CHAPTER II
REVIEW OF RELATED STUDIES

2.1 Introduction

A search and review of the literature is essential for all research projects because it provides the basis for defining, framing and designing research topic or problem. It is an analysis and synthesis of ideas, arguments, concepts, definitions and theories from the literature. The review of related literature gives the researcher an understanding of the research methodology which refers to the way the study is to be conducted. It helps the researcher to know about the tools and instruments which proved to be useful and promising in the previous studies. The advantage of related literature is also to provide insight into statistical methods through which the validity of results is to be established (Hart, 2005).

2.2 Role of Related Study in a Research Project

1) A knowledge of related research enables investigators to define the frontiers of their field.

2) A thorough review of related theory and research enables researchers to place their questions in perspective.

3) Reviewing related study helps researchers to limit their questions and to clarify and define the concepts of the study.

4) A critical review of related study often leads to insight into the reasons for contradictory results in an area.

5) The study of related study places researchers in a better position to interpret the significance of their own result.

2.3 Studies Related to Metacognition

Erickson and Heit (2015) conducted a study on metacognition and confidence: comparing math to other academic subjects. The objective was to compare calibration of estimates about math to the other two subjects science and language and also compare the predictions to post-dictions, allowing to determine if metacognitive judgements improved after completing a test, as would be expected from previous research. There
were 40 participants at Central Valley High School in Ceres, California, who took the study for extra credit in their Algebra. Mean, SD, t-test, ANOVA were used to analyse the data. The findings showed that there was a significant effect of predicted mean versus actual mean scores. The academic subject variables did not reach statistical significance indicating over confidence in predictions. No statistical significant in academic subject variable. There was a significant predicted versus actual score and academic subject interaction implying that over confidence differed by academic subject.

**Hassan and Ahmed (2015)** conducted a study on the impact of metacognitive strategies on academic achievement among special education students in Jazan University. The objective of the study was to verify the impact of metacognitive strategies on academic among special education students- university of Jazan. Descriptive statistics method was used. Sample consisted of 26 special education students. Mean, standard deviation and one sample t-test were used as statistical techniques. The findings of the study were: a) the availability of metacognitive strategies among special education students was positive. b) the availability of metacognitive strategies connecting planning strategy among special education students was positive, c) the availability of metacognitive strategies connecting monitoring strategy among special education students was positive, d) the availability of metacognitive strategies connecting evaluating strategy among special education students was normal and e) the metacognitive strategies had a significant influence on academic achievement.

**Huseyin (2015)** conducted a study on the relationship between metacognitive awareness and academic achievement among pre-service English teachers. The objective of the study was to find out the relationship between metacognition and academic achievement in a sample of 134 Turkish pre-service teachers of English as a Foreign Language (EFL). Participants’ course scores and grade point averages at the end of the semester were aggregated as a measure of academic achievement. The findings revealed a significant correlation between metacognitive awareness, exam scores and Grade Point Average (GPA). Both knowledge of cognition and regulation of cognition significantly contributed to the prediction of variation in students’ GPAs, with regulatory skills overweighing knowledge of cognition as a predictor of academic achievement. Students with higher levels of metacognition reap the rewards of
academic achievement. Participants’ GPA and gender differences were also found to moderate metacognitive awareness. Females had more use of metacognitive skills and strategies.

**Magno (2015)** conducted a study on the role of metacognitive skills in developing critical thinking. The study investigated the influence of metacognition on critical thinking skills. Two hundred and forty college students were selected as sample from different universities in the National Capital Region in Philippines. The findings showed that metacognitive skills provide a remarkable path to critical thinking. Metacognition and critical thinking had a significant role in the achievement of college students. The second model had a better application of fitness as compared with the first model.

**Nasab and Motlagh (2015)** conducted a study on a complete review for metacognitive, cognitive, and social/affective strategies as essential components of learning strategies and their relationships with EFL learners’ reading comprehension promotion. The objective of the study was to investigate the relationship of metacognitive, cognitive, and social/affective strategies with EFL learners’ reading comprehension in terms of their reading promotion. Quasi-experimental design was used in this study. A total of 90 language learners (females and males) in the age group of 16-26 participated in the study. The data were analysed by using independent sample t-test, Pearson product moment correlation, mean, median, mode, frequency, cumulative frequency, percentiles and skeness and kurtosis. The findings indicated no significant differences in the reading scores of male and female learners in cognitive group. There was no significant relationship between different age groups. There were no differences in male and female learners’ reading scores in metacognitive group. The female learners were more efficient in that they made the class atmosphere full of socio-affective strategies.

**Sadeghi and Zamanian (2015)** conducted an investigation into the relationship between metacognitive reading awareness and reading comprehension of Iranian EFL learners. The objective of the study was to compare the metacognitive awareness of the reading strategies of proficient EFL students and to find a possible correlation between metacognitive awareness and reading comprehension. A sample of 107 Iranian EFL learners studying English in two language institutes in Shiraz were
selected through simple two-stage cluster sampling technique. Participants were all between 21-25 years old (both male and female). Data were analysed by t-test and Pearson product moment correlation. The findings showed that there was no significant difference between high and low proficient subjects in terms of their metacognitive awareness and negative significant correlation between EFL learners’ metacognitive awareness and their reading comprehension scores.

**Salehe et al. (2015)** conducted a study on relationship between metacognition and self-efficacy with academic achievement in high school students of Bandar Abbas. The objective of the study was to find out relationship between metacognition, self-efficacy and academic performance among high school students of Bandar Abbas, Iran. Participants were 380 high school students. Stratified sampling technique was used to collect data and correlational methodology was employed. Mean, standard deviation, t-test and Pearson product moment correlation were used to analyse the data. The results showed that there was a strong relationship between metacognition and self-efficacy and academic achievement but a moderate relation was found between metacognition and achievement.

**Abu-Ameerh (2014)** conducted a study on the learning styles as a predictor of metacognition among undergraduate students at Albalaq’a Applied University. The objectives of the study were: a) to examine the relationship between metacognition and learning styles among the students of the Albalaq’a Applied University in Jordan, b) to examine whether there was any relationship between the students metacognition and their learning styles, and c) to determine the relationships between metacognition and learning styles. A sample of 715 undergraduate students from Albalaq’a Applied University in Jordan (270 males and 445 females) participated. Stepwise multiple regression was used for analysing the data. The results showed that the regulation of cognition was positively related to the concreteness, reflective, abstractness and experimentation learning styles. The knowledge of cognition was positively related to the concreteness, reflective, abstractness and experimentation learning styles and the cognition processing was positively related to the concreteness, reflective, abstractness and experimentation learning styles.

**Arslan and Akin (2014)** conducted a study on metacognition: as a predictor of one’s academic locus of control. The objective of the study was to examine the effect of
metacognition on one’s academic locus of control. The sample consisted of 451 university students enrolled in various programs at Sakarya University, Turkey, of whom 261 were female and 190, male. The correlations and path analysis were used to analyse the data. The findings of the path analysis revealed that as internal academic locus of control had a positive relation with metacognition, an external academic locus of control had a negative relation. Metacognition affects the academic locus of control in those students whose internal academic locus of control was high. They were more likely to adopt metacognition than the students whose external academic locus of control was low.

Aurah, Cassady and McConnell (2014) conducted a study on predicting problem solving ability from metacognition and self-efficacy beliefs on a cross validated sample. The objective of the study was to examine the influence of metacognition and self-efficacy beliefs on genetics problem solving ability among high school students in Kenya. It was a quasi-experimental research design. A total of 2,138 high school students were selected as sample. Data were analyzed through descriptive statistics, correlation, and multiple regression. The hypothesized regression model was tested for its stability through cross-validation. Findings showed that metacognition and self-efficacy significantly predicted genetics problem-solving ability. Furthermore, self-efficacy had a moderate relationship between metacognition and genetics problem-solving ability.

Himghaempanah, Karimi and Mahmoodnajafi (2014) conducted a study on the relationship between metacognitive skills and internet addiction with academic achievement in students of Islamic Azad University. The study examined the relationship between internet addiction and metacognitive skills with academic achievement in students of Islamic Azad University. A descriptive correlational method was used to measure metacognitive skills and internet addiction of students. Three hundred and seventy five students were selected through proportional stratified random sampling technique. The results showed that there was no significant relationship between metacognition and internet addiction. There was a significant relationship between metacognition and academic achievement of students. Also, a significant inverse relationship was found between internet addiction and academic achievement. There was a significant difference in terms of metacognition among the groups of different fields of studies.
**Jena and Ahmad (2014)** conducted an explorative study on metacognitive strategy usage and epistemological beliefs of primary school teacher trainees. The objectives of the study were: a) to explore the levels of metacognition of primary school teacher trainees, b) to explore the level of epistemological beliefs of primary school teacher trainees, and c) to find out the relationship between metacognition and epistemological beliefs of primary school teacher trainees. Descriptive survey method was used. Sample consisted of 300 primary school teacher trainees of three districts of Jammu & Kashmir. The results showed that 29% of teacher trainees had a high level of metacognition and 24% of teacher trainees had a high level of epistemological beliefs. There exists a significant positive relationship between metacognition and epistemological beliefs of primary school teacher trainees.

