Chapter III
CHAPTER III

REVIEW OF RELATED LITERATURE

3.0 Introduction

3.1 Studies Related to Mastery in Subject Content

3.2 Pedagogical Content Knowledge

3.3 Content Knowledge and Instructional Practices

3.4 Studies Related to Problem Solving Ability of School/College Students.

3.5 Studies Related to Problem Solving Ability of Teacher Trainees/Teachers.

3.6 Studies Related to Teaching Aptitude.

3.7 Studies Related to Performance in Science of Teacher Trainees.

3.8 Teaching Competency and Allied Factors
CHAPTER III

REVIEW OF RELATED LITERATURE

3.0 Introduction

"The key to the vast store house of published literature may open doors to source of significant problem" (Good, 1936, p.167). Every worthwhile research study in any field of knowledge requires an adequate familiarity with the work which has already been done in the area. A summary of writings of recognized authorities and of previous research provides evidence that the researcher is familiar with what is already known, what is still unknown and untested. Since effective research is based on past knowledge, this step helps to eliminate the duplication of what has been done and provides useful hypotheses and helpful suggestions for significant investigations (Best, 1983).

A review of related literature presented in this chapter is largely confined to the main variables studied in the current investigation. However it also looks into allied factors which were reported to have some impact on science education. The review of related literature for the present study is presented under the following heads.

3.1 Studies Related to Mastery in Subject Content

Knowledge of subject matter has a sufficient impact on how teachers organize instruction. The soul of effective teaching is the command of subject matter. The teacher who knows core concepts, skills and attitudes will have the skill of conveying it in an effective manner.
Mastery in subject content is reported as a significant predictor of teacher effectiveness. Tharyani (1986) examined the role of content knowledge, academic achievement, I.Q and teachers' attitude towards pupils on teacher effectiveness of B.Ed students, Pune. Major findings were: i) Teacher trainees' knowledge in their respective subject area was found to be the best predictor of teacher effectiveness. ii) The I.Q of teacher trainees was found to be a useful predictor of teacher effectiveness. iii) Teachers' attitude towards their pupils did not show any significant relationship with teacher behaviour in the case of high achievers.

Smith (1989) studied the teachers' subject matter knowledge, pedagogical knowledge of class room organization along with orientation to teaching science. Teachers' prior knowledge, content mastery, and orientation to teaching science were found to have strong relationship to implement planned conceptual change lessons. The results were discussed in terms of three perspectives on teaching: the role of teacher knowledge, the growth of expertise in teaching and its relationship to teacher knowledge.

Anwar (1991) explored the effect of short term content enrichment programme to overcome the deficiencies of trainees in science subjects in TCH (Training Course Higher) Course. Student teachers were divided into experimental and control groups. The tools used included diagnostic achievement test and content enrichment programme in science. Major findings were: i) There was significant difference between experimental and control
groups in the content competencies in general science after the enrichment programme. ii) There was significant difference between experimental and control groups in the learning of science subjects in practice teaching after the enrichment programme. iii) There was no significant difference between the variables – sex, institution, location and SES of student teachers in the learning of science subjects.

Steffens (1991) examined the perceptions of the National State Teachers of the year in relation to specific conditions and characteristics of effective teaching and learning. Data was collected through the use of a survey instrument and examined the characteristics of teacher effectiveness, classroom management, classroom presentation methodologies and demographic information. The findings of the research indicated that the most important characteristics necessary to be effective were knowledge of the subject matter, caring and compassionate personality, enthusiasm, organization, sense of humour and love for children.

Wolfee (1992) examined the effects related to the educators’ content knowledge to teaching. This qualitative project studied two preservice teachers completing student teaching in the sixth grade over a seven week period. The data collected included audiotapes of classroom instruction, field notes, interviews and relevant documents.
Major Findings

i) Science educator with less content knowledge was related to: a) greater dependence on the text book when planning instruction and during instructional presentation, b) increased emphasis on factual knowledge in lesson presentation and in teacher questioning; c) more instances of either ignoring or reinforcing students’ content errors d) greater amounts of instructional time spent in activities.

ii) Science educator with enhanced content knowledge was related to a) increased inclusion of content knowledge and process skills in lessons b) additional instances of student directed and discovery activities c) greater use of questioning for instructional purposes other than for review d) more emphasis on content accuracy in instructional presentations and increased efforts to enhance one’s own content knowledge when planning for instruction.

Sapre, (1993) examined the effect of mastery over the theory and planning skills on performance of some teaching skills of the teacher trainees. Pretest, post test control group design was selected for the experiment. The independent variables used were standard microteaching cycle, mastery over theory and mastery over planning. A sample of 36 student teachers were selected randomly. Major findings were: i).Training for mastery over theory and planning was effective in general teaching performance. ii). There was an interaction between nature of skills and training strategy. iii). Divergent operations were involved in learning skills.
Jarvish and Cavendish (1994) explored the influence of subject knowledge and pedagogical content knowledge on effective teaching and the use of teacher resource packs and practical activities in promoting effective classroom teaching and learning with small groups of pupils. The sample consisted of 11 teachers and 10 teacher trainees. Details of teaching experience, qualifications and a measure of self perceived confidence in teaching science were obtained. Teachers and teacher trainees completed a written test of their understanding of a range of scientific concepts. Their classroom performance was video recorded and these video cassettes were examined on the criteria of effective teaching. Major findings were: i). Student teachers had lower levels of content knowledge than experienced teachers in science, ii). High level of qualifications in science was related to higher levels of content knowledge and confidence in teaching. iii). Teachers and teacher trainees were positive about the support of the resource packs for providing knowledge iv). Experience of teaching in small groups of pupils along with the support of resource packs contributed significantly to their professional development.

