CHAPTER 2

REVIEW OF RELATED LITERATURE

2.0 INTRODUCTION

The meaning of *review of related literature* is collection and organization of previous researches related to problem in scientific method. It is a process of accumulation of previous researches in specific field of research. On the basis of related literature review, new knowledge is to be created that is much helpful in understanding of the selected problem. It reflexes uniqueness or novelty of selected research problem taken in hand. It provides direction and vision to researcher at each stage of solving problem. It help researcher in selection of good and pinpointed research problems, selection of variables, writing objectives and hypotheses, delimiting study, selection of research method, selection of sample and sampling techniques, selection of tools, collection of data, scoring, statistical analysis, presentations of results, discussion and prediction. It updates knowledge of researcher, avoid the replication and save money, time and energy of researcher.

This chapter deals with review of related literature. The purpose of present study is to study achievement in science in relation to scientific attitude and logical thinking of secondary school students. There are several studies have been conducted related to achievement in connection to various variables. But in present study review of related studies of achievement/concept attainment/concept understanding in science in relation to scientific attitude and logical thinking have been presented. The year wise review of related literature is presented under following sub-headlines and conclusion has been given at the end of the chapter.

1. Studies related to achievement in science and Demographic Variables
2. Studies related to achievement in science and scientific attitude
3. Studies related to achievement in science and logical thinking.
2.1 STUDIES RELATED TO ACHIEVEMENT IN SCIENCE AND DEMOGRAPHIC VARIABLES

Varghese (1983) studied achievement in biological science concepts of secondary school pupils in relation to sex and location. The test was administered on 800 students of 10th standard. The major findings of the study were- (1) Girls performed better than boys in the test of essential biological concepts and (2) The urban students were found superior to rural students in the mastery of essential concepts in biology.

Ghosh (1985) studied achievement of the students in chemistry in relation to gender and location. The findings of this study were - (1) Urban students did not show better performance in achievement in Chemistry than rural students. (2) Boys did not show superiority in achievement in Chemistry over girls.

Darchingpui (1989) studied science achievement sex of secondary school students in Aizawal and found that significant sex difference exists on achievement in science.

Phalachandra (1989) found a positive relationship between concept based achievement in chemistry and environment. Sex differences in achievement favouring boys existed. Parent's qualification, sex and place of birth (urban areas) contribute substantially to achievement.

Sundararajan (1989) studied higher secondary students’ achievement in biology. This study reveals that the boys’ students of higher secondary schools not differ significantly on achievement in biology than rural boys students. Significance difference was found between urban girls and rural girls on achievement in biology in favour of urban students. Significance difference was not found between urban girls and urban boys students on achievement in biology.

Rai (1990) conducted a study of achievement and sex on XI grade students of Varanasi and found that no significant difference exist between male and female on understanding of concepts in physics.

Young et al. (1994) conducted a study on gender differences in science achievement. Statistically significant sex differences were found in physics achievement for 10-year old, 14-year old and 12 year old students. School effects were much more powerful in explaining student differences when compared with gender.
Sunilkumar (1995) studied attainment of essential biological science concepts of upper primary school pupils and found that boys are getting more essential biological science concepts than girls. Rural pupil attained more essential biological concept than urban pupils. Difference in attainment of biological concepts between boys and girls were found to be significant in synthesis type questions.

Gopalakrishnan (1996) conducted a study of the attainment of select concept in physics in relation to sex of standard X pupils. This study was conducted on a sample of 520 students of Calicut and Malappuram revenue districts of Kerala. The result showed that significant difference does not exist in the mean scores of attainment of concepts between boys and girls.

Koutsantoni (2004) studied achievement in science in relation to gender and found that significant sex difference in achievement in science existed.

Kumar and Morris (2005) studied the role of gender in predicting scientific understanding of prospective elementary teachers. The results of this study showed that gender associated with scientific understanding.

Jeba and Anaraja (2008) studied multiple intelligence and achievement in chemistry of high school students. This study was conducted on 250 students of Kanyakumari district. Findings of this study indicate that significant differences were not found for gender, location, and types of schools on achievement in chemistry and multiple intelligence.

Leo and Venktesh (2009) studied multiple intelligence and achievement in biology of XI standard students. Significant differences were found for gender, medium of instruction, locality, types of school and community on achievement in biology.

Shanthy and Amaladoss (2009) studied multiple intelligence and achievement in physics of 250 college students. Significant differences were found for gender, medium of instruction and locality on achievement in physics.

Samy (2015) studied achievement in physics in relation to sex, location and school types on 240 students of Villupuram District in Tamilnadu. This study reveals that (1) urban students were found significantly higher on achievement in physics than the rural students, (2) Private schools students were found significantly higher on
achievement in physics subject than the government schools students, (3) girl’s students were found significantly higher on achievement in physics than the boy’s students.

