaching conducted by Dee (2006). The researcher found that participants interpreted their outdoor education program as a positive experience. Classes that were challenging and gave independence from adult support or supervision were perceived as most important by participants. Ganapathi (1993) in the study on the factor analysis of the para academic activities in improving science teaching at secondary schools found that of the thirteen factors identified, science project activities factor had the highest percentage (43.12 %) of variance; next in the order, was science club, science scrapbook and school garden. The organization of the above four important activities contributed for the improvement of science teaching at secondary school level. Similar finding was reported by Rathod (2007) in his study on learning styles. He found that sixty one percent of the students were kinesthetic learners who learnt by active involvement in manipulation of the objects and materials and for them project work, group activities, field work were more suitable ways to generate meaningful learning experiences.

With regard to the student teachers' immediate response on the feedback sheet after the completion of the activity, it can be said that in the activity 'discussion on the qualities of science teacher,' all student teachers (100%) rated it high on its potential to involve all students, thirty nine (97.5%) rated it high on its potential to promote curiosity and interest amongst students while twenty three (57.5%) rated it higher on its suitability of application in daily classroom while fourteen (35%) rated it average and three (7.5%) were not much confident of the potential of the activity in classrooms. This the researcher feels was due to the fact that the activity was designed keeping in mind the student teachers and not secondary school students which could be the case why student teachers rated it low on application in daily classroom.

In these lines if all the activities are to be viewed together it can be said that of the total eighteen activities nine of them were rated high by thirty nine to forty (97.5% to

100%) of student teachers on its potential to promote interest and curiosity; these activities were qualities expected of science teacher, demonstration of science concepts I and II, discussion on objectives of science teaching, field trip to Dharampur district science centre and community science centre Baroda, preparation of ideal science laboratory, film show on global warming and best out of waste. Looking into the nature of the activities and the common characteristic in each being the scope provided to the learners for experiential, co-operative and self learning could be the reason for the students rating it high on its potential to promote curiosity and interest.

Of the total eighteen activities, ten of them were rated high by thirty nine to forty (97.5% to 100%) of student teachers on its potential to actively involve all the students and engage their intellect. These were discussion on qualities of teacher, field trip to DSC and CSC, preparation of lay-out of ideal science laboratory, film show on global warming, best out of waste, discussion on the methods of teaching, inquiry training model and demonstrations. Except the film show on global warming all other activities were said to engage students' intellect too. Although all the activities were rated average or above on rest of the indicators by most of the student teachers, it can be said that depending on the nature of the activity there are bound to be limitations for example the field trips although being a first choice, demonstrations although being the most potent in engaging students' intellect, involving all students, developing their understanding and skills, promoting curiosity and interest, providing field exposure however fail to be a part of the daily activities in classroom or involve problem solving or be practically possible under different administrative settings and hence were rated low on those indicators. Therefore the researcher feels that ABSTP in schools should have a correct blend of all activities to provide inputs to students on different indicators of scientific progress.

Preparing layout of general science laboratory, inquiry training model, enlisting qualities of science teacher helped them in developing social skills and interpersonal skills. Goswami (2003) studied the four year integrated; participatory teacher education programme at Banasthali Vidhyapith and reported that participative programme increased involvement of the students, increased cooperation among the student teachers. The program made the student teachers responsible and committed

to the group. In the present study too, the student teachers developed confidence, openness to share the personal opinions and ability to tolerate others opinion too.

It was observed that discussion after each of the activities played a vital role in producing the maximum output while in the teacher supported activities the amount of time spent for discussions was insufficient; hence the activities with sufficient time for discussions were rated high and brought some behavioral changes which the researcher feels would sustain throughout life. This was evident from the oath that the student teachers took on two occasions, one after the completion of the film-show on global warming and another after visit to different schools for studying the status of science clubs. They joined hands to minimize the use of plastics and contribute their very bit for the conservation of the environment and promised themselves to start a science club in whichever school they would be placed in future. This is a great achievement

With regard to the students' mean achievement scores in the post test compared to the pre-test, it is evident from the graph on scores of mean achievement that there is improvement in the mean achievement scores of all forty students nevertheless the difference in the mean achievement score of roll numbers 152, 92 and 59 show less variation amongst the pre and post-test scores. This could be due to the conceptual clarity of these students on the different concepts of science curriculum at secondary level and hence the gain may be less. However in another activity involving the self rating of these students on the 'Science Teacher Quality Scale' except roll number 92 the other two showed significant improvement in their qualities. This may be due to the fact that although these students had conceptual clarity but lagged on the other qualities of science teacher like scientific temper, spirit of inquiry, scientific attitude which may have improved after the intervention. The others that showed a drastic improvement were roll number 60, 68 and 119 while the ones which showed negligible changes on STQ were student teachers with numbers 70, 80, 92, 126, 143 and 181.

