CHAPTER 4

Discussion

4.1 Evaluation of the Pre-Service Programme

For evaluating the pre-service science teacher education programme in Orissa, an attempt was made to hold three sources of evidence obtained from analyses of the survey data, the case study data and the interview data. Establishing a common denominator for the three sources of evidence the following findings were derived.

Science Method Course and Instruction

(i) The objectives of the science method course were made clear to the B.Ed. trainees. However, only 50% of the trainees were able to meet these objectives. This was validated against the case study data. In the case study, only 49% of the trainees were found to have met the objectives of the science method course.

(ii) In respect of the organisation and structure of the science method course, its level of difficulty, workload and usability, the participants expressed their satisfaction. As evident from both the survey and the case study, the course, as a whole, was worthwhile to the B.Ed. trainees.

(iii) To 70% of the trainees in the survey sample and 75% of the trainees in the case study, the instruction in the science method course was effective.

(iv) The prescribed course contents in science methodology for the B.Ed. trainees were found appropriate excepting the topics such as lecture method, assignment method and observation method.
Seventy six percent of the trainees in the survey and 56% of the trainees in the case study opined that it was appropriate to include science content aspect in the method course. Although the three universities in Orissa have launched content-based methodology course, marked variation in the course design was observed by 60% of the science teacher educators interviewed in the study.

As evident from both the survey and the case study, the trainees' access to the reference materials suggested in the science method course was found unsatisfactory.

Out of seventeen instructional strategies, discussion method, laboratory and practical/fieldwork were assessed to be the strong aspect of the science method course, and projects, supplementary readings and tutorials were assessed to be the weak aspect.

Significantly, higher percentage of B.Ed. trainees were of the opinion that the theoretical part of the method course could have been completed prior to the pre-practice teaching phase. The science teacher educators were also of the same view. However, it was mentioned that the time allowance for the completion of the theoretical part of the method course was too limited.

Pre-Practice Teaching Preparation

So far as pre-practice teaching preparation is concerned, the survey, the case study and the interview with the science teacher educators, gave a detailed picture of the demonstration, the criticism and the micro-teaching sessions in the teacher training programme.

Majority of teacher education programmes were found to provide for one-demonstration lesson in science. This did not cover all types of methods
followed in teaching science and all types of content—Physics, Chemistry and Biology.

(ii) The discussion-cum-demonstration method was mostly followed by the method teachers presenting the demonstration lesson. Eighty six percent of the survey sample and 93 percent of the trainees under case study were in favour of increasing the number of such lessons. Thus NCTE norms for prescribing 5 to 10 demonstration lessons were justified. The trainees were of the view that at least one lesson each in physics, chemistry and biology adopting a wide variety of approaches could be delivered by the method masters during the demonstration programme.

(iii) The manner in which science criticism lessons were conducted was not proper. Thirty six percent of the survey sample and 58 percent of the trainees under case study admitted of the fact that they could not get opportunity to deliver criticism lessons in science.

(iv) The B.Ed. students were adequately trained in skills such as use of blackboard, introducing the lesson and classroom management, but inadequately trained in writing instructional objectives, organising the science content, giving assignment and in improvising teaching aids in science. On the whole, the quality of pre-practice teaching preparation was not upto the expectation of the NCTE norms.

**Supervised Practice Teaching**

(i) The number of practice teaching lessons in science delivered by the trainees was found to be uniformly fifteen. Seventy four percent of the trainees under survey and sixty percent of the trainees under case study were satisfied with such number. However, in case of certain weaker trainees, such number could be enhanced to 25, if required:
(ii) The B.Ed. trainees were taught one science lesson per day during the first week of the practice teaching programme. However, the number of science lessons per day increased to two in the subsequent weeks (2nd, 3rd & 4th) in certain cases.

(iii) Delivery of practice lessons in science in various classes and in a school of trainees' choice was suggested by 64% and 84% of the respondents respectively. In the case study, 65% and 95% of the trainees suggested for the same respectively.

(iv) Observation of science lessons taught by fellow student teachers was made by 73 percent of the survey sample and by 67 percent of trainees under case study.

(v) The student teachers, during their practice teaching could establish good rapport with the staff of the practising schools.