2.2 STUDIES RELATED TO ACHIEVEMENT IN SCIENCE AND SCIENTIFIC ATTITUDE

Studies related to scientific attitude and achievement in science have been interest of science educators and researchers. Various studies show that there are significant and positive associations between students’ scientific attitudes and achievement in science. Some studies are given below:

Shrivastava (1975) studied scientific attitude and its measurement. This study reveals that the amount of scientific knowledge or general exposure of science courses had significant and positive impact on scientific attitude and scientific knowledge helped in formation of scientific attitude of students.

Shinde (1982) studied non-formal science activities in secondary schools of Maharashtra states with special reference to their impact on scientific attitude and achievement in science and found that students with high academic achievement in science had high scientific attitude, students with average academic achievement had average scientific attitude, and the low achievers had a low scientific attitude.

Mathur (1990) has conducted a study on the public understanding of science and its relationship with scientific attitude. This study conducted with following purposes: 1) To study the understanding of science among different groups of students and public. 2) To study scientific attitude among different groups of students and public. 3) To study relationship between students and other groups regarding their understanding of science and scientific attitude. 4) To find out the effect of parental occupation on public understanding of science. 5) To study the effect of type of school on public understanding of science. Hypotheses were formed in null form as follow: 1) The theoretical mean on public understanding of science scale is higher than the obtained mean of the total sample. 2) There is no difference between different groups of public and students regarding their understanding of science. 3) There is no difference among different groups of students taken from different types of schools regarding their public
understanding of science. 4) There is no difference among different categories of students taken on the basis of parental occupation regarding their understanding of science. 5) There is no difference between two groups of students due to sex regarding their understanding of science. 6) The theoretical mean on scientific attitude scale is higher than the obtained mean of total sample. 7) There is no difference among different groups of public and students regarding their scientific attitude. 8) There is no difference among different groups of students taken from different types of schools regarding their scientific attitude. 9) There is no effect of the type of sample on relationship among public understanding of science and scientific attitude. In this investigation 550 students and public of both the sexes, were selected. Purposive sampling method was used to select general public as well as schools for data collection. In this study two instruments (1) Public understanding of Science Scale developed by the investigator and Scientific Attitude Scale were used. The finding, have been as follows: 1) This study revealed that there was no significant difference between two groups namely students and public concerning their understanding of science. 2) There was significant difference between students from Government schools and students from Private schools concerning their understanding of science. It has also revealed that the students from Private schools possess significantly higher understanding of science than the students from Government schools. The students from Military schools were significantly better than the students from Government schools regarding their understanding of science. The students from Public schools possess significantly higher Understanding of science than the students from Government schools. The students from Military schools showed better performance on the public understanding of science scale than students from any of the other schools. 3) This study has shown that the parental occupation does influence the students' understanding of science. It has been found that the students coming from science related parental occupations are significantly different from the students coming from military services and other types of parental occupations. 4) This study has revealed that there was no significant difference between different groups of students based on sex differences concerning their understanding of science. 5) The product moment coefficient correlation was used to find out the correlation between public understanding of science
and scientific attitude. Result from this analysis show that the public understanding of science and scientific attitude are positively and significantly correlated for sample of public and students.

Paulose (1995) studied influence of scientific attitude of University entrants on their process out-comes in physics and stated that students with higher scientific attitude will achieve higher in science and the potential for higher science achievement will be carried to all forms of science achievement.

Rao (1996) investigated the relationship among scientific attitude, scientific aptitude, and achievement in biology of secondary students. Kerala University Scientific Aptitude Test constructed by Nair et. al., (1968) and Scientific Attitude Inventory standardized by Sood and Sanadhya (1979) were used as tools. This study reveals that scientific aptitude, scientific attitude and achievement in science were found to be significantly related with one other. Significant and positive relationship was found between scientific attitude and achievement in biology students for all categories-boys, girls, private school, Govt. school, urban, rural, telgu medium, English medium, residential and non-residential.

Bhaskar (2001) studied self-concept and scientific-attitude in relation to achievement in physical science of secondary school students. The study was conducted on a 600 pupils of standard IX. The study revealed that self concept and scientific attitude are positively related to achievement in physical science.

Kaur (2001) conducted a research on a sample of 400 students to study the achievement in science in relation to scientific attitude and scientific aptitude of high school students and found that pupils who had favorable aptitude towards science were high achievers in science.