Khourey - Bowers (1995) analysed the interrelationships among essential components of effective teaching: self efficacy, science content knowledge and constructivist practice. The sample for the study included the participants of inservice programme of teachers. Design of the inservice programme incorporated the fundamental elements of conceptual change instruction to enhance science content knowledge, self efficacy and constructivist pedagogy. Pretests and post tests were conducted before and after the inservice programme.
Findings indicated that for each content pretest and post test, significant gains were observed at the 0.01 level. The significance of gain in science content knowledge, self efficacy and constructivist practice indicated the value of designing an intervention programme which enhances the multiple components of effective teaching.

Fives (2003) explored the relations among the teacher efficacy to demonstrated content knowledge and pedagogical beliefs. One hundred and twenty preservice and one hundred and two experienced teachers completed a test packet that assessed the demographic information, knowledge efficacy and beliefs of the teachers and classroom performance of the teachers. Correlational analysis revealed that preservice teachers’ knowledge was related directly to performance where as experienced teachers’ knowledge and beliefs were related to teacher efficiency.

Hendrick (2003) assessed the content knowledge and professional development of Virginia physical science teachers. This survey study had two facets. First teachers were asked to provide descriptive and demographic data about themselves and their schools. Secondly, teachers were asked for their professional development preferences as well as organizational logistics. Three major findings emerged as listed below. i). Three areas which teachers assessed as lowest content knowledge included electricity, light and sound. These exactly matched the three topics most desired for professional development ii). Sixty eight per cent of Virginias’ teachers were providing out of field instruction. iii). Teachers desired for professional development in all 11 categories based on
Ingersoll's definition. This study highlighted the importance of professional development support for teachers who often lack an in-depth academic background in physical sciences.

3.2 Pedagogical Content Knowledge

There is a connection between content knowledge and pedagogical knowledge in science teaching. "The key to distinguishing the knowing base of teaching lies at the intersection of content and pedagogy" (Shulman, 1987, p.15). Pedagogical content knowledge consists of topic level knowledge, and of the most useful forms of representation of ideas, illustrations, explanations and demonstrations that makes it comprehensible to others (Shulman, 1986). Elements of subject matter knowledge and pedagogical content knowledge become tightly connected in content knowledge complexes and act as important resource for teachers in responding to instructional situations. And hence the study on pedagogical content knowledge is also considered.

Sanders (1990) studied the influence of teachers' content knowledge, pedagogical knowledge and pedagogical content knowledge on their planning and teaching. Interviews were conducted before and after each class session. Data sources included transcriptions of audiotaped interviews and observations and teachers' classroom documents. Experienced teachers were observed teaching classes in both their science area of certification and in another science area. The knowledge base was very influential on their teaching. The pedagogical content knowledge provided a framework for their teaching that they filled in with their content knowledge and pedagogical content knowledge.
In the unfamiliar area, their pedagogical knowledge and some pedagogical content knowledge for general science topics were especially influential in their interactive teaching. Teachers who had content knowledge and pedagogical content knowledge for general science topics seemed to sustain them in whatever content they were teaching.

Ebert (1994) investigated the pedagogical content knowledge of prospective secondary teachers with respect to the content area of functions. Shulman’s description of pedagogical content knowledge served as the working definition for the study. The subjects chosen for this study were prospective secondary teachers enrolled in a one-semester secondary methods course. The methods class of these prospective teachers was chosen as a research site because it presented the opportunity to examine evidence of the development of pedagogical content knowledge on a variety of assessment tasks. The results suggested that there was clearly a significant relationship between subject matter knowledge, knowledge of learners’ conceptions, beliefs and instructional practices.

Neagoy (1995) explored the nature of high school teachers’ pedagogical content knowledge, prior to and as a result of their participation in a summer institute. The study also explored how teachers plan to use this knowledge in teaching. Forty high school teachers who attended the Summer Institute in Mathematics and Modeling with Discrete Mathematics (SIMM) were the subjects of the research. The instruments that helped to assess the growth of pedagogical content knowledge were a personal data questionnaire; a pretest and
a post test; follow up interviews. The overall teachers’ pedagogical content knowledge grew as a result of the inservice intervention.

Lense (1996) examined the usefulness of Grossman’s conceptualization of pedagogical content knowledge for describing college teachers’ knowledge of teaching. Data included interviews, class observations, self report surveys, student essays and faculty reflection sheets. Results of each case were reported by four components of pedagogical content knowledge: knowledge of the subject matter, knowledge of the instructional strategies, knowledge of the students understanding of the subject matter and knowledge of the curriculum. Results suggested a need for i) increased discipline-specific programming in faculty development ii) enlargement of Grossman’s conceptualization to adequately describe the teaching in some disciplines in higher education and iii) more research on the development of college faculty members’ knowledge of teaching.

Johannessen (1998) analysed the pedagogical content knowledge of six prospective English teachers from two different graduate teacher education programmes. Using case study methodology, the study involved indepth interviews with student teachers, classroom observations and interviews with education programme directors. The results of the study indicated that the teacher education programme lacked a knowledge base for teaching that guided it. This study supported calls for more teacher education programmes with a strong knowledge base for teaching.
Lee (2001) investigated the perspectives of prospective chemistry teachers regarding activities and interactions toward enriching Pedagogical Content Knowledge (PCK) during a secondary physical science methods course. Case study methodology was used for four prospective chemistry teachers to investigate the activities and interactions involved in the enrichment of PCK. The findings suggested that PCK results from the integration of many possible combinations of teacher knowledge bases. Activities suggested, enriching PCK were varied, however activities associated with microteaching episodes focused participants on the integration of contextual and curricular knowledge into PCK.

Ongel (2003) measured the theoretical pedagogical knowledge of preservice teachers in a post bachelor degree programme. The knowledge of i) entering and graduating students in an integrated teacher education programme ii) science and mathematics preservice teachers and iii) male and female teachers were particularly examined. Results suggested that post bachelor degree programmes had an impact on students’ theoretical pedagogical knowledge as consistent with recent research. The preservice teachers improved in their pedagogical content knowledge from pretest to post test programme. Science majors were found more successful than maths students in some domains.