(vi) The practice of supervision by training college faculty prevailed in almost all colleges of education in Orissa. Due to inappropriate teacher student ratio (i.e., 1:25-1:40 as against the NCTE norms for 1:10), the supervision work was not upto quality. Supervisors did not observe the science lessons completely. Most of the science lessons got supervised by the faculty members without having expertise in science methodology. The beginning lessons of some trainees remained unsupervised and only got signed. No follow-up was made by the supervisor with regard to the improvement of the science lessons afterwards, if delivered. Observation of teaching of school teachers was rarely encouraged by the science teacher educators. Inspite of the satisfaction of the science teacher educators with regard to the trainees' performance during internship programme, the quality of supervision, on the whole, was observed to be not upto expectation of the NCTE norms and standards.
Evaluation of Practical Teaching/Skills

(i) Trainees' involvement in practical work/activities concerning science method was observed to be unsatisfactory by 60% of the science teacher educators.

(ii) The evaluation of a single final science lesson by external and internal examiners was the convention followed in colleges of education in Orissa. The teacher trainees' performance in the practical teaching in science was expressed in terms of marks instead of grades. The examiners did not observe the practical teaching as a whole. There was neither any specific duration of evaluation nor any specific criteria of evaluation to which the evaluators would be adhered to. The quality of evaluation was not free from doubt.

(iii) The skill test in non-school teaching situation was only emphasised in the pre-service teacher education programme of colleges of education affiliated to Sambalpur University. In case of the other two universities there was no such provision. However, 56 percent of the trainees in the survey sample opined that such skill test would be more effective in assessing the student teacher's skill in lesson planning, formulating instructional objectives, preparing objective-based test items, and devising visual aids.

Human and Material Resources

(i) Seventy five percent of the science teacher educators stated that staff members of many colleges of education in Orissa did not possess content knowledge in science for which their suggestions on science techniques were often inadequate. There were even teacher educators who did not have any school teaching experience. 100 percent of the science teacher
educators contended that a science method master must have studied the science subject at least up to degree stage as well as the methodology of science up to master's degree level. Lecturers teaching content-based science methodology in some training colleges hardly qualify themselves to the requirements of the NCTE norms. These norms can be only assured in case of new recruits.

(ii) Seventy-five percent of the science teacher educators were not exposed to innovations in science methodology and most of them usually followed the techniques of their method masters. Many of them did not bother to try out new techniques in their instructional strategies. The science teacher educators in Odisha need to come out of inertia and get exposed to innovations in science education.

(iii) The teacher training institutions showed a weak linkage with other institutions such as local general colleges and practising schools. Such weak linkage puts an adverse impact upon the quality of science teacher education programme in general and the practice teaching aspect in particular.

(iv) As stated by 70% of the science teacher educators, most of the teacher training colleges suffered from paucity of material resources. Even separate laboratories for science were non-existent in many colleges of education.

On the whole, the science teacher education programme undertaken in the teacher training colleges in Orissa portrayed a dismal picture, if the NCTE norms and standards were held as a mirror framework. Excellent science teacher education programme would require excellent human resources and excellent material resources, too. The training colleges in Orissa are in acute need of such resources.
4.2 Evaluation of the In-Service Programme

For evaluating the in-service science teacher education programme in Orissa, an attempt was made to hold three sources of evidence obtained through analyses of the survey data, the case study data and the interview data. Establishing a common denominator for the three sources of evidence following findings were derived.

Perceptions of the Science Teachers

(i) The objectives of the inservice science teacher education programme as perceived by majority of the secondary science teachers were as follows:

- Enrichment of content in science on selected topics;
- Knowledge of methods to transmit new science content to students;
- Development of understanding, attitudes, skills etc. for improved science teaching;
- Development of competency in demonstration, project and problem solving methods for science teaching;
- Learning to improvise aids and use locally available materials for science teaching.

(ii) Majority of the in-service science teachers gave more priority to the orientation of science content and its practical components. The need-based topics reported by the respondents, were Combustion and Internal Combustion Engine, Wave, Electric Cell and Current, Nuclear Energy, Energy Crisis and its Solution, Magnetism, Electricity, Chemical Bonding and Reaction, Periodic Table, Heredity and Variation, Evolution of Human Being and Structural Limitation, Heat, Atoms and Molecules, Electrolysis, Motion and Space Science in order of priority.
(iii) The science teachers attached greater importance to the physics content area for orientation. Less importance was assigned to the areas of biology, chemistry and technology.

(iv) The science teachers perceived greatest need in the areas of research and innovations in science education, latest trends in science curriculum, preparation of audio-visual aids, improvisation of equipment in science, organisation of science club activities such as field trips, exhibitions, guest talks, quizzes, etc, value-oriented teaching in science, population related awareness through science teaching, environmental awareness through science teaching and unit planning in science.