Rajeswari (2001) conducted a study of scientific attitude in relation to achievement in chemistry of higher secondary school students. A sample of 300 students was selected randomly. This study reveals that no significant relationship exist between scientific attitude and achievement in chemistry for boys, girls, boy’s schools, girl schools, co-educational schools, aided schools, unaided schools and rural schools. But
significant relationship exists between scientific attitude and achievement in chemistry for urban area students.

**Koutsantoni (2004)** examined relationship between achievement in science and scientific attitude. The study indicated no significant relationship between scientific attitude and achievement in science.

**James and Marice (2004)** studied achievement in science in relation to scientific aptitude and scientific attitude. The sample constituted 470 students of standard XI drawn from 10 schools of Coimbatore District in Tamil Nadu. Marks secured by the students in science in the S. S. L. C. or Matriculation Board Examination considered as the science achievement score. The results of the study reveal that there was positive relationship between achievement in science and scientific aptitude whereas achievement in science and scientific attitude were not related. Students from different types of schools (gender wise) differed in their achievement in science favoring girls’ schools. There was significant association between gender and science achievement, and gender and scientific attitude whereas no significant association was observed between achievement in science and scientific aptitude. Significant association was observed between residential origin (rural and urban) and scientific aptitude. But students irrespective of their residential origin had similar scientific attitude and same type of achievement in science. School type (syllabus wise) was found to be significantly associated with scientific attitude. Achievement in science and scientific attitude were found to be significantly associated with school type (gender wise) whereas no significant association was found between scientific aptitude and school type.

**Mukhopadhyay (2013)** investigated to explain achievement in physics by the factors aptitude in physics, scientific attitude, and deep approach to study. Four deep approach namely deep processing, relating ideas, use of evidence, and intrinsic motivation have been selected separately for this purpose. Total 400 (200 male and 200 female) students of class XII, studying different schools in West Bengal were selected as the sample. Students score in Physics of annual examination of class XI was considered as achievement in physics. To achieve objectives of this study coefficients of correlation and multiple regression analysis were used. Achievement in physics was found to be
correlated strongly and positively with aptitude in physics, scientific attitude, and also with two dimensions of deep approach—use of evidence, and relating ideas. The dimension intrinsic motivation of deep approach was not correlated significantly with achievement in physics. Result of regression analysis reviled that four factors of aptitude in physics, scientific attitude, use of evidence, and relating ideas were found to predict 50.83% of variance of scores of the achievement in physics. Only related idea contributes 34.89% of variance, combining with use of evidence contribute 47.32% of variance, combining with use of evidence and aptitude in physics contribute 50.55% of variance and after combining with use of evidence, aptitude in physics and scientific attitude contribute 50.83% of variance on prediction of achievement in physics. The dimension intrinsic motivation of deep approach was not found significant predictor of achievement in physics.

Ksheerasagar and Kavyakishore (2013) studied achievement in science of secondary school students in relation to scientific attitude. The Sample for the present study consists of 600 IX standard secondary school students of Bangalore city. The sample was drawn using stratified random sampling technique from government, private secondary schools in Bangalore city. Achievement in Science test by researcher and Scientific attitude Scale by Avinash Grewal were used Findings of study were—1. Positive relationship was found between scientific attitude and achievement in science among secondary school students. 2. Significant difference was found in achievement in science between male and female students of IX standard in favour of female students. 3. Significant difference was found in achievement in science between IX standard students studying in govt. and private schools of Bangalore city in favour of private schools. 4. Significant difference was found in achievement in science between low and high levels of scientific attitude, moderate and high levels of scientific attitude and low and moderate levels of scientific attitude in favour of high and moderate level of scientific attitude respectively.

Olasehinde and Olatoye (2014) examined scientific attitude, attitude to science and science achievement of senior secondary school students in Katsina State, Nigeria. The descriptive survey research design was used for this study. Using random sampling
technique 204 senior secondary school students were selected from the three geopolitical zones of the state. Three instruments- (1) Scientific Attitude Questionnaire (SAQ); (2) Attitude to Science Questionnaire (ASQ) and Science Achievement Test (SAT) were used to collect data. Pearson Product-Movement Correlation and t-test were used. Following results were found- (1) Significant and positive relationship was found between scientific attitude and attitude to science. (2) Significant relationship was not found between scientific attitude and science achievement. (3) Significant relationship was not found between attitude to science and science achievement. (4) Significant difference was not found between male and female students in scientific attitude, attitude to science and science achievement. (5) Attitude to science and scientific attitude together account for 0.7% of variance in science achievement; scientific attitude accounts for 0.06% of variance in science achievement; attitude toward science accounts for 0.01% of variance in science achievement.