Strawhecker (2004) explored the impact of different designs on preservice teachers’ beliefs about teaching mathematics content knowledge and pedagogical content knowledge. Additionally the relationship between the domains was examined. Results indicated that preservice teachers’ beliefs about teaching elementary mathematics changed significantly during the semester.
Significant gains were made in content knowledge for all groups. Additionally the results of this study suggest that field experiences combined with other aspects of teacher preparation further develop preservice teachers’ pedagogical content knowledge.

3.3 Content Knowledge and Instructional Practices

Research on content knowledge indicates that teacher’s knowledge of subject matter influences instructional practices across subject area and at different grade levels. (Brophy, 1991; Ebert, 1994). Subject matter knowledge is the first necessary but insufficient condition for effective instruction. (Garnett and Tobin, 1988). Research in science education indicates that teachers who possess subject matter expertise and ability to represent the subject matter to their students engage in those class activities that facilitate student learning, such as skillfully leading free ranging class room discussion of content (Roth, Anderson and Smith, 1986; Tobin and Fraser, 1990). Darling- Hammond (1998) cites reviews of several studies suggesting that most successful teachers are fully prepared in their discipline.

studies. Teachers with weak content knowledge rely heavily on the textbook as the primary source of subject matter content (Ball and Feiman-Nemser, 1998; Stoddart, et. al. 1994; Claremont, et. al. 1993; Lee, 1995). Further these teachers tend to minimize student participation in a public forum in an effort not to display their inadequate subject matter knowledge (Carlsen, 1991). Teachers with weak content knowledge tend to choose lecture or recitation, rather than solicit student question or engage in class room discussion and may avoid teaching certain subjects; fail to challenge misconceptions; discourage student interactions (Ball and Mc Diarmid, 1989). Ball (1990) and Mosenthal and Ball (1992) found that maths teachers with weak content backgrounds had difficulty in choosing and designing problems. Asking appropriate questions was also difficult. Subject matter knowledge strongly influence in teacher’s teaching style. When teaching unfamiliar topics, changes in teaching style were linked to depth of teacher knowledge (Carlsen, 1993). There is evidence that experience improves a teacher’s ability to structure information for teaching. A comparative study of preservice and inservice teachers revealed that preservice teachers “function at structuring mode” while inservice teachers “function at the tuning mode” (Barba and Rubba, 1992).

The studies related to mastery in subject content and pedagogical content knowledge mentioned above can be summarized as follows –

i. Teacher trainee’s knowledge in their respective area was found to be the best predictor of teacher effectiveness (Tharyani, 1986; Steffens, 1991).
ii. Teachers' knowledge of subject matter influences teacher success (Brophy, 1991; Ebert, 1994; Khourey-Bowers, 1995).

iii. Teachers with limited knowledge may avoid teaching certain subjects; fail to challenge misconceptions; discourage student interactions and avoid classroom discussions (Ball and Mc Diarmid 1989). Teachers who are weak in content knowledge have increased reliance on text books (Stoddart, et. al. 1994; Claremont et. al., 1994 and Lee, 1995).

iv. Subject matter knowledge strongly influence the teacher’s teaching style (Carlsen, 1993).

v. There is a significant relationship between subject matter knowledge, pedagogical content knowledge and instructional practices (Ebert, 1994).

vi. Teachers who are found better in content knowledge, and pedagogical content knowledge seems to sustain them in whatever content they are teaching (Sanders, 1990).

The current research on teaching is seeking for a knowledge base for teaching. The research studies given above indicate that only few studies have been carried out in India to explore the influence of content knowledge on instructional practices. Unfortunately, little research has been focused on science teacher trainees with regard to the same topic.

3.4 Studies Related to Problem Solving Ability of School / College Students

Research findings of Sadasivan and Rajagopalan (1982) who made a comparative study of problem solving approach and text book approach in
student achievement showed that the two groups differed significantly in their achievements under the objectives namely, knowledge, comprehension and skill in problem solving while no significant difference was noticed under the objective application.

Dutt (1989) investigated the effect of problem solving strategies for problem solving ability in science and examined the relationship with certain cognitive style and intelligence. The sample constituted 300 students of Standard X selected randomly. Tools used were i) Problem Solving Ability Test in Science developed and validated by the researcher ii) The Group Embedded Figure Test by Witkin, Ottman and Raskin and iii). General Mental Ability Test by Jalota. The major findings were: i). Strategies of problem solving significantly affected the problem solving ability of the students. ii). High intelligent students, irrespective of the strategies of training scored higher on problem solving ability test. iii). Cognitive style and intelligence were found to contribute significantly to the total variance in the problem solving ability.

Socio economic status and family facility of the parents is a deciding factor for problem solving ability in science. Darchingupui (1989) examined the relationship among the variables such as achievement in science, attitude towards science and problem solving ability under certain conditions like SES, parental education, occupation, location etc. The study investigated sex differences in problem solving ability and achievement in science. High socio economic status, family facility and type of school favoured problem solving ability, scientific attitudes and achievement in science.
Tripathi (1990) compared the performance of higher and lower group of students to problem solving test. A special test prepared and validated by the investigator was used to measure problem solving behaviour. The study revealed that school scores had significant correlation with the scores obtained by the students in the problem solving ability test and higher achievers differed significantly with low achievers. It was obvious that in problem solving situations, the intelligent students did better.

Research studies revealed that content knowledge interacts with thinking and problem solving in science. Berquist (1993) made an observation and assessment on problem solving proficiency of university level general chemistry students. The results of the study indicated that chemistry content knowledge was a significant factor in the regression equation developed for problem solving.