(v) Lecture-cum-discussion and lecture sessions were perceived to be more useful than workshop, seminar and role play.

(vi) Face-to-face contact and correspondence-cum-contact were perceived to be the most feasible modalities in the in-service training.

(vii) Majority of the in-service science teachers were in favour of in-service training programmes being organised on vacations.

(viii) Length of the in-service training course as suggested by majority of the science teachers was 7 to 10 days.

(ix) College with science faculty was perceived to be the most suitable venue for in-service science teacher education programme.

(x) Majority of the science teachers were of the opinion that method teachers of training colleges and lecturers of science faculties jointly could act as resource persons in the in-service programmes in science.

(xi) The science teachers considered special allowance with T.A. as well as increment benefit to be proper incentives for participating in in-service programmes.
Carrying out Assessment of the Trainees, and Carrying out an Evaluation of the Training

(i) The science teachers were interested in undergoing the in-service course in science.

(ii) From the point of view of adequacy of methods used, usability and adequacy of time, the in-service science teacher education programme was perceived by the participants as effective one. However, from the point of view of quality of practical skills, theory-practical link and adequacy of in-service training activities, the said programme was underrated.

(iii) The methodology aspect of the in-service course was quite unnecessary for the participants. However, they were satisfied with the selection and treatment of the remaining aspects of the course.

(iv) Lectures on content by science faculty members, lectures on methods by training faculty members, and library and reading room source were overrated by the participants, whereas sources such as field trip, laboratory and group project were underrated.

(v) Except for a few, majority of the topics covered under the in-service course were upto satisfaction of the participants (minimum of 60% to a maximum of 94%). The topics that derived lesser degree of satisfaction from the participants were science club (45%), heat (47%), magnetism (50%), work, energy and power (50%), motion (52%) and group activities (55%).

(vi) Sixty eight percent of the participants opined that lecture-notes could have been provided to them.

(vii) Eighty five percent of the participants reported that the resource persons were sensitive to their hopes.
(viii) On participants' self-appraisal, their content knowledge in science was reported to have increased very much for 37% of the respondents and quite a lot for 40% of the participants. Significant change in science content knowledge did not occur in case of 23% of the participants.

(ix) Seventy seven percent of the participants assessed the programme to be effective, while 23% of the participants assessed the same to be ineffective.

(x) Majority of the participants were found favourable towards the in-service programme in science after its completion.

(xi) Majority of the participants were motivated to utilise their training experiences in improvisation of aids and objective-based test construction/quizzes at their school situation in future.

(xii) Ninety percent of the participants favoured the follow-up of the training course by the staff members of IASE through school visits or correspondence.

(xiii) As per assessment of the science teacher educators, the participating science teachers were involved in the in-service activities satisfactorily, and the in-service programme, thus, resulted in better morale among the participants to a greater extent.

(xiv) The science teacher educators interviewed contended that the schedule of the course was appropriate and adequate.

On the whole, the in-service science teacher education programme under study was conducted well. However, it could have resulted better output, had it been collaborated effectively by the SCERT, Board of Secondary Education and the Department of Education of the Government, had all the resource persons been well oriented had the training course been organised on the basis of the participants' needs, etc. Due to lack of congruencies between
what science teachers perceived as actual and desirable in-service science teacher education practices, a balanced and need-based course outline was not made possible, for which the expected result could not be obtained through the programme. The result could be described as 'just average' as compared to the desirability of the course. A quality programme should bring about 100% change in science teachers' knowledge, attitude and practice. The in-service science teacher education programme hardly met this target.

4.3 Implications for Future Programmes

On the basis of the evaluation of the preservice and the inservice programmes in science education, as well as the perceptions and suggestions obtained from the trainees and the trainers, alternative models of presevice science teacher education and inservice science teacher education programmes have been suggested by the researcher. The suggested models are as follows:

Model for Pre-Service Science Teacher Education Programme

(This is only a tentative model. It needs to be examined for application in a particular situation)

Major Emphases

• A judicious mix of theoretical and practical courses so as to develop the practising teacher's scientific knowledge, understanding, skills and attitudes.

• Making science meet the challenges of the 21st century.

• New role of prospective science teacher in the context of broader concerns of education.