**Minikutty and Gopinath (2014)** conducted a study on metacognitive awareness in teaching among student teachers at secondary level. The objectives of the study were: a) to identify the existing level of metacognitive awareness in teaching among student teachers at secondary level, and b) to compare the existing level of metacognitive awareness in teaching among student teachers at secondary level based on type of management, locale of institution, educational qualification and subject of study. Survey method was used. The sample consisted of 500 student teachers randomly selected from four districts of Kerala. Mean, median, standard deviation, skeness and kurtosis were used as statistical techniques. The findings were: a) the metacognitive awareness in teaching of student teachers at secondary level was less, b) student teachers studying in government aided and unaided teacher education colleges, rural and urban teacher education colleges, student teachers with graduate and postgraduate degree, and student teachers studying language and science subjects had equal level of metacognitive awareness in teaching.

**Prasadh and Sankareswari (2014)** conducted a study on metacognition and problem solving style of women’s college students. The objectives of the study were: a) to find out whether there was any significant difference between autonomous and non-autonomous women’s college students in their metacognition and problem solving style, b) to find out whether there was any significant difference among Hindu, Christian and Muslim students of women’s colleges in their metacognition and problem solving style, and c) to find out whether there was any significant relationship between metacognition and problem solving style of women’s college
students. Survey method was used in this study. The sample consisted of 250 students from seven women’s colleges in Tirunelveli and Thoothukudi districts. Mean, SD, ‘t’ test, ANOVA and Pearson product moment correlation were the statistical techniques used to analyse the data. The findings were: a) there was no significant difference between autonomous and non-autonomous women’s college students in their metacognition, b) there was no significant difference among Hindu, Christian and Muslim students of women’s college in their metacognition, c) there was a significant difference between autonomous and non-autonomous women’s college students in their sensing, intuitive, feeling, thinking and problem solving style, d) there was no significant difference among Hindu, Christian and Muslim students of women’s college in their sensing, intuitive, feeling and problem solving style, but a significant difference was observed among Hindu, Christian and Muslim students of women’s college in their thinking, and e) there was a significant relationship between metacognition and problem solving style of women’s college students.

Sadeghi, Hassani and Rahmatkhah (2014) conducted a study on the relationship between EFL learners’ metacognitive strategies and their critical thinking. The objective of the study was to find out the relationship between metacognition and critical thinking in language learning. One hundred and two intermediate students from two language institutions in Rasht were selected. Data were analyzed by using Pearson correlation procedures. Results indicated that there was a positive correlation between metacognition and critical thinking. Male participants scored more in critical thinking and metacognitive strategies than female participants.

Sasikumar (2014) conducted a study on metacognitive awareness as an indicator of mathematics achievement. The objective of the study was to find out the relationship between metacognition and achievement in mathematics of higher secondary students. Sample consisted of 500 students from fifteen schools in Thiruvananthapuram district. Survey method was adopted in this study. Statistical methods used for the analysis were mean, standard deviation and correlation. Significant positive correlation was found between the metacognitive awareness and achievement in mathematics. Higher scores in achievement correspond to greater metacognitive knowledge and greater metacognitive regulation.
Sheeja (2014) conducted an analytic study on the relationship between metacognitive skills and home environment of high school students. The objective of the study was to find out the significant relationship between metacognitive skills and home environment of high school students. A normative survey was conducted on a sample of 750 high school students from Kanyakumari, Tirunelveli and Virudhunager districts in Tamilnadu. The data was analysed by Pearson product moment correlation. The findings of the study indicated that the metacognitive skills like numerical thinking and figural analogy had no significant relation with home environment aspect of study habits. But the metacognitive skills like verbal analogy, analytical thinking and critical thinking had a significant relation with home environment aspect of study habits and metacognitive skills had a significant relation with the study habits in the dimension of home environment.

Shetty (2014) conducted a study on the metacognition levels of student teachers on the basis of their learning styles. The objective of the study was to find out the learning styles and higher levels of metacognition. The descriptive survey method was adopted for the study. One hundred and seventy two student teachers were selected as sample for the study. The data were analyzed by using ‘t-test’. The student teachers with the learning styles-introversion and thinking were found to be significantly higher in metacognition than the student teachers with the learning styles-extroversion and feeling.

Sivakumar (2014) conducted a study on metacognitive awareness of secondary teacher education students in relation to their attitude towards teaching. The objectives of the study were: a) to find out the level of metacognitive awareness of the B.Ed., students, b) to find out the significance difference in metacognition of B. Ed., students with defence to sex, age and location of college, c) to find out the significance difference in attitude towards teaching of B.Ed. students with reference to sex, age and location of college, d) to find out significant relationship between metacognitive awareness and attitude towards teaching of B.Ed. students. Percentage analysis, mean, standard deviation and ‘t’-test were used to analyse the data. The findings of the study were: a) 75% of B.Ed., students had moderate level of metacognitive awareness. b) male B.Ed., students are better than female B.Ed., students in their metacognition, c) female students had positive attitude towards teaching profession than their counterpart, d) no significant difference was found between rural and urban students
in their metacognition, e) there was no significant relationship between metacognitive awareness and teaching attitude of B.Ed., students.

**Tali and Dar (2014)** conducted a study on metacognitive strategy usage of primary school teacher trainees in relation to their gender. The objectives of the study were: a) to study the levels of metacognition of primary school teacher trainees, b) to find out the differences in the use of knowledge of cognition among primary school teacher trainees in terms of gender, and c) to find out the differences in the use of regulation of cognition among primary school teacher trainees in terms of gender. It was a descriptive survey and comprised 300 primary school teacher trainees taken randomly from three districts of Jammu and Kashmir. The mean and the t-test were used to analyze the data. Results showed that the teacher trainees differ significantly in the use of knowledge of cognition. Male teacher trainees were found to be better than female teacher trainees in the use of knowledge of cognition. No significant differences were found in regulation of cognition among primary school teacher trainees in terms of gender.

**Vijayakumari and D’Souza (2014)** conducted a study on metacognitive-cooperative learning approach to enhance mathematics achievement. The objectives of the study were: a) to study the difference, if any, in achievement in mathematics among the pupils of standard IX taught through metacognitive-cooperative learning approach and traditional method, and b) to compare the effect of metacognitive-cooperative learning approach and traditional method on the achievement in mathematics among the higher achievers and low achievers of standard IX. Experimental design was used. The sample consisted of 54 pupils of standard IX. The data were analysed by using Mean, SD, t-test, cumulative percentage distribution, bar graph and Ogive curves. The findings showed that metacognitive-cooperative learning had a positive effect on the achievement in mathematics among the pupils of standard IX. Metacognitive-cooperative learning approach and traditional method of teaching mathematics were equally effective in increasing achievement in mathematics. Metacognitive-cooperative learning approach was significantly more effective than traditional method on achievement in mathematics with respect to high achievers.

**Vijayakumari and Jinto (2014)** conducted a study on the effectiveness of KWL metacognitive strategy on achievement in social science and metacognitive ability in
relation to cognitive styles. The objectives of the study were: a) to study the effectiveness of KWL metacognitive strategy on achievement in social science among the students of standard nine, b) to study the effectiveness of KWL metacognitive strategy on metacognitive ability among the students of standard nine, c) to study the effectiveness of KWL metacognitive strategy on achievement in social science in relation to cognitive styles among the students of standard nine, and d) to study the effectiveness of KWL metacognitive strategy on metacognitive ability in relation to cognitive styles among the students of standard nine. The sample consisted of forty randomly selected students of IX standard studying in CBSE School, Koppa Taluk, Chickamangalore district. Experimental method was adopted in this study. Mean, median, standard deviation, cumulative percentage distribution, Ogive graph and t-test were employed to analyse the variables of the study. The findings were: a) significantly effective in enhancing the achievement in social science among standard nine students, b) significantly effective in enhancing the metacognitive ability among the students of standard nine, and c) equally effective in enhancing the achievement in social science of the students of standard nine in relation to cognitive styles and equally effective in enhancing the metacognitive ability of the students of standard nine in relation to cognitive styles.