Enoch (1994) explored whether the combination of cognitive behaviour modification and metacognition would improve the students’ ability to solve problems and improve one’s self efficacy. A single case experimental design was used with six 10-9 to 11-7 subjects who demonstrated problem solving deficits. Subjects were exposed to a combination of cognitive behavioural techniques and metacognitive strategies during one hour sessions, two days a week. Results indicated that they improved in their problem solving skills and increased their perceived self efficacy. The subjects demonstrated better planning and organizational skills and were able to stop and think before determining a solution.
The use of metacognitive skills in solving problems was analysed by many investigators and found good evidences for the involvement of metacognitive skills in successful problem solving (Edward, 1990; Artzt and Armour, 1992; Thobias and Everson, 1995; Hmelo and Cote, 1996; Car and Jessup, 1997). Use of metacognitive skills predict problem solving success better than traditional predictors of general ability such as achievement scores (Swanson, 1990).

Walker (2003) determined the effects of teaching problem solving through the use of cognitive apprenticeship paradigm. The research used a nonequivalent control group design. The control group received instructions through a traditional, prescriptive approach while treatment group received problem solving instruction through a cognitive apprenticeship approach. Each group covered the same content. However the treatment group received additional exercises to aid in the metacognitive processes and was guided through problem solving activity. Both groups received instructions for two weeks. The results of the study provided some evidence that teaching problem solving through the use of cognitive apprenticeship was more effective than that of more traditional approaches. Significant differences were found in the key areas that were stressed in the cognitive apprenticeship model such as increased importance placed on using a process as well as motivation to solve problems.

Creativity is another factor associated with problem solving ability in science. Creative students were reported to be good at problem solving ability
(Rai, 1982; Mishra, 1986; Kumar and Kumari, 1988). Singh (1992) found the relationship between scientific creativity, problem solving ability and risk taking behaviour of rural and urban students. Major findings were: i). Girls were superior to boys in problem solving ability. ii). Urban students were superior to rural students in all levels of Green’s classification of problem solving ability and risk taking tendency.

Sharma (2000) evaluated the effectiveness of problem solving teaching techniques for the evolvement of higher learning outcomes. The sample comprised of 40 students equally divided into two groups. An achievement test on “higher level learning outcomes” (Sharma, 1993) was used for the assessment of higher level learning outcomes: analysis, application, synthesis and evaluation. Group I was taught through problem solving technique and group II was taught through conventional method. Pretest, post test matched subjects design was used. Results revealed that both the techniques of teaching i.e. problem solving and conventional method were equally effective with respect to the total gain of higher level learning outcomes in terms of application, analysis, synthesis and evaluation.

Chang and Taipei (2002) determined the relationship between tenth grade students’ problem solving ability and their science process skills. The investigations employed both quantitative and qualitative methods. The quantitative analyses indicated a significant relation between students’ problem solving ability and their science process skills. In addition, significant mean differences were found on the students’ skills of data interpretation, observation
and hypotheses formulation between higher ability and lower ability problem solvers. More over qualitative analyses revealed that higher ability problem solvers performed better on problem solving processes than lower ability problem solvers. The results suggested that incorporating problem solving activities and science process skills into instruction might be used to improve students' problem solving abilities.

Research evidence showed that problem based learning helped students to learn about a topic and create a feeling of excitement about coming to class. Cerezo (1999) examined the effect of problem based learning and how students and teachers in the middle grade science class room perceived its effectiveness. Teachers and students tended to perceive problem based learning as a catalyst for students’ motivation and overall success. Students’ self efficacy has risen and all students benefited from problem based learning in one way or other.

Turner (2002) reported the effect of providing students the opportunity to engage in the problem solving process, while achieving the competencies of the small group communication course at the community college. The results of this highly pragmatic approach to educating significantly increased student and teacher motivation. Additionally, students met cognitive and affective learning objectivities. The study also showed that this method was highly efficacious.

Visser (2003) compared the effect of lecture method to that of a problem-based instruction on learner performance, problem solving processes and attitudes in a genetic course. The study also analysed the prior academic achievement on performance for both instructional strategies. Sixty xi^{th} grade
students at a public science and maths academy were assigned to either lecture based instructional strategy or problem based instructional strategy. Both the groups received 18 weeks of Genetics instruction through the assigned instructional strategy. Results revealed that problem based group performed significantly better in post test problems than their counter parts in the lecture based strategy. The learners in the lecture based instructional treatment were significantly more likely to employ data driven reasoning in solving problems whereas learners in the problem based instructional treatment were significantly, more likely to employ hypothesis driven reasoning in problem solving. Further a significant positive correlation between prior academic achievement and problem solving performance scores was detected in both treatment groups.

Lin (2003) examined the relationship between student perception of constructivist learning environment, problem solving skills and teamwork skills. A high correlation existed between students who observed a higher level of constructivism practices being used with higher scores on problem solving than their peers. This study suggested that student learning in a constructivist environment could improve their self directed learning readiness, problem solving skills and teamwork skills.

3.5 Studies Related to Problem Solving Ability of Teacher Trainees/ Teachers

Cognitive science research shows the development of optimally interconnected procedural knowledge and declarative knowledge improve students' abilities to think critically, reason logically and solve more complex
problems. Lavoie (1991) examined the intricacies of students’ knowledge networks by constructing a cognitive network model associated with problem solving skill which is prediction. Fourteen prediction problem sheets involving six different conceptual systems in biology and three different problem formats were administered to preservice college students. Each problem sheet required students make a prediction, either in writing or on a graph and then to explain their reasoning in writing. The mechanism of successful prediction problem solving was shown to be dependent upon a complex interplay between procedural and declarative knowledge. This research represents one significant step toward development of problem solving teaching strategies that take more advantage of the tremendous potential of reasoning and problem solving of student teachers.

Banerji and Power (1991) examined the effect of three modules and chemical equilibrium developed as resource materials for a content methodology course in chemistry for intending teachers and also for general chemistry courses at the senior secondary and tertiary levels. The use of these modules in a methodology course showed a significant development of competence in the knowledge and understanding, processes, problem solving and applications domain.