Srivastava (2014) investigated to find out whether achievement in science contributes to prediction of scientific attitude in intent as well as action. The sample consisted of 480 (240 boys and 240 girls) 9th grade students of Allahabad city, India. Scientific Attitude Questionnaire prepared by K. S. Misra and Science Achievement Test (Form A) prepared by researcher were used. This study reveals that knowledge, comprehension and application in science do not contribute to the scientific attitude in intent among male students. Male students with more ability to comprehend in science was not found better scientific attitude in their action. Comprehension in science was found to be a predictor of scientific attitude in intent and knowledge in science for female students.

Panneerselvam and Muthamizh selvan (2015) studied scientific attitude and achievement in science of secondary school students. Objectives of this study were (i) to study the differences in achievement in science of boys and girls of IX standard students, (ii) to study the differences in achievement in science of boys and girls of IX standard students studying in different types of schools and (iii) to study the achievement in Science of IX standard students in relation to their different levels of scientific attitude. The sample of 600 IX standard was drawn using stratified random sampling technique.
from government, private secondary schools in Vriddhachalam, Cuddalore District. Achievement in Science test developed by investigator and Scientific Attitude Scale by Avinash Grewal were used to collect data. The data were analyzed by using t-test, coefficient correlation and two ways analysis of variance. Following results were found- (1) Significant and positive relationship was found between scientific attitude and achievement in science of secondary school students. (2) Significant difference in achievement in science was found between IX standard boys and girls of Vriddhachalam, Cuddalore District in favour of girls. (3) Significant difference in achievement in science was found between IX standard students studying in govt. and private schools of Vriddhachalam, Cuddalore District in favour of private school. (4) Significant difference in achievement in science was found between low and levels of scientific attitude, moderate and high levels of scientific attitude, low and moderate levels of scientific attitude IX standard students. (5) No significant interaction effects were found between sex and scientific attitude and school types and scientific attitude on achievement in science.

Samy (2015) studied achievement is physics in relation to scientific aptitude, scientific attitude sex and school types. The sample of 240 students, among the samples 120 are boys and reaming girls, was collected from two educational blocks of Villupuram District in Tamilnadu. Following are findings of present study: (1) Significant influence of scientific aptitude was found on achievement in physics. (2) Significant influence of scientific attitude was found on achievement in physics. (3) Urban students were found significantly higher on achievement in physics than the rural students. (4) Private schools students was found significantly higher on achievement in physics subject than the government schools students. (5) Girl’s students were found significantly higher on achievement in physics than the boy’s students.

Thakur (2015) studied relationship between achievement in science and scientific attitude of high school pupils. Objectives of study were (1) to study the relationship between scientific attitude and achievement in science in public school students and (2) to study the relationship between scientific attitude and achievement in science in private school students. Sample consists 200 students of five Private and five
Public schools of Amritsar (Punjab). Correlation coefficient was calculated to know relationship between scientific attitude and achievement in science. Following conclusions were drawn: (1) Positive and significant correlation was found between scientific attitude and achievement in science of Public school students. (2) Positive and significant correlation was found between scientific attitude and achievement in science of private school students.

2.3 STUDIES RELATED TO ACHIEVEMENT IN SCIENCE AND LOGICAL THINKING

Sheehan (1970) studied the effectiveness of concrete and formal instructional procedures with concrete and formal-operational students between the ages 12 years 6 months to 13 years 5 months. He hypothesized that subjects classified as formal-operational would score higher on criterion measures after formal instructional procedures than after concrete instructional procedures. However, the reverse was found to be true. Formal-operational students achieved significantly higher scores as a result of concrete instruction that from formal instruction. Formal-operational students, achieved significantly higher scores across both instructions than concrete-operational students.

Sayre and Ball (1975) conducted a study of Piagetian cognitive development and achievement in science on 419 subjects from grades 7 to 12 and five interview tasks, reported that formal-operational subjects received significantly, but only moderately, higher grades than non-formal-operational students. Moreover, for grade seven (general science) and grade twelve (physics) subsamples, no relationship between developmental level and achievement was found, as Herron (1976) notes, due to the extreme proportion of formal-operational, 8.6% and 80.7%, respectively.

Cantu and Herron (1978) studied concrete and formal Piagetian stages and science concept attainment. They classified a group of chemistry students as concrete or formal, using the Longeot Test of cognitive development. Concrete examples and non-examples were used for presenting three concrete concepts, while the three formal concepts were presented by concrete pseudo-examples, and non-examples, involving models, diagrams, and so forth. Immediate feedback was a feature of the instructional
technique. Contrary to the hypothesis that concrete students should do as well as formal students on concrete concepts, formal students outperformed concrete students on two of the concrete concepts, as well as on all three formal concepts. Further, the pseudo-examples in concrete form aided both groups equally and significantly. In a post-hoc analysis, differences between those instructed with and without pseudo-examples were significant for concrete students only.