Yogaraj and Selvaraju (2014) conducted a study on a gender-wise analysis on metacognition and learning styles on problem solving skill of B.Ed., trainees. The objectives of the study were: a) to find out whether there was any significant difference between male and female B.Ed., trainees in their metacognition, b) to find out whether there was any significant difference between male and female B.Ed., trainees in their learning styles, c) to find out whether there was any significant difference between male and female B.Ed., trainees in their problem solving skill, and d) to find out whether there was any significant influence of metacognition, learning styles and problem solving skill of B.Ed., trainees. Survey method was used. Data were collected from the colleges of education in Tirunelveli, Thoothukudi and Kanyakumari Districts and from 915 randomly selected B.Ed. trainees. Mean, SD, “t”-test and Pearson product moment correlation were used for analysing the data. The findings were: a) there was no significant difference between male and female B.Ed., trainees in their metacognition, b) there was no significant difference between male and female B.Ed., trainees in their visual, kinaesthetic learning styles and learning
style *in toto*. But there was a significant difference between male and female B.Ed., trainees in their auditory learning styles, c) there was no significant difference between male and female B.Ed., trainees in their problem solving skill, and d) there was a significant influence of metacognition, learning styles on problem solving skill of B.Ed., trainees.

**Yogaraj and Selvaraju (2014)** conducted a study on metacognition and learning style of B.Ed. students. The objectives of the study were: a) to find out the difference between male and female secondary education students in their metacognition, b) to find out the difference between male and female secondary education students in their learning style, and c) to find out the relationship between metacognition and learning style of secondary education students. Survey method was adopted in this study. A sample of 100 secondary teacher education students from Tirunelveli district was selected for the study randomly. Mean, SD, t-test and Pearson product moment correlation were the statistical method used for analysis of the data. The findings of the study were: a) there was no significant difference between male and female students in their metacognition, b) there was no significant difference between male and female B.Ed. students in their kinaesthetic style of learning, but there was significant difference between male and female B.Ed. students in their auditory, visual and learning styles, and c) there was a significant relationship between metacognition and learning styles of B.Ed. students.

**Yogaraj and Selvaraju (2014)** conducted a study on metacognition and problem solving skill of secondary education students. The objectives of the study were: a) to find out the level of metacognition of secondary education students, b) to find out the level of problem solving skill of secondary education students, and c) to find out the relationship between metacognition and problem solving skills of secondary education students. Survey method was used and 100 randomly selected secondary education students from two colleges of education in Tirunelveli district were selected for the study randomly. Mean, standard deviation, t-test and Pearson product moment correlation were the statistical methods used to analyse the data. The findings of the study were: a) there was no significant difference between male and female secondary education students in their knowledge of cognition, regulation of cognition and metacognition, b) there was no significant difference between male and female secondary education students in their intuitive and feeling, but a significant difference
was found between male and female in their sensing, thinking and problem solving skill, and c) there was a significant relationship between metacognition and problem solving skill of secondary teacher education students.

Al-Zoubi (2013) conducted a study on the level of metacognitive thinking among special education students. The objective of the study was to identify the level of metacognitive thinking among special education students at Najran University, Saudi Arabia. The sample consisted of 282 students. Mean, standard deviation, Scheffe’s test and three-way analysis of variance were used to analyse the data. The results indicated a high level of metacognitive thinking in favour of students with a high academic achievement; however, there were no statistically significant differences that could be attributed to gender or level of study.

Bozkurt (2013) conducted a study on the relation between the history teacher candidates’ learning styles and metacognitive levels. The study aimed to determine learning styles and the metacognitive levels of the history teacher candidates, and examine the relation between these two variations. The study was carried out with 163 pre-service teachers in history teaching at the faculty of education at a state university in Turkey. Correlation analysis technique was used to analyze the data. Results showed that there was a positive relation between metacognitive levels of the teacher candidates and independent, collaborative, dependent and participant learning styles and a negative relation between avoidant learning styles.

Inomiesa, Achufusi and Mgbemena (2013) conducted a study on the effects of self-regulated learning and metacognitive learning cycle on the academic achievement of physics students. This study was designed to determine the effects of self-regulated learning and metacognitive learning cycle on the academic achievement of secondary school physics students. Sample consisted of 325 students drawn by purposive random sampling technique. The design was a quasi-experimental study (two treatment groups and one control) and the instrument was a Physics Achievement Test (PAT) administered to 325 students after five weeks of teaching. The data collected were analyzed using a three-way analysis of covariance (ANCOVA). The findings indicated that the self-regulated learning group performed better than the metacognitive learning cycle group while the metacognitive learning cycle group performed better than the
lecture method group. No significant difference was observed in the performance of male and female students.

Narang and Saini (2013) conducted a study on metacognition and academic performance of rural adolescents. The objectives of the study were; a) to examine the association between metacognition and academic performance of rural adolescents, and b) to analyse the impact of different components of metacognition on academic performance of rural adolescents. Two hundred and forty rural students were selected at random in grade VII, VIII, IX and 1X from Ludhiana district. The findings showed that there was a significant association between metacognition and academic achievement performance of rural students. Metacognitive components, namely knowledge of cognition and regulation of cognition, significantly contributed to academic achievement of rural students. The girls had higher mean scores for the component of ‘knowledge of cognition’ at all levels as compared to the boys. It was found that collectively both the independent variables contributed positively and significantly to improve the academic performance of the rural adolescents. In case of ‘regulation of cognition’, the girls showed better mean scores than boys indicating that girls could better plan, monitor, regulate and evaluate their learning strategies.

Khan and Khan (2013) conducted a study on metacognitive reading strategies in relationship with scholastic achievement in science of IX standard students of English medium schools in Aurangabad city. The objectives of the study were: a) to study the relationship between metacognitive reading strategies and scholastic achievement in science of IX standard students of English medium schools, b) to study the relationship between global reading strategy and scholastic achievement in science of IX standard students of English medium schools, c) to study the relationship between problem solving strategy and scholastic achievement in science of IX standard students of English medium schools, d) to study the relationship between support reading strategy and scholastic achievement in science of IX standard students of English medium schools, and e) to study the difference between metacognitive reading strategy of boys and girls of IX standard students of English medium schools. Survey method was adopted in this study. The total number of sample was 100 out of which 54 were male and 46 were female students. The findings indicated that there was a moderate and positive correlation between global reading strategy and scholastic achievement in science, between problem solving strategy and scholastic achievement.
in science, and between support reading strategy and scholastic achievement in science. There was significant difference between male and female IX standard students in English medium schools in their metacognitive reading. There was positive and moderate relationship between metacognitive reading strategies and scholastic achievement in science.

Kunjivaru and Rajagopalan (2013) conducted an analysis of the level of metacognitive awareness: the case of secondary school teachers. The objectives of the study were: a) to find out the difference in the metacognitive awareness of male and female teachers, and b) to find out the significant difference in metacognitive awareness between the government and private school teachers. Survey research design was employed in this study. Sample consisted of 408 secondary school teachers of Thrissur, Palakkad, Malappuram, Kozhikode and Kannur districts of Kerala state. Mean, median, mode, SD, one-way ANOVA, Skewness and kurtosis were the statistical techniques used for analysis of data. The results showed that significant difference was found between male and female teachers and metacognitive awareness level which was higher among female teachers. It was found that metacognitive awareness among teachers of private schools and government schools were alike.

Jayapraba and Kanmani (2013) conducted a study on metacognitive awareness in science classroom of higher secondary students. The objective of the study was to examine the effects of inquiry based learning and cooperative learning on metacognitive awareness in science classroom. The study was carried out by using a quasi-experimental design with pre and post tests with two experimental groups and one control group. Higher secondary students from municipal girls’ higher secondary school, Tirunelveli town, Tamilnadu, were taken as the sample of the study. The sample was divided into three groups each consisting of 35 students. Mean, SD and t-test were used to analysis the data. The findings of the study were: a) there was no significant difference between metacognitive awareness pre-test mean scores achieved by experimental groups with control group, b) there was a significant improvement in metacognitive awareness in inquiry based learning, c) there was a significant improvement in metacognitive awareness in cooperative learning, d) there was no significant improvement in metacognitive awareness of low ability students in inquiry based learning, e) the low metacognitive ability students in cooperative learning group received higher metacognitive awareness and they could also answer higher level of
cognitive questions compared to inquiry group and control group, and f) Students in cooperative learning had a higher metacognitive awareness compared to other groups.