Barba and Rubba (1992) compared inservice and preservice earth and space science teachers on general mental abilities, content knowledge and procedural knowledge in solving earth and space science problems. This
investigation revealed significant difference between inservice and preservice earth and space science teachers in their general mental ability and their declarative, procedural and structural knowledge. Preservice earth and space science teachers in this study lacked sufficient knowledge to master the content of the high school earth science curriculum.

Sohoni (1992) explored the effect of a training programme on the development of problem solving skills in the students teachers and the effect of teaching experience of the student teachers on the development of problem solving skills. Sample comprised 116 Marati medium students teacher from SNDT College of Education, Pune. The sample was further divided into control and experimental design of equal size selected randomly. Major findings were i) mean scores of the experimental group on problem solving skills were highly significant as compared to those of the control group ii) mean scores of the experienced and inexperienced student teachers did not differ significantly.

Hamil (1997) determined the effects of problem solving activities in physical science classes designed for elementary education majors. A post test only control group design was used with 50 student teachers participating during a 5-week treatment period. The experimental group performed problem solving activities while, control group did not perform any problem solving activities. Results of the study indicated that there were significant differences between experimental group and control group. The experimental group had a better perception of their ability to approach the problems and had more confidence in their problem solving ability.
Crawford (1999) examined the effect of inquiry based instruction in which teachers engage students in scientific investigations and problem solving situations as an important strategy. Using a case study approach, this research simultaneously examined a preservice teacher's planning and the reasons behind her planning, interactions with students, reflections before and after the lessons. The results indicated preservice teacher showed significant results in her thinking and teaching as she encountered obstacles through out the course of the year. Implications for teacher education programme were suggested, including the need to engage preservice teachers in an ongoing endeavour to focus on inquiry in teaching.

Siegel and Lee (2001) examined preservice science teachers' scientific knowledge base and skills necessary to search for that knowledge. Four class periods of video data from a problem based educational psychology course were examined. The preservice teachers grappled with science concepts of electricity and atomic structure as they analyzed a video case of a physics class room and devised ways to redesign instruction in order to enhance students' learning. Analysis of the video segment showed the student teachers identified a need for knowledge in the form of direct question or two types of inquiring statements. Student teachers made few reflective remarks during problem solving. They engaged in extended scientific reasoning during the video segment, constructed concepts related to charge imbalances and generated difficult questions; according to science experts.
Problem Based Learning (PBL) method of teaching was found to be effective for successful learning (Diercks, 2002). Science teacher efficiency belief instrument was administered before and after Problem Based Learning (PBL) experience. The results indicated an increase in the preservice teachers' self efficacy in teaching science. The results of the study provided teacher education with a model for instruction that would help preservice teachers develop the skills and understanding of inquiry based methods.

Bucalos (2003) examined the effectiveness of video based anchored instruction as a strategy for developing higher order thinking and problem solving skills of preservice teachers. Anchored instruction with problem based learning is a technique for authentic instructions that uses shared experiences between teacher and learner to facilitate the construction of new knowledge within a problem solving context. Results demonstrated that anchored instruction resulted in the acquisition of content knowledge but did not support a significant difference between anchored instruction and traditional instruction in knowledge acquisition, problem solving or higher order thinking skills as measured by debates and essays. Participants reported positive attitude toward using anchored instruction. Results were discussed in terms of continuing research needed to examine the connection between anchored instruction and problem based learning determining whether this combination of strategies was effective.
The studies related to problem solving ability in science are summarised and given below.

1. Problem solving strategies significantly influence the problem solving ability of the students (Dutt, 1989; Sharma, 2000).

2. Socio economic status and family facility of the parents is a deciding factor for problem solving in science (Darchingupui, 1989).

3. Content knowledge interacts with thinking and problem solving ability of university level chemistry students and is found to be a significant factor in regression equation developed for problem solving (Berquist, 1993; Visser, 2003).

4. A combination of cognitive behaviour modification and meta cognition would improve students' ability to solve problems (Edward, 1990; Swanson, 1990; Enoch 1994; Walker, 2003).


6. Problem based learning method of teaching is found to be effective for successful learning (Cerezo, 1999; Diercks, 2002; Turner, 2002 and Visser, 2003).

7. Student learning in a constructivist environment could improve self directed learning readiness, problem solving skills and team work skills (Lin, 2003).

Most of the studies reviewed have assessed the problem solving ability of high school or college students. However research on problem solving ability of teachers or teacher trainees seems to be very limited in number.
3.6 Studies Related to Teaching Aptitude

Bhasin (1988) examined teaching aptitude and its relationship with teaching effectiveness of the higher secondary school teachers. Tools used were Teaching Aptitude Test of Prakash and Srivasthava and Teacher Effectiveness Test of Kumar and Mutha. Major findings were i). Teaching aptitude had a significant positive correlation with teaching effectiveness. ii). No significant difference was found between rural and urban, government and non government male and female teachers with regard to their aptitude and effectiveness.

A similar finding was reported by More (1988) who examined the relationship between personality, aptitude for teaching and effectiveness of secondary teachers. The study revealed that teaching effectiveness and teaching ability had positive correlation and total personality was found to be influencing effective teaching. The study attempted to bring an improvement in the criteria for admission to the teacher preparation programme (B.Ed training for secondary teachers).

Meera (1988) made an attempt to explore the relationship between teacher behaviour and teaching aptitude of teacher trainees. Major findings were: i). There was significant correlation between teaching aptitude score and content cross ratio ii). The high aptitude group and low aptitude group differed significantly in their teacher behaviour components. iii).Content emphasis, teacher talk and teacher response were significantly higher in the high aptitude group.
Shah (1991) revealed that teacher effectiveness was significantly influenced by teaching aptitude of the teachers and variables like locality, type of school, level of educational qualification and teaching experience. An analysis of the data revealed that teacher effectiveness was significantly affected by teaching aptitude, locality, type of school and educational qualification.