**Liberman and Hudson (1979)** studied correlation between logical abilities and success in physics on 60 college students. This study reveals that concrete reasoning play significant role in predicting failure in physics achievement.

**Lowell (1979)** conducted to hierarchical classification in concrete and abstract thought on a study of 112 junior/senior high school students. This study reveals that formal thinkers did better than concrete thinkers on a test of classification.

**Wolfgang (1979)** studied the relationship between teaching the concepts of floatation and living thing and the level of cognitive development among four to seven-years old students. She found that concrete-operational students did better than the pre-operational students.

**Ehndero (1979)** investigated formal operational precocity and achievement in biology among some Nigerian high school students. This study was conducted on 60 Nigerian pre-service secondary science teachers. Result of this study indicates that there was no difference between formal and concrete-operationals on planning for concrete concepts. On formal concepts the formals succeeded more frequently. On performance in practical situations, formal-operationals succeeded differentially with formal concepts but demonstrated no significant difference with concrete concepts from concrete-operationals.

**Piburn (1980)** investigated the connection among spatial reasoning (the ability to perceive spatial patterns or to maintain orientation with respect to objects in space) and formal thought, especially the schema of proportionality, and science achievement of 6th-form (11 years) high schools students in New Zealand. The subjects were found to be 18% concrete reasoners and 35% formal reasoners and the others were at a transitional level. Male students were more successful on a science achievement test and a Piagetian
task, but no significant differences were observed on other tasks and spatial ability. In this study investigator reported that examination scores were significantly different for the formal and concrete groups. Examination scores were correlated between 0.34 to 0.41 with logical thinking problems shadows, balance and surface development measures.

Johnston (1981) studied relationships between Piagetian operational levels and science achievement by junior high school students in science classes categorized as inquiry and non-inquiry oriented. For this study the Longeot Test was administered on 400 students in a non-urban junior high school and reported that correlation of these scores with DAT science scores was 0.51 and with grades was 0.23. The author inferred that achievement in the inquiry science classes at the school was related to high science achievement scores and to formal operations capacity.

Aiello-Nicosia and Sperandeo-Mineo (1982) conducted an experimental study of the relationship between formal thinking and physics achievement. Investigators refer to the Piaget's theory for the intellectual development and to Bloom's taxonomic levels of understanding and application for the evaluation of physics achievement. Positive and significant correlations reported among Piagetian tasks (formal operational thinking) and physics concepts achievement.

Lawson (1982) reported substantial correlations among the measures of formal reasoning and achievement in various areas (reading, language, arts, mathematics, social studies and science) using a sample of 72 ninth grade students (mean age 15.1 years). The correlation between formal reasoning and biology achievement came out to be 0.56 for a sample of 72 college students (mean age 23.6 years). When the effect of fluid intelligence was partialled out, the correlation came down to 0.51, which substantiated the existence of strong relation between formal reasoning and achievement.

El-Sowygh (1982) conducted a study of performance of a Piagetian test by Saudi Arabian students in Colorado colleges. Result of multiple regression analysis indicated that among 14 demographic and academic variables formal reasoning was most strongly related to mathematics GPA and amount of course work in science and engineering.

Song (1982) studied Science relationship between Piagetian cognitive developmental levels and achievement in science of prospective Korean secondary school
teachers. Results of this study indicate that achievement in science; cognitive style and IQ were found to be related to cognitive developmental level.

**Hofstein and Mandler (1985)** studied use of Lawson's test of formal reasoning in the Israeli science education context. This study reported that formal thinkers scored significantly higher than non-formal thinkers in mathematics, physics, chemistry and biology.

**Wilson (1987)** studied teaching through formal thought for improved chemistry achievement. Attrition rates from the foundation science programme at the University of Papua New Guinea are high and related to an inability to use formal thought. An intervention measure with marginal students in this foundation course is reported here. This five-week intensive intervention was intended to assist these marginal students to perform better on formal elements of the chemistry course. Short-term beneficial effects of intervention were observed but these were not maintained once the intensive programme ceased.