**Mathew and Joseph (2013)** conducted a study on metacognitive ability of adolescent students and its relation with academic achievement. The objectives of the study were: a) to study the relationship between metacognitive ability and academic achievement among adolescent students, b) to study the relationship between the different components of metacognitive ability and academic achievement among adolescent students, and c) to study the difference in relationship between metacognitive ability and academic achievement among adolescent students in the sub-samples based on gender and curricula followed in schools. Stratified random sampling method was used and students between 11 to 15 years of age were selected. Sample consisted of 342 VIII standard students of which 184 boys and 158 girls selected from five different schools of Kottayam district in Kerala. Karl Pearson’s correlation test was used. The findings of the study were: a) there was a significant positive correlation between metacognitive ability and academic achievement adolescent students, b) there was a significant positive correlation between components of metacognitive ability and academic achievement of adolescent students, c) there was a significant correlation between metacognitive ability and academic achievement of boys as well as girls, d) there was a significant correlation between metacognitive ability and academic achievement of State as well as CBSE School students, and e) there was no significant difference in the relationship between metacognitive ability and academic achievement based on curricula followed in the school.

**Rani and Govil (2013)** conducted a study on metacognition and its correlates. The objectives of the study were: a) to investigate correlates of metacognition of undergraduate students, and b) to find out the relationship of metacognition of undergraduate students with demographic variables like gender, place of living, academic achievement and parents’ education. The study was conducted on the sample of 313 undergraduate students of Aligarh district. ‘t’ test and analysis of variance had been employed to analyze the data. The findings showed that gender had no significant impact on the metacognition of undergraduate students. On the other hand, the metacognitive level of urban students differed significantly from their rural counterparts. The high and low achieving undergraduate students differed significantly
on their metacognitive level. Fathers’ educational qualification had no significant impact on metacognition of the students while mothers’ education had a significant impact on it.

**Gafoor and Ali (2012)** conducted a study on the effect of a metacognitive strategy instruction on problem solving in Newtonian mechanics among vocational higher secondary students. The objective of the study were: a) to try out MSI for enhancing problem solving ability in Newtonian mechanics of vocational higher secondary students, and b) to test the effect of MSI on problem solving ability in Newtonian mechanics of vocational higher secondary students. The study employed a pre-test post-test control group quasi experimental design on two intact group of 21 students each of XI standard from vocational higher secondary school, matched one to one based on pre-test. Results showed that MSI found significantly contributing to the problem solving ability of students.

**Kapadia and Garg (2012)** conducted a study on relating metacognition of secondary school students with their perceived teacher competencies. The objective of the study was to investigate metacognition and perceived teacher competencies of secondary school students. Descriptive research method was used in this study. Nine hundred and twenty IX standard students selected from schools across Greater Mumbai through stratified sampling technique. The findings were: a) female students possess higher metacognition than male students. b) no significant difference was obtained for the sub-task monitoring scores between male and female students, c) female students perceive total teacher competencies better than male students, d) female students perceive social competency, technical competency and affective competency better than male students, and e) the correlation between total metacognition and total teacher competencies was stronger for male students than female students.

**Titus and Annaraja (2012)** conducted a study on metacognitive awareness of secondary teacher education students. The objectives of the study were: a) to assess the metacognitive awareness of the secondary teacher education students in Kanyakumari district, and b) to study whether there was any significant difference in metacognitive awareness of students with respect to gender, type of college and locality of college. Normative survey method was adopted in this study. The sample for the study was 240 secondary teacher education students of six B.Ed. colleges in
Kanyakumari district of Tamilnadu. Results showed a significant difference between male and female secondary teacher education students in their knowledge of cognition and metacognition. Significance difference was found between aided and unaided college secondary teacher education students in their regulation of cognition. Significance difference was found between rural and urban college secondary teacher education students in their regulation of cognition.

Sekar (2012) conducted a study on correlation of metacognition and teaching competency of D.T.Ed. teacher trainees of teacher training institutes. The objectives of the study were: a) to study the level of metacognition and teaching competency of D.T.Ed., teacher trainees, b) to find out whether there was any significant difference between male and female D.T.Ed. teacher trainees in their knowledge cognition, regulation cognition and metacognition, and c) to find out whether there was any significant relationship between metacognition and teaching competency of D.T.Ed. teacher trainees. The survey method was used in this study. Sample consisted of 200 students selected from those studying in teacher training institutes in Thanjavur district, Tamilnadu. Mean, standard deviation, ‘t’ test, and correlation were used to analyse the data. The findings of the study were: a) majority of D.T.Ed. students had moderate level of metacognition and teaching competency, b) there was no significant difference between male and female D.T.Ed. teacher trainees in their knowledge cognition, regulation cognition and metacognition, and c) there was a significant relationship between metacognition and teaching competency of D.T.Ed. teacher trainees.

Akar, Tenkkaya and Cakiroglu (2011) conducted a study on the interplay between metacognitive awareness and scientific epistemological beliefs. The objective of the study was to explore contributions of metacognitive awareness level to students’ scientific epistemological beliefs. 250 eighth grade students were selected as sample. Correlation analysis and multiple regression analysis were used as statistical techniques. The findings showed that both knowledge of cognition and regulation of cognition dimensions of metacognition related with certainty/simplicity of knowledge, source of knowledge, attainability of truth dimensions of epistemological beliefs. Multiple regression correlation analysis revealed that the model that includes regulation of cognition reached statistical significance. The positive beta values
indicated that students controlling all aspects of their learning tended to have more scientific knowledge as well as more attainable knowledge.

**Sendurur et al. (2011)** conducted a study on metacognitive awareness of pre-service teachers. The objectives of the study were: a) to investigate the pre-service teachers’ levels of metacognitive awareness and comparison of sub-awareness scores, and b) to explore relationship among metacognitive awareness factors and other independent variables including gender, GPA, course grades, and graduated high school type. Survey method was used in this study. Sample consisted of forty nine students studying in colleges of education. Descriptive statistics were explored to analyse the data. The findings showed that pre-service teachers got slightly better scores in knowledge of cognition. Differences were found between the mean scores of knowledge of cognition and regulation of cognition factors. Knowledge of cognition scores of pre-service teachers was significantly higher than regulation of cognition scores.

**Titus and Annaraja (2011)** conducted a study on teaching competency of secondary teacher education students in relation to their metacognition. The objectives of the study are: a) to find out whether there was any significant difference between male and female secondary teacher education students in their metacognition, b) to find out whether there was any significant difference between rural and urban college secondary teacher education students in their metacognition, and c) to find out whether there was any significant relationship between metacognition and teaching competency of secondary teacher education students. Survey method was used in this study. The study was conducted on teacher education students from various colleges in Tirunelveli and Tuticorin districts of Tamilnadu, India. The sample size was 600. It was selected by using stratified random sampling technique. Statistical techniques such as mean, SD, ‘t’ test and Pearson’s product moment correlations were employed to analyze the data. The findings of the study were: a) female students were better than the male students in their metacognition, b) urban college students were better than the rural college students in their metacognition, and c) there was a significant relationship between metacognition and teaching competency of secondary teacher education students.
Rajkumar (2010) conducted a study on analyzing the role of metacognitive skills involved in the process of problem-solving in physics among higher secondary students. The objective of the study was to investigate the role of metacognitive skills in assisting higher secondary students in school to solve physics problems individually. By random sampling technique 150 twelfth standard students studying physics in government higher secondary school, Kalakad and Tirunelveli were selected as sample. Mean, standard deviation and t-test were used for analysis. The findings showed that the mean scores in the metacognitive skills in post-test 1 and post-test 2 were significantly greater than the mean scores in pre-test t-value in post-test 1 and post-test 2. It brought out the positive effect of the experimental inputs.

2.4 Studies Related to Critical Thinking

Karagoil and Bekmezci (2015) conducted a study on investigating academic achievements and critical thinking dispositions of teacher candidates. The objectives of the study were: a) to examine the relationship between academic achievements and critical thinking dispositions of teacher candidates, b) to find out whether there was a relationship between critical thinking dispositions and academic achievement of teacher candidates. The population consisted of the teacher candidates in primary school teaching, social science teaching, Turkish teaching and science teaching at Ege university and Celal Bayar university. Survey method was used in this study. Independent sample t-test and Kruskal Wallis test were used to analyse the data. The findings showed that a) critical thinking dispositions of teacher candidates did not differ according to gender, but academic achievement differs according to the gender, b) critical thinking dispositions and academic achievement of teacher candidates did not differ according to type of school, and there was a positive and weak relationship between critical thinking dispositions and academic achievement of teacher candidates.