Diwan (1991) investigated the predictive of teaching aptitude, attitude, cooperation, dedication and scientific outlook on academic achievement of student teachers. Major findings were i) academic achievement of student teachers has been predicted successfully on the basis of their aptitude and attitude for teaching. ii) female student teachers were found significantly higher in their teaching aptitude. iii) students teachers of urban background were found significantly better as compared to student teachers of rural background.

Research studies revealed that teaching Aptitude is a determinant of successful teaching. Kukretti (1992) made an attempt to study the psychological correlates of successful teachers. Findings of the study indicated significant positive correlation between teaching success and teaching aptitude.

Jain (1992) made a detailed inquiry on student teachers’ creativity and its relation to teaching aptitude, teaching skills and personality variables. Major findings were i) positive and highly significant correlation was found between teaching aptitude, teaching skills and creativity of the student teachers ii) low but positive and significant relationship was found between teachers’ classroom activity and teaching aptitude.
Kumaran (1997) assessed the teaching aptitude of student teachers undergoing B.Ed degree course in the Institute of Correspondence Education, University of Madras. The findings revealed that i) all the student teachers were found to have a very high aptitude towards teaching profession ii) aptitude was high in the dimension of moral character and discipline. The teaching aptitude was low in the dimension “optimistic attitude” iii) female student teachers had more aptitude than male student teachers iv) student teachers belonging to urban area had more aptitude than student teachers belonging to rural area v) the graduate and post graduate comparison did not show any significant difference between them.

Important findings of the studies on teaching aptitude are summarized and given below:

i) Teaching aptitude of secondary school teachers had a significant positive correlation with teacher effectiveness (Bhasin, 1988; More, 1988; Shah, 1991).

ii) Female student teachers were found significantly higher in comparison to male student teachers in their teaching aptitude (Diwan, 1991; Kumaran, 1997).

iii) Student teachers of urban background were found significantly better as compared to student teachers of rural background (Diwan, 1991; Kumaran, 1997).

iv) There is significant positive correlation between teaching success and teaching aptitude of secondary school teachers (Kukretti, 1992)
v) Positive and highly significant correlation was found between
teaching aptitude and teaching skills of student teachers (Jain,

3.7 Studies Related to Performance in Science of Teacher Trainees

Many research studies showed that teacher trainees’ performance in
science have a strong relationship to their ability to implement planned
conceptual change lessons. Gopalacharyalu (1984) conducted a study to find out
whether differences in psychological factors of the student teachers make
significant differences in their academic performance. The findings revealed that
socio economic status and attitude towards profession and training were
significant predictors of both theory and practical.

Pradhan (1989) made an attempt to find out the relationship between
performance in science at degree level and academic performance of the B.Ed
students. The sample consisted of 906 B.Ed. students of five successive
academic years from 1984-89 of the Department of Education of M.S.
University of Baroda. Findings showed that past achievement and levels of
classification were significantly related to academic performance of the B.Ed.
students.

Linda (1990) studied the relationship of performance in science,
programme preparation, critical thinking ability and class room performance of
preservice teachers in two selected universities in Georgia. The study revealed
that academic achievement, the type of preparation programme and perception
of the quality of one's preparation programme were significant predictors of teacher performance in the classroom.

Diwan (1991) determined the relationship between academic achievement and student teachers' attitude, aptitude, co-operation, dedication, scientific outlook and tolerance. He also examined the factors relating to academic achievement of student teachers. The sample comprised 400 student teachers (B.Ed. students). Major findings were i) academic achievement of student teachers was related to attitude for teaching, teaching aptitude, co-operation, dedication, scientific outlook and tolerance. ii) female student teachers were found significantly higher in comparison to male student teachers in their academic achievement iii) student teachers of urban background were found significantly higher as compared to student teachers of rural background in their academic achievement iv) Academic achievement in total has been predicted successfully on the basis of their aptitude and attitude.

Thongchumnum (1999) examined the relationship between teaching competency and academic achievement of science programme fourth year students under the faculty of education. The sample consisted of 151 science programme fourth year students doing student teaching practicum over a four-month period. Achievement in educational profession courses in science foundation was drawn from the achievement records. Dependent variables comprised six specific skills of teaching competency and was collected through the use of student teaching behaviour observation forum. Major findings were
The academic achievement in educational professional courses could make predictions for five skill areas of teaching competency namely, introduction to the lesson, manipulation of instructional activities, questioning skills, reinforcement skills and evaluation skills except the inclusion skill. ii). The subjects’ teaching competencies in decending order were inclusion skills, evaluation skills, introduction to the lesson skills and reinforcement skills respectively.

Bridget (2001) compared teacher trainees’ performance in science subject taken at degree level with their teaching competency. The observation schedule was rated by 40 teacher educators from 10 training colleges in Kerala selected by random sampling. Analysis of the data revealed that i) academic achievement of the teacher trainees and their teaching competency were significantly correlated ii) graduate and post graduate comparison revealed that post graduate teacher trainees were superior to graduate teacher trainees in the execution of the lessons iii) teacher trainees from urban area were superior in all the variables of study iv) female teacher trainees were superior to the males in their classroom performance.