Comparing their scores on STQ scale and performance test it was found that student teachers with roll number 2 and 41 happened to show little difference in the scores on STQ while in the performance test two of them showed drastic improvement. This means either the student teachers have not rated them honestly on the scale or were lacking in the science process skills compared to other qualities of teacher.

On the understanding in the nature of science scale the roll numbers 80, 90, 132,135 and 169 showed improvement of which number 132 had steep rise. This does not mean that other student teachers were conceptually very clear of the nature of science; a look at the graph reveals that sixteen of the total forty teachers were below the mean line in the pre-test, showed certain improvements however remained below the mean line in the post test too. This entails that the individual improvement apart from depending upon the potential of the activities also depends on the individual's interest, participation, regularity, punctuality and sincerity in the task at hand. Therefore in case of student teacher with roll number 92 we see either no or negligible improvement. In three cases roll number 116, 124 and 149 we see that they have recorded improvement in achievement test and STQ scale but shown no or negligible change in case of enhancement of science process skills and nature of science scale. This makes it apparent that these student teachers were basically sound on science knowledge and skills however have improved on their content knowledge and overall qualities of teachers in general and science teachers in particular may be due to the sensitization that took place as a result of the number of activities carried out throughout the year. However the scientific methodology operating more on the behaviorist paradigm focusing on the overt than the covert changes limits the researcher in measuring these affect level outcomes and hence the sensitization, the increase in enthusiasm which perhaps must have led to improvement in the STQ scale cannot be recorded.

If we look into the content of each of the tools like the achievement test which had questions related to the scientific concepts, the performance test which expected student teachers to demonstrate the concepts, the STQ scale with statements that checked the present potential of the would be teachers on expected qualities of science teachers while tool on the nature of science skill had statements that talk of the understanding of students on different aspects of science and statements to measure the attitude of students. The first two if we see are the ones which the students are acquainted with while the other two like rating the statements on a scale for authentication require sensitization of the respondent regarding the objective of the tool lest it gets influenced by social desirability. Hence the improvement in achievement test is significant for all candidates and the t-value is highest while there is less consistency in the scores of the student teacher on the STQ scale and nature of

science. This inconsistency in the scores on different tests could also be attributed to the sensitization during the intervention leading to a righteous estimation of their abilities as future science teachers resulting to negligible gap between the pre and post-test.

"In Science the credit goes to the man who convinces the world not the man to whom the idea first occurs."

- Francis Darwin

ABSTP is not new in teacher education but was perhaps not tried at teacher education level, there have been studies of its trial in school education or something of similar nature in the in-service trainings but the researcher feels that in pre-service itself if the student teachers are exposed to so many activities engaging them in self learning, experiential and co-operative learning, giving food for thought would result into competent and enthusiastic teachers. This is endorsed by Raijiwala (1975) who studied effect of the training and feedback provided to the in-service science teachers to perceive their own classroom behavior to modify and sustain the behavior and further studied the effect of training on teachers in terms of increased academic achievement of their students. He found that the training and feedback given to the teachers of the experimental group have affected pupils' class room trust positively and significantly and also affected the academic achievement of the pupils in science positively. This finding strengthens the assumption that ABSTP will enhance performance of the student teachers as well as their students. Mehna (1986) endorsed that adequate information and training for teachers in arousing pupils' motivation for learning science made science teaching interesting. Hence, training them in such techniques is required.

At the end researcher would like to affirm that all the activities designed were aimed at arousing the interest, enthusiasm and motivation of the future teachers so as to have positive impact on students at school level and it was also observed that the student teachers tried most of the feasible activities in the schools during their practice teaching program. This further enhanced their motivation and confidence in independently engaging their class actively.