Lourduraj and Xavier (2015) conducted a study on relationship between decision-making and critical thinking of prospective teachers. The objectives of the study were: a) to find out whether there was any significant difference between male and female prospective teachers in their critical thinking, b) to find out whether there was any significant difference among UG, PG and M.Phil. qualified prospective teachers in their critical thinking, and c) to find out the relationship between decision-making and
critical thinking of prospective teachers. Survey method was used in this study. Sample consisted of 500 prospective teachers from Trichirappalli district. Percentage analysis, mean, standard deviation, t-test, ANOVA, Post ANOVA and correlational analysis were used as statistical techniques. The findings of the study were: a) there was no significant difference between male and female prospective teachers in their critical thinking, b) there was no significant difference among UG, PG and M.Phil., qualified prospective teachers in their critical thinking, and c) there was a significant relationship between decision-making and critical thinking of prospective teachers.

Nordin (2015) conducted a study on critical thinking as a predictor of students’ academic achievement: a study on Islamic studies students at Pahang Islamic College, Sultan Ahmad Shah, Kuantan. The objective of the study was to find out the existence of critical thinking skills among Islamic studies students at Pahang Islamic College, Sultan Ahmad Shah, Kuantan, based on academic achievement. A total of 152 students-76 males and 76 females from year one to three from Islamic studies piloted Preliminary English Test (PET). Experimental design was used. Mean, Standard deviation, t-test and Pearson correlation were used to analyse the data. At the end of the instructional period, both groups were given a writing post-test, and the comparison of their means revealed that the difference between the two groups’ post-test scores were non-significant. There was no significant difference between the impact of autonomy and critical thinking on EFL learners’ writing achievement. Autonomy and critical thinking techniques were equally effective on the learners’ writing achievement.

Nelson and Crow (2014) conducted a study on the topic, “Do active-learning strategies improve students' critical thinking?” The objective of the study was to investigate if active-learning strategies improve students’ critical thinking ability. Participants were pre-service teachers in physical education and athletic training education taking a teaching methods service-learning course. Findings showed significant improvement with critical thinking measures across both quasi experimental conditions. Academic tracking showed students pursuing a B.A., in physical education benefitted significantly more from the active-learning assessment than students pursuing a B.S., in athletic training.
Sadeghi and Malekian (2014) examined the role of education through curriculum development, creative and critical thinking view elementary third grade. The objective of the study was to analyze the teaching effect based on creative representation and curriculum progression and critical thinking of female students in grade three elementary schools. The research method was based on quasi-experimental with pre-test and post-test. Forty students were selected as sample from female students grade three elementary school in Kermanshah and divided into two groups of 20 students each. Kolmogorov normality test and Mann-whitney test were used to analyse the data. The result showed that in all cases teaching that performed in creative representation on enhancing critical thinking skill including inference, identifying assumptions, deduction, explanation and interpretation, evaluation, elements and educational progression of students in grade three primary school was effective and it approves the critical thinking and curriculum progression.

Sanavi and Tarighat (2014) conducted a study on critical thinking and speaking proficiency: a mixed-method study. The objective of the study was to investigate the impact of teaching critical thinking skills on the speaking proficiency of Iranian EFL learners in Tehran. The participants of the study were 30 female Iranian intermediate level learners of English, studying at an English institute situated in the north-east of Tehran. A mixed-method approach was employed in the analysis of the data. In the quantitative analysis, a quasi-experimental method was adopted in this study. The results indicated that teaching critical thinking explicitly had a significantly positive impact on the speaking proficiency of female Iranian adult intermediate EFL learners.

Slameto (2014) conducted a study on developing critical thinking skills through school teacher 'training and development personnel' model and their determinants of success. The purpose of the study was to test the efficiency and effectiveness of the training model and find the determinant factors of teachers' development of critical thinking. The training was attended by 37 elementary teachers. Mean, SD, ANOVA and regression were used to analyze the variables. The findings showed that primary school teachers perceived the training they had ever attended was not efficient and not effective, and did not developed critical thinking skills; After the training model
adolescent girls studying in class VIII, IX and X selected from government schools in Punjab. The findings of the study were: a) effect of psychoticism on depression was significant, b) levels of psychoticism and depression were significant, c) effect of neuroticism on depression was not significant, and e) effect of extroversion and depression was not significant.

**Harish (2011)** conducted a study on the impact of integrated critical thinking skills on achievement in mathematics of secondary school students. The objectives of the study were: a) to probe the impact of integrated critical thinking skills on achievement in mathematics, b) to determine the relationship between integrated critical thinking skills and achievement in mathematics with respect to gender, and c) to find out the difference in critical thinking skills and achievement scores based on gender. The randomized pre-test, post-test control group design was used with a purposive sample in the form of intact sections of class IX of the same school. The findings were: a) there was a significant difference between the post-test achievement of control and experimental groups, b) there was no significant difference between the mean scores of boys and girls in the post-test achievement, c) there was a significant interaction between groups and genders on post-test achievement, and d) there was a significant interaction between group and gender on total integrated critical thinking skills on achievement after the intervention program.

**Chung et al. (2011)** conducted a study on critical thinking in asynchronous online discussion: an investigation of student facilitation techniques. The objective of the study was to investigate the types of facilitation techniques exhibited by student facilitators, and how these techniques might influence in-depth levels of critical thinking in asynchronous online discussion forums. Sample consisted of ten education major students at an Asia-Pacific university. An exploratory qualitative case study methodology was employed. Data were collected from the students’ online discussion postings and interviews. The top 30% of discussion forums in terms of the most number of in-depth critical thinking incidences were first identified. Next, the bottom 30% forums were identified as the lower-level critical thinking group. The findings of the study suggested that it may serve student facilitators well to employ a variety of facilitation techniques rather than just utilise a few preferred ones in order to achieve higher levels of critical thinking.
Smitha and Rao (2011) conducted a study on relative effectiveness of inquiry training model and guided discovery learning on critical thinking of secondary school students. The objectives of the study were: a) to determine the relative effectiveness of inquiry training model or guided discovery learning approaches in teaching in developing critical thinking of secondary school students, b) to determine whether inquiry training model was better than the conventional teaching method in developing critical thinking, and c) to determine whether guided discovery learning approach was better than the conventional teaching method in developing critical thinking. Purposive sample technique was used. Quasi experimental design and 3 x 2 factorial matrix, ANOVA and ANCOVA were used. Sample was taken from class VIII students of a government run vocational higher secondary school in Meppayur village of Kozhikode district, Kerela state. There were 126 students, 66 boys and 60 girls in the age group of 13-14. The findings of the study were: a) there was no significant difference in critical thinking between the experimental group I and the experimental group II, b) there was no significant difference in critical thinking between the experimental group I and the control group, and c) there was no significant difference in critical thinking between the experimental group II and the control group.

Rani and Porgio (2010) conducted a study on academic achievement of higher secondary students in relation to their multiple intelligence, critical thinking and creativity. The objectives of the study were: a) to find out whether there was any significant difference in critical thinking of higher secondary students, b) to find out whether there was any significant difference in academic achievement of higher secondary students, and c) to find out whether there was any significant relationship between critical thinking and academic achievement of higher secondary students. Survey method was adopted in this study. Sample was collected by random sampling technique. Sample consisted of 1092 students studying XI and XII standard from various higher secondary schools in Alapuzha, Pattanamttta, Kollam and Thiruvananthapuram districts of Kerala. Percentage analysis, mean, SD, t-test, and Pearsons product moment correlation were used as statistical technique to analyse the data. The findings of the study were: a) there was no significant difference between male and female students in their multiple intelligence, b) there was a significant difference between male and female higher secondary students in their total critical thinking, maturity, analyticity, systematicity, self confidence and truth seeking. Male
students were better than female students in their total critical thinking, maturity, analyticity, systematicity, self confidence and truth seeking. c) co-education school students were better than girls school students in their truth seeking nature, d) rural school students were better than urban school students in their critical thinking, inquisitive, maturity, analyticity, systematic, self confidence and truth seeking in nature. e) unaided students showed more systematic nature than that of government and aided students. f) Muslim students showed more self confidence and truth seeking nature than that of Hindu students, and g) there was a significant relationship between critical thinking and academic achievement of higher secondary students.