**Pandey (1987)** studied logical thinking in relation to concept attainment in physics. This study was conducted on 240 (147 boys and 93 girls) XI grade science students using incidental sampling from Varanasi city. Following conclusions were drawn:

1. Majority of XI-grade science students (71%) are functioning at the concrete-operational level. Only 29% students show formal-operational thinking.
2. Various aspects of operational reasoning, viz., class-inclusion, propositional reasoning, proportional reasoning, combinatorial reasoning, and their total (logical thinking) are highly related with total concept attainment in physics of XI-grade students. Significant correlations were also found between logical thinking including different aspects of operational reasoning and concept attainment in physics, after holding constant the effects of general intelligence and achievement motive.
3. The formal-operational XI-grade science students outperform their concrete-operational counterparts on total concept attainment in physics as well as on concept attainment in individual concepts, viz., Force, Couple, Total Internal
Reflection and Atom even after both groups had been made equal with respect to previous knowledge in physics, general intelligence and achievement motive. Formal-operational students seemed to possess greater capacity to attain concepts than concrete-operational students.

4. Results of regression analysis indicate that 69.89% of the variance in total concept attainment in Physics has been covered by these three predictor variables. Logical thinking (63.84%), general intelligence (5.05%) and achievement motive (1.00%), all make significant contributions towards prediction of total concept attainment in Physics.

5. The results of multiple regression analysis for concept attainment in each concept on logical thinking, general intelligence and achievement motive indicated that attainment in concepts Force, Couple and Atom was predicted significantly by all three variables. For concept Total Internal Reflection, logical thinking and general intelligence were the best predictors. The total variance explained by the combination of best predictors was 51.84%, 50.55%, 51.41% and 57.76% for concepts Force, Couple, Total Internal Reflection and Atom, respectively. Among these variables, logical thinking emerged as the strongest predictor of concept attainment in all the concepts.

6. Results of regression analysis indicated that 71.74% of the variance in total concept attainment scores in Physics was being explained by six predictor variable. Out of these six predictors, proportional reasoning (52.27%), combinatorial reasoning (12.05%), general intelligence (6.07%), achievement motive (1.01%) and propositional reasoning (0.34%) make significant contributions. Class-inclusion fails to make any significant contribution.

7. The multiple regression analysis of concept attainment in each concept on general intelligence, achievement motive and various aspects of operational reasoning revealed that combinatorial reasoning, proportional reasoning, general intelligence, class-inclusion and achievement motive were the best predictors for concept Force; proportional reasoning, general intelligence, combinatorial reasoning and achievement motive were the best predictors for concept Couple;
combinatorial reasoning, proportional reasoning and general intelligence were the best predictors for concept Total Internal Reflection; whereas proportional reasoning, general intelligence, combinatorial reasoning, achievement motive and propositional reasoning were the best predictors for the concept Atom. The total variance explained by the combination of these best predictors was 54.17%, 52.71%, 53.29% and 58.68% for concept of Force, Couple, Total Internal Reflection and Atom, respectively.

8. Significant interaction effect of achievement motive and stages of cognitive development was found on total concept attainment in Physics.

Rai (1990) studied concept attainment in physics in relation to some cognitive and non-cognitive factors. This study was conducted with following objectives: 1. To find out the sex difference on understanding of concepts in physics, 2. To find out the effect of Piagetian cognitive developmental levels on understanding of concepts in physics, 3. To find out the effect of intelligence on understanding of concepts in physics, 4. To find out the effect of attitude towards physics on understanding of concepts in physics, 5. To find out the effect of achievement motivation on understanding of concepts in physics, 6. To find out the effect of socio-economic status on understanding of concepts in physics, 7. To find out the effect of personality factors on understanding of concepts in physics and 8. To find out the contribution of cognitive and non-cognitive factors on understanding of concepts in physics. The hypotheses for objectives were framed in null form as follow: 1. There is no sex difference on understanding of concepts in physics, 2. There is no significant effect of Piagetan cognitive developmental levels on understanding of concepts in physics, 3. There is no significant effect of intelligence on understanding of concepts in physics, 4. There is no significant effect of attitude towards physics on understanding of concepts in physics, 5. There is no significant effect of achievement motivation on understanding of concepts in physics, 6. There is no significant effect of socio-economic status on understanding of concepts in physics, 7. There is no significant effect of personality factors an understanding of concepts in physics and 8. There is no significant contribution of logical thinking, intelligence, attitude towards physics, achievement motivation, socio-economic status and personality
factors on understanding of concepts in physics. The present Investigation was an ex post facto research and conducted on the population of higher secondary science students of Varanasi city. To draw out the sample, incidental sampling technique was employed. The sample consisted of 309 (178 boys and 131 girls) XI grade science students selected from Varanasi city. Following results were found:

1. No sex difference was found on understanding of concepts in physics.
2. Significant effect of Piagetian cognitive developmental levels was found on understanding of concepts in physics. Formal level student was higher on concept understanding than concrete level students.
3. Significant effect of intelligence was found on understanding of concepts in physics.
4. Significant effect of attitude towards physics was found on understanding of concepts in physics.
5. Significant effect of achievement motivation was found on understanding of concepts in physics.
6. Significant effect of socio-economic status was found on understanding of concepts in physics.
7. Out of fourteen personality factor, significant effect of only factor B (power intelligence) was found an understanding of concepts in physics.
8. Out of 14 personality factors (except intelligence) did not cover a significant variance towards understanding of concepts in physics. Logical thinking, intelligence, attitude towards physics, achievement motivation and socio-economic status accounted for 29.23%, 5.27%, 2.67%, 2.80% and 0.74% of variance on understanding of concepts in physics, respectively.