Important finding of the studies on performance in science of the teacher trainees are summarised and given below.

i). Socio economic status and attitude towards profession and training were significant predictors of teacher trainees' academic performance (Gopalacharyalu, 1984)
ii) Teacher trainees’ performance in science at degree level was significantly related to their academic performance (Pradhan, 1989; Bridget, 2001)

iii) Academic Achievement, type of preparation programme and perception of the quality of one’s preparation programme were significant predictors of teacher performance in the class room (Linda, 1990)

iv) Academic achievement of student teachers has been predicted successfully on the basis of their teaching aptitude and teaching attitude (Diwan, 1991)

v) Academic achievement in educational profession courses could make predictions for five skill areas of teaching competency namely, introduction to the lesson skills, manipulation of instructional activities skills, questioning skills, reinforcement skills, and evaluation skills (Thongchumnum, 1990)

3.8 Teaching Competency and Allied Factors

Lalitha (1981) compared the effectiveness of the experimental treatment with control treatment for training in integration of teaching skills in terms of teaching competence of student teachers. General Teaching Competency Scale (GTCS) and the Indore Teaching Competence Scale (ITCS) were used to measure teaching competence in integrating various teaching skills. After training the integration of teaching skills in stimulated conditions followed by real school conditions, experimental group had made greater mean gains than the control group in terms of teaching competence measured on GTCS.
Joshi and Kumar (1983) studied the effect of the skill based approach and
decision making ability on the development of teaching competence of the
student teachers. An observation schedule and a scale developed by the
investigators were used to measure the skills. Mean performance was
significantly higher in case of group where the number of skills, time duration
and number of pupils gradually increased in the light of their teaching
competence scores as against the group where all the skills were taken together.

Natarajan (1984) examined the relative efficiency of competency based
teacher education in the preservice teacher education programme of secondary
school teachers. Five treatment groups with 40 student teachers in each group
were formed by random selection. These treatment groups were given
instruction through lecture method, small group discussions, conduct of seminars
followed by discussions and the last group studied by means of self instructional
modules that were based on the competencies approach. These experiments
lasted for five months. Validated criterion referenced tests were used for pretests
as well as post tests for all groups. Major findings were: i). Competency based
instruction proved suitable for teaching selected units in the instructional
planning and administration. ii). Seminar method seemed to be an effective
method and it compared favourably with the competency based approach.

Microteaching based practice teaching was reported to contribute
significantly towards teaching skills of the teacher trainees. Rajameenaksy
(1988) made a study of the factors affecting teaching competency of B.Ed
teacher trainees in physical science. The effect of microteaching was studied on
a sample of 50 student teacher using the pretest, and post test design. The result findings indicated that training in the skill of demonstration through microteaching significantly increased teaching competence. Verma (1988) made an attempt to develop teaching competency using micro teaching technique among the student teachers studying in six training colleges of Agra University. Major findings were: i) The experimental group showed better teaching skills like skill of reinforcement, skill of probing, skill of questioning, skill of stimulus variation, skill of illustration with examples and the skill of explaining. ii) Teaching competency of female student teachers of science group was better in comparison to male student teachers. iii) The teaching competency of urban student teachers was found to be better than that of their counterparts from rural areas.

Singh (1989) tried to identify certain teaching skills required for science teaching in secondary schools and compared the effect of microteaching technique with the traditional technique to develop the teaching competency of the teacher trainees. The result of the study revealed that i).Quality of science teaching could be raised through competent science teachers prepared through training of identified science teaching skills in microteaching settings. ii). Microteaching feed back device might help and develop creativity among student teachers in a way to generate useful behaviour pattern. Iii) Microteaching combined with Flander's Interaction Analysis System is found to be helpful for teacher training institutions to impart knowledge and practice to teacher trainees. Such a training is found to be very effective to produce better teachers.
Singh (1986), Mishra (1992) and Sharma and Kumar (1993) examined the effect of microteaching based practice teaching using skills training on teaching competence of prospective teachers. The results of the study have shown that microteaching based practice teaching (using skills training) was found to be effective than conventional programme of practice teaching.

Singh (1988) studied teaching efficiency in relation to job satisfaction and socio-economic status of secondary teachers. He also compared the teaching efficiency of teachers with selected variables like gender, region and socio economic status. The findings showed a positive relationship between teaching efficiency and socio economic status. Teaching efficiency of male and female teachers differed significantly favouring female teachers.

Prakasam (1988) compared teacher effectiveness and teaching competency of teachers. The sample comprised 800 teachers and 92 principals selected by random quota sampling. Major findings were: i). There existed significant relationship between teaching competency and teacher effectiveness. ii). Teachers of urban schools significantly excelled over teachers employed in rural schools in both teaching competency and teacher effectiveness.

Sauceda (1995) tested the teachers' sense of efficacy as a predictor of teacher effectiveness on a sample of elementary level teachers. The efficacy construct measured two dimensions – self-efficacy and teaching efficacy. Major findings were: i) A significant relationship existed between teaching efficacy of the teachers and campus performance and ii) between total efficacy and campus performance. The findings also indicated that a greater proportion of teachers in
the high performing campus category rated high in total efficacy than did teachers in the low performing campus category.

Thiagarajan, et.al (1995) studied the relationship between teaching competency as perceived by the students and achievement in economics as a function of sex. The sample comprised 170 boys and 120 girls selected randomly from eight higher secondary schools. Tools used were GTCS by Passi and Lalita (1979). Findings revealed significant correlation between teaching competency of the teachers and achievement of the learners. The magnitude of correlation between teaching competency and achievement was significantly different for boys and girls.

Chang (1998) assessed the teaching competency of science teacher trainees by observing their classroom practices and their perception and reflections of the teacher competence evaluation. Data related to instructional skills and changes in the growth of instructional skills was analysed and found that teacher trainees transmit content knowledge to students. Only few teacher trainees used most appropriate instructional practices.

Bekalo and Welford (1999) examined secondary preservice teacher education in Ethiopia and its impact on teachers’ competence and confidence to teach practice work in science. This study described the experiences of Ethiopian science student teachers and considered the factors affecting their professional development. This study also proposed the ways in which the Ethiopian Ministry of Education might implement changes to practice in preservice teacher education inorder to meet the objectives of new educational reforms.
Xavier and Amalraj (2002) studied the teaching competency and its dimensions of post graduate chemistry teachers working in the Higher Secondary Schools of Kanyakumari District. To study the teaching competency and its dimensions, a teaching rating scale was constructed and validated by the investigator. Major findings were: i). The study revealed that teaching competency and its dimensions in postgraduate chemistry teachers were average. ii). There is significant relationship between the teaching competency and its seven dimensions at the low level of competency where as when the level of competency increases, there is no significant relationship between teaching competency and some of its dimensions such as knowledge, communication and personality. It shows that to attain high level of competency one must concentrate on some of the dimensions. They are knowledge, communication and personality.