**Sibichen and Annaraja (2010)** conducted a study on critical thinking and decision making skills in teaching. The objectives of the study were: a) to find out whether there was any significant difference between male and female, and b) graduate and postgraduate secondary teacher education students in their critical thinking and decision making skills. The sample consisted of 75 secondary teacher education students. The findings of the study were: a) there was a significant difference between the graduate and the postgraduate secondary teacher education students in the decision making, b) mean scores revealed that, postgraduate secondary teacher education students were better than graduate secondary teacher education students, c) there was a significant difference between the graduate and the postgraduate secondary teacher education students in their critical thinking skills, and d) mean scores revealed that postgraduate secondary teacher education students were better than graduate secondary teacher education students.

### 2.5 Studies Related to Achievement in Science

**Karagol and Bekmezci (2015)** conducted a study on investigating academic achievement and critical thinking dispositions of teacher candidates. The objective of this study was to examine the relationship between academic achievement and critical thinking dispositions of teacher candidates. The population consisted of the teacher candidates at the department of primary school teaching, social science teaching, Turkish teaching and science teaching at Ege University and Celal Bayar University. The study group was determined by survey method. The sample of the study was determined by convenience sampling method and the study was conducted with 377 teacher candidates. Independent sample t-test, frequencies, Kruskal Wallis test, one-
way ANOVA and Pearson product moment correlation were used to analyse the data. The findings showed that the critical thinking dispositions of teacher candidates did not differ according to gender, but academic achievement differed according to the gender. Both critical thinking dispositions and academic achievements of teacher candidates did not differ according to type of school. Critical thinking dispositions of teacher candidates differed according to field of study. There was a positive and weak relationship between critical thinking dispositions and academic achievement of teacher candidates.

Sridevi (2015) conducted a study on social maturity and achievement in science of secondary students. The objectives of the study were: a) to find out the significant difference in social maturity of secondary school students with reference to gender, type of school, locality of school and nature of family, b) to find out the significant difference in achievement in science of secondary school students with reference to gender, type of school, locality of school and nature of family and c) to find out the significant relationship between the social maturity and achievement in science of secondary school students. The Normative survey method was adopted for the study. The sample consisted of 299 secondary school students. Pearson product moment correlation, Percentage analysis and t-test were used to analyse the data. The findings of the study were: a) there was significant difference in social maturity of secondary students with respect to gender, locality and nature of family, but there was no significant difference in social maturity of secondary school students with respect to type of school, b) there was no significant difference existed in achievement in science of secondary school students with respect to gender, but significant differences was found with respect to locality of school, type of school and nature of family, and c) there was significant relationship between social maturity and achievement in science of secondary school students with respect to sex-female and nature of family-joint family.

Jayapraba and Kanmani (2014) conducted a study on the effect of metacognitive strategy on jigsaw cooperative learning method to enhance biology achievement. The objectives of the study were: a) to determine how the adoption of metacognitive strategy in jigsaw cooperative learning method influences students’ achievement in biology, b) to find whether there was any significant difference between control group and experimental group in gain scores of higher secondary students, and c) to find
whether there was any significant difference between control group and experimental group in gain scores on attainment of objectives knowledge understanding and application of higher secondary students. Experimental method was used. 70 students drawn from municipal higher secondary school in Tamilnadu, India were used as sample for the study. The findings showed that the control group and the experiential group students differ significantly in gain scores. Control group and experimental group students differ significantly in mean gain scores of knowledge objective. Control group and experimental group students differ significantly in mean gain scores of understanding objective. Control group and experimental group students differ significantly in mean gain scores of application objective. Metacognitive awareness and gain score of control group were not correlated significantly. But metacognitive awareness and gain score of experiential group were correlated significantly. Thus it was suggested that instruction in the metacognitive strategy improve the students’ achievement in biology.

Sreedevi and Amalaraj (2014) conducted a study on problem solving style and academic achievement of prospective science teachers in colleges of education. The objectives of the study were: a) to find out if there was any significant difference in problem solving styles of prospective teachers of science in colleges of education, b) to find out if there was any significant difference in the academic achievement of prospective teachers of science in colleges of education, and c) to find out if there was any significant correlation between problem solving style and academic achievement of prospective teachers of science in colleges of education. Normative survey method was used for the study. Sample consisted of 700 prospective teachers of science in colleges of education affiliated to University of Kerala. Mean, standard deviation, t-test and Pearson product moment correlation were used to analyse the data. The findings showed that there was a significant difference between male and female, joint family and nuclear family prospective teachers, UG and PG qualification of prospective teachers in their problem solving style. A significant difference was also found between nuclear and joint family, UG and PG qualification of prospective teachers in their academic achievement. There was a significant relationship between problem solving style and academic achievement with reference to gender, locality of college, nature of family and educational qualification of prospective science teachers.
John (2014) conducted a study on the impact of problem based learning strategy on higher cognitive outcome in biology at secondary level. The objectives of the study were: a) to find out the effectiveness of problem based learning strategy on higher cognitive outcomes by comparing the post test achievement of problem based learning strategy (PBL) group and activity method (AM) group, b) to find out the effectiveness of problem based learning strategy on higher cognitive outcome comparing the post test achievement of problem based learning strategy group and activity method of the following categories like i) remembering ii) understanding iii) applying iv) analysing v) evaluating vi) creating, and c) to compare the post test achievement of boys and girls in the problem based learning strategy. Experimental method with pre-test post-test non-equivalent group design was used. The sample consisted of 80 eighth standard students from Kollam district. Mean, standard deviation and t-test were the statistical techniques employed. The findings showed that a significant difference between mean post test scores of the PBL and AM groups with regard to categories viz. remembering, understanding, applying, analyzing, evaluating and creating and also revealed that the PBL was superior to AM with regard to the achievement of higher order categories such as applying, analyzing, evaluating and creating, whereas in the case of remembering and understanding the values reveals that no significant difference existed between the post test scores and PBL group and AM group. The mean post test scores of boys and girls of PBL group revealed that there was no significant difference between the boys and girls in their post test achievement.

Dhar (2014) conducted a study on the effectiveness of tree-chart for teaching botany at higher secondary level. The objectives of the study were: a) to prepare a tree-chart for botany for higher secondary school students, b) to test the effectiveness of tree-chart for teaching botany at higher secondary school students by comparing the pretest achievement scores of experimental group with that of control group, which was taught through the traditional lecture method, c) to test the effectiveness of tree-chart for teaching botany at higher secondary school students by comparing the post-test achievement scores of experimental group with that of control group, which was taught by the traditional lecture method, d) to test whether there was any significant difference among the tree–chart group and control group with regard to post-test achievement scores and e) to test the effectiveness of tree-chart by comparing the post-
test achievement scores of the experimental group (sub-sample) based on the variables sex and locality. The researcher developed a tree–chart of class-dicotyledons, after giving specimens and pictures and thereafter collecting opinion from the students by adopting activity method and parallel group design. The sample consisted of 62 XII students from a government higher secondary school, Thiruvananthapuram, Kerala. The age of the students ranged from 16-18 years. Experimental method was used in this study. The findings showed that the tree-chart was an effective tool for teaching botanical classifications at higher secondary level.

**Shankar and Thilagavathy (2014)** conducted a study on achievement in chemistry of first year higher secondary students in relation to their scientific aptitude. The objectives of the study were: a) to find out the significant difference, if any, in gender, location of school, type of school, parental annual income and parental educational qualification, and b) to find out the relationship between achievement in chemistry and scientific aptitude of first year higher secondary students. Simple random technique was used in this study. Sample consisted of 60 first year higher secondary students in Namakkal district. Mean, SD, correlation were used to analyse the data. The findings showed a significant difference in gender, location of school, type of school, parental income and parental educational qualification of first year higher secondary students in their scientific aptitude except government and aided school students. A significant relationship was also found between achievement in chemistry and scientific aptitude of first year higher secondary students.

**Thandavamoorthy (2014)** conducted a study on the relation between emotional maturity and academic achievement of biological science B.Ed. students. The objectives of the study were: a) to find out the level of emotional maturity of biological science B.Ed., students, and b) to study the correlation between emotional maturity and academic achievement of biological science students. Normative survey method was employed. Sample consisted of 100 students selected from five colleges of education in Pondicherry. The findings were: a) most of the biological science B.Ed., students had moderate level of emotional maturity, b) they did not differ in emotional maturity based on their age group and locality, and c) there was a positive relationship between emotional maturity and academic achievement.
Sepahi et al. (2014) conducted a study on the correlation between critical thinking disposition and academic achievement of preclinical and clinical medical students at Kermanshah University of Medical Sciences. The objective of the study was to compare the association between critical thinking disposition and academic achievement in preclinical and clinical medical students. The sample consisted of 259 students from Kermanshah University of medical sciences and selected through stratified random sampling. Data were analyzed by using descriptive statistics, t-test, and Kolmogrov-Smirnov and correlation coefficient tests. The results indicated that the mean of critical thinking disposition in the preclinical stage indicated a significant correlation with academic achievement. In the clinical stage, however, the mean of critical thinking disposition showed no significant correlation with academic achievement. The mean of critical thinking disposition and its components in preclinical and clinical stages revealed not significant correlation and merely curiosity component showed a significant correlation.