**Bitner (1991)** studied to test the hypothesis that formal operational reasoning modes are predictors of critical thinking abilities and grades assigned by teachers in science and mathematics of 9th to 12th grade students. For this study the Group Assessment of Logical Thinking (GALT) and Watson-Glaser Critical Thinking Appraisal (WGCTA) were administered on 101 rural students of 9th to 12th grade. The grades assigned by teachers were also collected. This study indicates that the five formal
operational reasoning modes in the GALT were found to be significant predictors of critical thinking abilities and grades assigned by teachers in science and mathematics. The variance in the five critical thinking abilities attributable to the five formal operational reasoning modes ranged between 28% and 70%. The five formal operational reasoning modes explained 29% of the variance in mathematics achievement and 62% of the variance in science achievement.

BouJaoude and Giuliano (1994) studied relationships between achievement and selective variables of chemistry course non-major students. The purpose of this study was to investigate contribution of students' approaches to studying, prior knowledge, logical thinking ability, and gender on their performance in chemistry course of a non-major college freshman. For this study 220 students (128 females and 92 males) enrolled in the second semester of a freshman chemistry course for non-majors at a private university in New York State were selected as sample. The students' grades on an hour-long exam early in the semester were used as students' prior knowledge, while the semester cumulative final examination scores were used as achievement in chemistry. The results of a stepwise multiple regression analysis revealed that prior knowledge, logical thinking scores, and meaning orientation accounted for 32% of the variance on the final chemistry examination scores.

Ertepmar (1995) studied relationship between formal reasoning ability, computer assisted instruction, and chemistry achievement of 119 tenth grade students enrolled in four chemistry classes of two teachers in a high school. CAI and worksheet modes of the treatment were used in this study. This study reveals that formal reasoning ability and treatment, each made a significant contribution to the variation in achievement in chemistry. The two predictor variables together accounted for 76.24% of the variance in chemistry achievement.

Williams and Cavallo (1995) studied relationships between reasoning ability, meaningful learning and students’ understanding of physics concepts. This study showed that formal reasoning significantly predicted college students’ understanding of physics concepts and explaining 37.3% of the variance.
**Cavallo (1996)** studied relationships among school students' meaningful learning orientation, reasoning ability and acquisition of meaningful understandings of genetics topics, and ability to solve genetics problems. Results revealed that meaningful learning orientation best predicted students' understanding of genetics interrelationships, whereas reasoning ability best predicted their achievement in solving genetics problems. The interaction of meaningful learning orientation and reasoning ability did not significantly predict students' genetics understanding or problem solving.

**Johnson and Lawson (1998)** investigated the effect of the reasoning ability and prior knowledge on biology achievement in expository and inquiry classes on 366 students enrolled in a one-semester non-majors biology course at a large suburban south western community. They found that the effect of reasoning ability on achievement is more than prior knowledge effect and the improvement of reasoning ability in inquiry classes is higher than expository classes.

**Rajeswari (2001)** conducted a study of reasoning ability in relation to achievement in chemistry of higher secondary school students. A sample of 300 students was selected randomly. This study reveals that no significant relationship exist between reasoning ability and achievement in chemistry for boys, girls, boy’s schools, girl schools, co-educational schools, aided schools, unaided schools and rural schools. But significant relationship exists between reasoning ability and achievement in chemistry for urban area students.

**Huppert, Lomask and Lazarowitz (2002)** conducted a study to investigate the computer simulation's impact on students' achievement in microbiology and on their mastery of science process skills in relation to their cognitive stages. This study indicates that the concrete and transition operational students in the experimental group achieved significantly higher achievement in microbiology than their counterparts in the control group. Students with higher cognitive operational stage were found higher in microbiology achievement. In the control group students at concrete and transition operational stages did not differ significantly on achievement in microbiology. Girls achieved equally with the boys in the experimental group.
Sungur and Tekkaya (2003) studied the effect of gender and reasoning ability on the human circulatory system concepts achievement and attitude toward biology. This study consists 47 10th grade students. Group Assessment of Logical Thinking, Attitude toward Biology Scale, and the Human Circulatory System Concepts Test were administered to determine students' reasoning ability, attitude toward biology, and achievement, respectively. Two-way Analysis of Variance was used to analyze the data. The results revealed that no statistically significant mean difference between boys and girls with respect to achievement and attitude toward biology, there was statistically significant mean difference between concrete and formal students with respect to achievement and attitude toward biology.