• Professional growth of science teachers through life long science education.
Objectives

The objectives of preservice science teacher education should be to develop such competencies and skills in the student teacher so that he/she is able to:

- develop an understanding of the nature of science
- analyse science contents in terms of concepts, sub-concepts, and learning experiences
- analyse and appraise secondary science syllabi and textbooks
- formulate instructional objectives in terms of specific behavioural outcomes
- develop ideas on unit planning, lesson planning, content organisation, use of audio-visual aids and appropriate evaluative devices
- develop skills of organising out of school activities such as science clubs, science fairs, science exhibitions and field studies
- appreciate his/her role 'beyond' classroom such as inculcating in the students the relationship of science with various aspects of living, using scientific knowledge in erasing superstitions and developing in students decision-making and problem solving skills in daily life situations

Syllabus Outline for Content-Based Methodology Course in Science

**Time Allocation** - 120 Hours (80 theory + 80 practical periods)

Unit-1 Nature of science education

Concept of 'science for all', process and product approach, substantive and syntactical structures of science; science in school curriculum - its relationship with other areas of school curriculum. (4 periods; weightage 5%)
Unit-2  Aims and objectives

Aims of teaching different branches of science: Physics, Chemistry, Biology, Astronomy, Geology & Human Physiology; Types of instructional objectives, Statement of objectives in behavioural terms, Relating objectives to behavioural outcomes; Defining Minimum Levels of Learning (6 periods; weightage 10%)

Unit - 3  Science curriculum

Explaining the term 'curriculum', determinants of curriculum and principles of curriculum organisation, science curriculum projects in India and abroad (PSSC, BSSC, Chem Study), Emerging trends, Analysis and evaluation of science syllabus and text book for any one secondary class. (5 periods, weightage 5 %)

Unit - 4  Approaches / Methods of science teaching

Lecture, Demonstration-cum-discussion, Observation, Discovery method, Laboratory method, Problem solving, Project & Assignment method. (10 periods weightage 15%)

Unit - 5  Science laboratory & Teaching aids

Designing of a science laboratory, management of science laboratory, maintenance of laboratory equipments, safety and precautionary measures in a science laboratory; Audio-visual aids in teaching-science, Preparation of improved teaching aids in science. (6 periods; weightage 10%)

Unit - 6  Science for pleasure & everyday use

Student teachers shall prepare an outline for organising the following:
Field study; science club, science fair, science exhibition, science for fun and pleasure reading. (5 periods; weightages 10\%)

Unit - 7  Lesson planning & Evaluation:

Unit vs Lesson planning, detailed and short lesson plans on different areas of science using different methods of teaching.

Concept of continuous, comprehensive evaluation, Teacher-made test to measure pupil's achievement in science; Essay, short-answer, and objective type items; science quizzes; Evaluation of science practicals. (8 periods, weightage 15\%)

Unit - 8  Teaching of Physics

Identification of concepts, sub-concepts, learning experiences, skills/competencies, instructional strategies for the following topics:

- Motion and Force, Light, Electricity, Universe & Space Exploration. (12 periods; weightage 10\%)

Unit - 9  Teaching of Chemistry

Identification of concepts, sub-concepts, learning experiences, skills/competencies, instructional strategies for the following topics:

- Structure of Matter, Chemical Reactions, Metals and Non-metals, Carbon & its compounds (12 periods; weightage 10\%)

Unit 10  Teaching of Biology

Identification of concepts, sub-concepts, learning experiences, skills/competencies, instructional strategies for the following topics:

- Ways of Living, Food & Health, Man and Environment. (12 periods; weightage 10\%)
Practical Works / Activities*

1. Observation of demonstration lessons (2 to nos.)

2. Observation of 5 to 10 science lessons taught by fellow student teachers.

3. Planning and teaching criticism lessons in science (2 to 3 nos.).

4. Preparation of lesson plans and teaching science in real school situation (15 to 20 nos.).

5. Preparation of scheme of lessons in science for any secondary class for one academic session.

6. Construction of test items, unit test, and examination question paper in science.

7. Preparation of teaching aids - 2 working models, 2 static models, 2 charts and 2 improvised aids.

8. Practising 2 to 4 science experiments selecting from the school science textbook.

9. Practice in the use of audio-visual equipments available in the institution for teaching science.

10. Conducting a survey of any school science laboratory and preparing a report on the facilities and equipments available there.

*Note. - The above list is not exhaustive but suggestive.

Model for In-Service Science Teacher Education Programme

(This is only a tentative model. It needs to be examined for application in a particular situation)


Duration. 10 days each

Total Session. 40 (each session is of 1½ Hrs.)