Anitha (2002) made an attempt to develop a profile of essential teaching skills implicit in B.Ed. teacher education programme in Kerala University. The study examined to what extent the basic teaching skills were demonstrated in the actual teaching situation. The findings showed i). A profile of essential teaching skills ‘implicit’ in the B.Ed teacher education programme was developed with 11 teaching skills identified with the help of experts. ii). The beginning teachers did not demonstrate the basic teaching skills to the maximum extent in the actual classroom situation. iii).There was a low transfer of teaching skills developed during the training period to actual classroom situation.
Kagathala (2002) constructed a reliable and valid scale to assess effectiveness of teachers and examined the effectiveness of teachers of secondary schools related to sex, educational qualifications, type of schools etc. The test was administered to 1800 teachers of secondary schools in Gujarat. Major findings were: i) The effectiveness of teachers of secondary schools in Gujarat were found to be average. ii). Teachers from urban area were superior to teachers from rural area. iii). The teachers with master’s degree possessed more teacher effectiveness than teachers with bachelor’s degree.

Teaching competencies of science teachers were related to the academic achievement of high school students in science. Tamilmani (1990) examined the effect of teaching competency and teacher personality in relation to achievement of high school students in science. Major findings were: i). Teaching competencies of science teachers were related to the academic achievement of high school students. ii). Both male and female teacher trainees were similar in their teaching competencies and personality, human relation and interpersonal skills.

Teacher competency is found to be a significant determining factor in students’ achievement. Rao (2002) examined teacher competency and learners’ achievement in the tribal areas of Karnataka. The teachers’ competency and learner’s achievement were studied in different school subjects by administering the competency test to teachers and achievement test to students. The findings revealed that the teachers did not possess required competencies either in the subjects or in the pedagogical methods. Similarly, students’ performance was
found to be low. A significant relationship was found between the teachers’ competencies and learner’s achievement in language and mathematics. Madhusudan and Yeli (2004) examined the effect of teacher competency on student’s achievement. 1200 students and 60 teachers were observed for achievement and teacher competency respectively. The M.I.L. based achievement test developed by the investigator and General Teaching Competency Scale developed by Passi et al (1976) was administered among the teachers. Teacher competency was found to be a significant determining factor in students’ achievement.

Research studies reported positive and significant relationship between creativity and teaching efficiency. (Singh, 1978; Safaya, 1981; Morrow, 1984; Brar, 1986; Venketeswaran, 1989; Skariah, 1994; and Skariah, 2003). Skariah (2004) examined the relationship between creativity and teaching efficiency. The sample of the study consisted of 150 student teachers from training colleges in the district of Alappuzha, Pathanamthitta and Kollam from the state of Kerala. Major findings were, The high creative student teachers were higher in teaching efficiency than the average creative student teachers. The average creative student teachers were higher in teaching efficiency than low creative student teachers.

Morton (2004) examined preservice teachers’ instructional skill before and after coaching and the effects of lesson planning activities by preservice teachers on classroom instruction and coaching methodologies. Qualitative and quantitative analysis of case studies were utilized to ascertain the effect of peer
coaching and coaching on preservice teachers’ ability to plan and implement improved instruction to their students. This study showed improvement in preservice special education teacher trainees to enhance their ability to provide feedback regarding effective instructional skills to their teaching colleagues.

Jeba (2005) examined the relationship of mental health variable with teaching competency among student teachers in DIET. The sample of study consisted of 300 student teachers in the DIET. The result indicated no significant differences between arts and science student teachers in teaching competency. There is no significant difference between male and female student teachers in teaching competency. The study showed the mental health variable had a low positive relationship with the teaching competency of student teachers.

Viswanathappa (2005) investigated the influence of attitude towards teaching and admission test marks on teaching competence of student teachers at secondary level in Andhra Pradesh. The tools used were i) Attitude towards teaching by Panda (1998) and teaching competence scale developed by Viswanathappa and Venketaiah (1992). Major findings were i) Attitude of student teachers towards teaching predicts their teaching competence in lesson planning, presentation, closure of lesson and evaluation. ii) Admission test rank, age, father’s occupation and father’s education do not predict their teaching competence in lesson planning, presentation, closure of lesson and evaluation.

The findings of the studies on teaching competency are summarised and given below:
1. Microteaching based practice teaching is reported to contribute significantly towards teaching skills of teacher trainees (Lalitha, 1981; Joshi and Kumar, 1983; Singh, 1986; Rajameenakshi, 1988; Verma, 1988; Singh, 1989; Mishra, 1992).

2. Academic achievement of educational professional courses could make predictions on teaching competency of the student teachers (Thonguchumnum, 1999).

3. Academic achievement of the teacher trainees and their teaching competency are significantly correlated (Bridget, 2001).

4. Teaching competency and its dimensions in post graduate chemistry teachers were average. There is significant relation between teaching competency and its seven dimensions (Xavier and Amalraj, 2002).

5. Teacher competency is found to be a significant determining factor in students’ achievement (Tamilmani, 1990; Madhusudhan and Yeli, 2004).

6. Graduate, post graduate comparison of teacher trainees showed that post graduate teacher trainees were superior to graduate teacher trainees in the execution of the lessons (Bridget, 2001).

7. The teachers from urban areas were superior to teachers from rural areas. (Kagathala, 2002).

The research studies on teacher competency focused more on the effects of microteaching skills towards teaching competency, teacher efficiency, teacher effectiveness etc. Research reviews revealed that, valid and genuine research is needed to assess the teaching competency of the student teachers which is related to their subject competency and problem solving ability in science.