Boujaude et. al., (2004) studied relationships between selective cognitive variables and students’ ability to solve chemistry problems and found that students with high formal reasoning ability performed better than those with low formal reasoning on conceptual chemistry problems.

Yenilmez, Sungur and Tekkaya (2006) investigated students’ achievement regarding photosynthesis and respiration in plants in relation to reasoning ability, prior knowledge and gender on 117 eighth-grade students. Test of logical thinking and the two-tier multiple choice tests were administered to determine students’ reasoning ability and achievement, respectively. An analysis of covariance was used to assess the effect of reasoning ability on students’ achievement. The independent variable was the reasoning ability (low, medium, and high), the dependent variable was the scores on the two-tier test. Students’ grades in science in previous year were used as a covariate. This study revealed a statistically significant mean difference between students at high and low formal levels with respect to achievement. Result of stepwise regression analysis revealed that reasoning ability, prior knowledge and gender were significant predictors of students’ achievement in photosynthesis and respiration in plants and explaining 42% of the variance.

Bayram and Comek (2009) investigated the relations between students’ science teaching attitude, logical thinking ability, information literacy self efficacy and academic achievement through internet assisted chemistry education. The study was conducted on
prospective science teachers enrolled in the science teacher education program at Marmara University admitted in the spring term of the 2006-2007 academic years for 10 weeks. For this purpose, the students were randomly split into two groups. Group-1 (N = 30) developed a teaching website for electro-chemistry and Group-2 (N = 31) prepared teaching portfolio for the same subject as homework. Pearson Moments Correlation coefficient was used to analyse the data. Regression analysis was used to predict achievement in chemistry for both group using science teaching attitude, logical thinking ability, information literacy self efficacy. This study revealed that the students’ chemistry achievement significantly correlates with their science teaching attitude and logical thinking ability for first group. But correlation between the students’ chemistry achievement and information literacy self efficacy was not found significant. For the second group, the students’ chemistry achievement significantly correlates with their information literacy self efficacy. No significant correlation was found between the students’ chemistry achievement and science teaching attitude and logical thinking ability. Information literacy self efficacy significantly predict the students’ chemistry achievement and explains about 20.3% of variance on chemistry achievement. Result of regression analysis indicates that science teaching attitude and logical thinking ability explain about 78.4% of the total variance of the chemistry achievement of first group. Information literacy self efficacy significantly predict the students’ chemistry achievement and explains about 20.3% of the total variance of the chemistry achievement.

**Szyjka, Mumba and Wise (2011)** studied cognitive and attitudinal predictors related to line graphing achievement among elementary pre-service teachers. Sample of this study was 87 pre-service elementary teachers. Predictors included Reading comprehension and mathematics scores, logical thinking performance scores, attitudes toward science, mathematics and graphing were selected as predictor variables. This study revealed that mathematical and logical thinking ability were most significant predictors of line graph performance relation to other variables, accounting for 41% of the total variability. Investigators suggest that elementary science education should incorporate mathematics and logical thinking related aspects in course.
Nnorom (2013) studied to find out the effect of reasoning skills on student’s achievement in biology in Onitsha Education Zone of Anambra State, Nigeria. A descriptive survey research design was used for the study. A sample of 400 biology students were randomly selected from 10 secondary schools in Onitsha Education Zone of Anambra State using stratified random sampling. Two instruments - Test of Logical Thinking (TLT) developed by the researcher and Biology Achievement Test (BAT) were used. The result showed that students with high reasoning skills performed better in biology than the students who have low reasoning skills; also that gender does not have any effect on reasoning skills of student on biology achievement.

Yuksel and Geban (2014) examined chemistry course achievement in relation to the academic self-concept, attitudes towards the chemistry course and logical thinking skills. In this study 252 students in a vocational high school in Ankara selected as sample using convenience sampling method. This study reveals that academic self-concept and logical thinking were found correlated significantly with academic achievement in chemistry be significant predictors on academic achievement. The results of the regression analysis determined that the variables of attitude towards chemistry course and logical thinking skill, together, explained 26% of variance for academic achievement chemistry. As a result of discriminate analysis, the academic self-concept and logical thinking were determined to be the variables which distinguish successful from unsuccessful students. The classification of successful and unsuccessful students by distinctive variables was found to be successful at 69.4%.