Objectives

i) To systematise experiences and strengthen the professional competency of inservice science teachers.

ii) To imbibe the knowledge and develop understanding of innovative methods and approaches of organising learning experiences of secondary school students.

iii) Enrichment of content knowledge in Physical Science / Biological Science on selected topics.

iv) To develop competency in demonstration of experiments.

v) To encourage independent thinking for improvisation and use of locality available materials and environment.

vi) To develop an appreciation of the role of the science teacher in the prevailing socio-cultural and political context in general and educational system in particular.

Strategy

i) Resource persons such as training faculty, Professors of physics & chemistry, Subject experts from Board of Secondary Education, delivering lecture/demonstration cum- discussion;
ii) Laboratory centred activities;

iii) Film /video show on science themes;

iv) Group activities;

v) Field-trip & Library work.

**Course Contents for Physical Science Group**

**Branches To Be Covered**

Physics

Chemistry

Astronomy

Earth Science

Technology

**Discussions (8 Sessions)**

1. Teaching of physical science in recent times— A global view.

2. Impact of science and technology and challenges to be met by science teachers in schools for the 21st century.

3. Philosophy of science; Scientific literacy and science for all.

4. Outcomes of science education with reference to the branches mentioned above.

5. Current trends in curriculum development and their reflections upon the physical science education at the secondary level.
6. Methods of teaching physical science with emphasis on innovations.

7. Problems connected with teaching of physical science.

8. Diagnosis, remedial measures and enrichment programmes in physical science education.

Activities (14 sessions)

1. Preparation of unit and lesson plans.

2. Improvised apparatus for physical science teaching.

3. Preparation of objective based objective type test items.

4. Model plans and unit of study for laboratory work.

5. Demonstration of physical science lessons.

6. Film show.

7. Field trips.

Content Orientation (16 Sessions)

Identification of difficult units and sub-units in physical science by participants followed by clarification of doubts and discussions by subject experts.

Programme Evaluation (2 Sessions)

Follow-up

Course Contents for Biological Science Group

Branches To Be Covered

Agriculture

Physiology

Botany

Zoology
Discussions (24 Sessions)


2. Biology in the secondary school curriculum.

3. Biological Science Curriculum Study (BSCS) and NCERT projects in connection with biology syllabi and textbooks at the secondary level.


5. Practical work in biology; the biology laboratory and apparatus

6. Community resources in biological science teaching.

7. Problems connected with teaching of biology.

8. Diagnosis, remedial measures and enrichment programmes in biological science

(Topics to be covered—Organisation of life: cell structure and functions, tissues in plants and animals; Life process: Photosynthesis, Respiration, Reproduction, Growth & Development; Biological Adaplation; Origin and Continuity of Life)

Activities (14 Sessions)

1. Preparation of unit and lesson plans in biology.

2. Demonstration of biological science lessons.

3. Acquaintance with the biological laboratory and apparatus.

4. Developing plans for a school biology museum.

5. Preparation of objective based objective type test items.

6. Film/video show pertaining to biological science themes and field study.

Programme Evaluation (2 Sessions)

Follow-up
4.4 Recommendations for Further Research

With the beginning of the new millennium, there are many signs that major impediments in field of science teacher education will be removed and that new initiatives and alternatives will prove valid and appropriate models. Still many specific issues in science teacher education remain unresolved. These issues are: (a) Who should become a science teacher? (b) How should science experiences for teachers be organised and what should the science education sequence be? (c) What are other important dimensions for a model programme? (d) How can continuous education of science teachers be ensured and how can the gap between pre-service and in-service programmes be minimized? (e) Who should become a science teacher educator? How should they be prepared? How can they best model desired behaviours?

The field of science teacher education need more exploratory studies. Keeping in view the unfinished task related to the present study, a tentative list of topics for further research is presented as follows:

(i) Follow-up of Pre-Service Science Teacher Education Programme in Physical Science.

(ii) Follow-up of Pre-Service Science Teacher Education Programme in Biological sciences.

(iii) Follow-up of In-Service Programmes for Physical Science and Biological Science Teachers.


(v) Evaluation of the Two-Year B.Ed. (Science) Distance Programme Launched by Indira Gandhi National Open University.
(vi) Relative Effectiveness of Pre-Service Training Models: One-Year B.Ed. (Science), Two-Year Distance B.Ed. (Science) and Four-Year Integrated B.Sc.B.Ed.

(vii) Education and Training of Science Teacher Educators.

(viii) Innovations in In-Service Education and Training of Science Teachers.

(ix) Case Studies of Innovations in Pre-Service Science Teacher Education Programmes

(x) Study of Innovations in Distance Education Applied to Professional Development Programmes of Science Teachers and Science Teacher Educators.