Sharma (2014) conducted a study on the effectiveness of concept mapping strategy on student’s achievement and concept retention in organic chemistry. The objective of the study was to investigate the effectiveness of concept mapping strategy on the achievement and concept retention in organic chemistry of class XII science students belonging to higher intelligence and lower intelligence groups. A sample of 80 science students was drawn from class XII science students from a school at Varanasi. The pre-test-post-test-non-equivalent groups design was used for this study. Two intact sections- ‘A’ and ‘B’ of class XII were chosen as the sample of the study. The students were tested with pre-test and post-test containing 25 multiple-choice questions. t-test was applied for the analysis. The findings were: a) experimental group was found to attain significantly higher achievement scores and retained more in both higher and lower intelligence groups as compared to the control group, b) higher intelligence experimental group was found to attain significantly higher achievement scores and retained more as compared to the lower intelligence experimental group.

Sharma (2014) conducted a study on emotional intelligence in relation to academic achievement. The objective of the study was to find out whether the students of different academic achievement level have the same emotional intelligence and to examine if there was any correlation between EQ and academic achievement. The normative survey method was used. A total sample of 240 students studying in class
XI from all disciplines, science, arts and commerce, was taken and the schools from both urban and rural areas were chosen. Emotional intelligence inventory was used to measure the EQ of the students, and marks obtained in the annual examination of class X were used to form groups according to their academic achievement. The result showed that emotional intelligence was an independent variable from not only academic achievement but gender as well. It also revealed an insignificant correlation between emotional intelligence and academic achievement.

Ali, Toriman and Gasim (2014) conducted a study on the academic achievement in biology with suggested solutions in selected secondary schools in Kano state, Nigeria. The objectives of the study were: a) to determine the students’ academic achievement in biology for proper, effective, and sound science programs in the secondary school, b) to examine the factors that influence students’ academic achievement in biology, and c) to identify solutions to the problems that hinder students’ performance in biology subject. Survey was preferred for the study and simple random sampling was used in choosing the participants. Data was collected from 100 respondents from five selected secondary schools in Kano District. The statistical techniques were frequency table and simple percentages. The findings of the study were: a) the level of students’ academic achievement in biology subject was low, b) 76% of students had never used computer although 76% of the respondents agree that computer assisted learning would help immensely in the study of biology, and c) 80% of the students in the selected schools had a very good parental support and only 20% of them had a poor parental support towards their academic ladder in learning biology.

Eddy, Brownell, and Wenderoth (2014) conducted a study on gender gaps in achievement and participation in multiple introductory biology classrooms. The objective of the study was to compare the relative position of males and females within a classroom and not to document the absolute value of their performance in the class. Data were collected from twenty three large introductory biology classes for major and two measures of gender disparity in biology: academic achievement and participation in whole-class. Mean, standard deviation and average were used to analyse the data. The findings showed that females consistently underperform in exams compared with males with similar overall college grade point averages. The females on an average represent 60% of the students in these courses; their voices make up less than 40% of those heard responding to instructor-posed questions to the
class students engaging in large lectures and despite numerical dominance of females, gender disparities remain an issue in introductory biology classrooms.

Mojarad, Shabani and Gatab (2014) conducted a study on the effects of teaching cognitive and metacognitive strategies on self-efficacy and goal-selecting of orphan girl students. The objective of the study was to find out the effects of teaching cognitive and metacognitive strategies to the self-regulation learning of girl students in orphanage centres and at guidance school level. The sample included 20 girl students living in residential centres supervised by the Tehran welfare organization; 10 of whom were assigned in the experimental group and 10 in the control group. Independent-sample t test was applied. The results showed a significant difference between the self-efficacy of the orphan girl students who took the learning cognitive and metacognitive-strategies and those who didn’t take the course. There was a significant difference between the goal-selecting of the orphan girl students who took the learning cognitive and metacognitive strategies and those who didn’t take the course.

Ramdiah and Corebima (2014) conducted a study on learning strategy equalizing students’ achievement, metacognitive and critical thinking skills. The objective of the study was to find out the appropriate learning strategy that can enhance and equalize the male and female students’ achievement, metacognitive, and critical thinking skills. The study had been carried out in quasi-experiment of pre-test-post-test non-equivalent control group design. Population of the study was second grade of Banjarmasin Senior High School students majoring in science. PQ4R strategy combined with concept mapping strategy, and conventional strategy were used. One-sample Kolmogorov-Smirnov test and homogeneity testing of Levene’s test of equality of error variances and ANCOVA were used as statistical techniques. The findings of the study showed that the students’ learning achievement, metacognitive, and critical thinking skills were similar or almost similar between the two genders, when the PQ4R strategy combined with the concept mapping strategy was applied.

Dhar (2013) conducted a study on school climate and achievement in botany among higher secondary school students. The objective of the study were: a) to find out the relationship between school climate and achievement in botany for the whole sample, and relevant sub sample viz sex, locality, nature of management and medium of
instruction, b) to find out whether there was any significant difference in the relationship between school climate and achievement in botany, and c) to test whether there was any significant difference in the mean score of achievement in botany. Survey method was adopted for the study. Data was collected from the 400 sample from 10 different schools. The findings were: a) there was a relationship between school climate and achievement in botany among higher secondary school students, b) there was no significant relationship between school climate and achievement for male and female, rural and urban, government and private aided, Tamil and English medium students, c) there was a relationship between achievement and school climate and both were influenced by variables viz, sex, locality, medium of instruction, type of school and monthly income of the family, and d) students from schools of better environment had a significantly better academic achievement than the students from poor school environments.

**Joshua and Yohannan (2013)** conducted a study on blended learning strategy and achievement in biology. The objective of the study was to compare effectiveness of blended learning with that of activity oriented method on achievement on biology of secondary school students. Experimental method was used. Sample consisted of 30 eighth standard students from Holy Family High School in Kottayam district, Kerala. The findings showed that blended learning strategy was more effective than the activity oriented method on achievement in biology of secondary school students.

**Mehar and Singh (2013)** conducted a study on the effect of concept mapping strategy on achievement in biology in relation to attitude towards biology. The objectives of the study were: a) to compare the performance of group taught through concept mapping strategy and conventional teaching strategy, b) to study the performance of students with different levels of attitude towards science, and c) to examine the interaction effect between concept mapping strategy and attitude towards science. The study was conducted on a random sample of 100 students of IX standard selected from two different schools of Chandigarh. Experimental method was employed. Pre-test, post test and factorial design were also employed. The findings were: a) concept mapping strategy group was found to have significantly higher achievement scores as compared to the control group, b) performance of students with different attitude towards biology group taught through concept mapping strategy was found significant,
and c) no significant interactional effect was found between the two variables at achievement level.

**Chinna and Dada (2013)** conducted a study on effects of developed electronic instructional medium on students’ achievement in biology. The objective of the study was to investigate the effects of developed electronic instructional medium (video DVD instructional package) on students’ achievement in biology. Quasi-experimental design method was adopted in the study. Sample consisted of one hundred and eighty senior secondary school boys and girls selected from six co-educational schools in Niger state. Mean, standard deviation, ANCOVA and Scheffe’s test were used to analyse the data. Scheffe test indicated that the achievement of students in biology greatly improved with the use of electronic instructional medium. Students’ gender had no significant effect on their achievement in biology when electronic medium was used. The mean achievement score of students in the experimental group was higher than that of the students in the control group. Male and female students in the experimental group had higher mean achievement scores than their male and female counterparts in the control group.

**Ikitde and Edet (2013)** conducted a study on the influence of learning styles and teaching strategies on students’ achievement in biology. The objectives of the study were: a) to determine the effect of teaching strategies on students’ achievement in biology based on different learning styles, b) to examine the difference in achievement in biology by students with different leaning styles taught using different teaching strategies, and c) to determine the influence of gender on biology achievement by students taught using demonstration, guided-inquiry and lecture teaching strategies with different learning styles. Experimental design was used in this study. A total of two hundred and forty Senior Secondary Two (SS2) biology students took part in the study. A purposive sampling technique was used to select six schools from the population. Data were analyzed by using analysis of covariance (ANCOVA). The findings were: a) sequential/global learning style was the most effective in facilitating students' achievement in biology when taught with demonstration, b) achievement of students in biology was attributable to the influence of different learning styles of students when taught using lecture strategy, c) visual/verbal learning styles was the most effective in facilitating students' achievement in biology when taught with lecture strategy, and d) there was no significant influence of gender on biology students'
achievement with different learning styles when taught using guided-inquiry, demonstration and lecture teaching strategies.

Kosgei (2013) conducted a study on teacher characteristics and students’ academic achievement: case of biology subject in selected secondary schools in Nandi south district, Kenya. The objective of the study was to establish the relationship between teacher characteristics and students’ academic achievement in biology. The study focused on the following independent variables: teacher qualification and teacher experience and their effect on student academic achievement. Causal comparative research design was used. Sample consisted of biology teachers of 20 secondary schools in the district from a total population of 26 schools in Nandi south district. Data were analyzed by using descriptive and inferential statistical techniques. The findings showed that there was no significant relationship between teacher qualification and student academic achievement. The teacher experience had a significant relationship with student academic achievement in biology.

Aktas et al. (2013) conducted a study on gender and experience as predictor of biology teachers’ education process self-efficacy perception and perception of responsibility from student success. The objective of the study was to examine the relation between biology teachers, education process self-efficacy perception, perception of responsibility from student success, and gender and experience. Descriptive survey model was used in the study. The research had been prepared according to the scanning model. A total of 82 biology teachers working in the central districts of Ankara participated in the research. In data analysis, besides descriptive statistics, Pearson product moment correlation coefficient was used in the calculation of the relation between the variables; and linear regression analysis was performed to determine the level of prediction of the dependent variables by the independent variables. The findings showed that the level of biology teachers’ education process self-efficacy perception and the level of perception of responsibility from student success had been found as medium. The regression analysis showed that both gender and experience variables positively and significantly predict education process self-efficacy perception and perception of responsibility from student success.

The objective of the study was to establish the relationship between motivational beliefs and self-regulation in biology learning and the differences related to ethnicity, gender and grade level in Nakuru and Siaya-counties dominated by Kikuyu and Luo ethnic communities respectively in Kenya. This research was a non-experimental quantitative one. Sample consisted of 317 students in two co-educational schools of Nakuru and Siaya in Kenya. MANOVA test was used to analyse the data. The findings showed that there was a statistically significant difference between the Nakuru group and the Siaya group with regard to self-efficacy in Biology learning. There were no statistically significant gender differences in motivational beliefs and self-regulation in biology learning. Boys were more self-efficacious with low test anxiety than girls. Girls had higher intrinsic value, cognitive strategy and self-regulation than boys.

Osuafor and Okonkwo (2013) conducted a study on influence of family background on academic achievement of secondary school biology students in Anambra state. The objective of the study was to determine the influence of family background on academic achievement of secondary school biology students. To determine the influence of: a) family structure (monogamous and polygamous families) on students’ academic achievement in biology, b) occupation of parents on students’ academic achievement biology, and c) parents’ level of education on students’ academic achievement in biology. Descriptive survey was adopted for the study. The study was carried out in public secondary schools in Anambra State of Nigeria. Five hundred and forty-six students constituted the sample for the study. Data were analyzed by using mean, t-test, and ANOVA. The findings were: a) students from polygamous families achieved higher in biology than the students from monogamous families, b) students whose parents were civil servants achieved higher in biology than those whose parents were traders, c) there was no significant influence of family structure on students’ achievement in biology, d) there was no significant influence of parents’ occupation on students’ achievement in biology, and e) there was no significant influence of parents’ level of education on students’ achievement in biology.

Samikwo (2013) conducted a study on factors which influence academic performance in biology in Kenya: a perspective for global competitiveness. The objective of the study was to find out what the students’ perceptions regarding the cause of failure as the first step towards improving academic performance in biology. Sample of 215 students from 15 secondary school of Uasin Gishu west district were selected in this
study. The findings of the study showed that there was a relationship between students’ attitude towards biology and their performance. Students with a positive attitude towards biology subject registered a good performance than those with a negative attitude. A majority of the students had a positive attitude towards biology.

Meena (2012) conducted a study on the impact of learning approaches on achievement of pupil teachers in relation to their academic streams at different levels of intelligence. The objectives of the study were: a) to compare the achievement scores of pupil teachers of arts and science group at different levels of intelligence, b) to study the learning approaches of pupil teachers at different levels of intelligence, and c) to study the interaction effect of learning approaches and academic streams (arts/science) of pupil teachers at different levels of intelligence. Stratified sampling was employed to select the pupil teachers from the arts and science groups. Sample consisted of 200 pupil teachers and employed a 2x2 factorial design. Mean and standard deviations, two-way ANOVA were used as statistical techniques. The findings of the study were: a) pupil teachers under arts and science group yielded significant differences in mean scores at an average level of intelligence, and b) academic streams (arts/science) and learning approaches interacted significantly with regard to mean scores at average and low levels of intelligence.

Dhar (2012) conducted a study on the effectiveness of field trip on teaching botany at higher secondary level. The objective of the study was to find out the effectiveness of field trips over conventional lectures for teaching botany at higher secondary school level. Parallel group design experimental method was adopted in this study. Sample consisted of 62 XII standard students from Government Boys’ Higher Secondary School, Neyyattinkara, Thiruvananthapuram. t-test was used to analyse the data. The findings showed that mean scores of the experimental and control groups on post-test achievement were significant. Post-test and retention test scores were significant. Control group and experimental group means scores were significant. Mean scores of the experimental group on post test achievement revealed that there was no significant difference for the variables such as sex, locality, income and community.

Saravanakumar and Subbbiah (2012) conducted an experimental study on stimulus variation techniques on enhancing students’ achievement. The objectives of the study were: a) to identify the factors related to stimulus variation on enhancing students’
attention, b) to implement stimulus variation techniques in classroom teaching, and
c) to find out the effectiveness of stimulus variation techniques on students’ attention
and their achievement. Sample consisted of 30 tenth standard students. Experimental
design was used. Non-parametric technique was used. The findings were: a) there
was a significant difference between pre-test and post-test performance of the students
in the experimental group, b) students who had been taught through effective stimulus
variation on enhancing attention technique performed better in their achievement,
c) there was a significant difference between the pre-test and post-test scores, and
d) the performance of the post-test was significantly greater than the pre-test
performance.

Saroja and Amalraj (2012) conducted a study on the relationship between cognitive
style and academic achievement of prospective teachers of biological science. The
objectives of the study were: a) to find out the difference, if any, in cognitive style and
academic achievement of biological science prospective teachers with reference to
background variables, b) to find out the significant difference in the academic
achievement of prospective teachers with reference to background variables, and c) to
find out the significant relationship, if any, between cognitive style and academic
achievement of prospective teachers with reference to background variables. Survey
method was adopted in the study. Sample consisted of 500 prospective teachers of
biological science studying in colleges of education in Tirunelveli, Kanyakumari and
Thoothukudi districts of Tamilnadu. Mean, standard deviation, t-test, ANOVA and
Pearson product moment correlation were used to analyze the data. The findings of the
study were: a) there was no significant difference between male and female
prospective teachers in their systematic, intuitive and cognitive style, b) there was no
significant difference in systematic style of biological science prospective teachers
using internet and those not using it, c) there was no significant difference between
male and female, women and co-education college and internet using and non-using
prospective teachers in their academic achievement whereas a significant difference
was observed between PG and UG biological science prospective teachers, and d)
there was a significant relationship between systematic style and academic
achievement, intuitive style and academic achievement of female biological science
prospective teachers.
**Surapur (2012)** conducted a study on the impact of urban students interested in science, study habits and school adjustment on academic achievement in science. The objectives of the study were: a) to study the effect of urban students interested in science on academic achievement in science, b) to study the effect of urban students’ study habits on academic achievement in science, and c) to study the effect of urban students’ school adjustment on academic achievement in science. Survey method was used. The sample consisted of 300 urban students studying science subject in IX standard belonging to Bijapur district. The data were analysed by using three-way ANOVA technique. The findings of the study were: a) the urban students with a higher interest in science had more influence on academic achievement in science than the urban students with a lower interest in science, b) the urban students with good study habits had more influence on academic achievement in science than urban students with poor study habits, c) the urban students with high school adjustment had more influence on academic achievement in science than the urban students with low school adjustment.

**Thilagavathy (2012)** conducted a study on the achievement and the emotional maturity of teacher trainees in Thanjavur district. The objectives of the study were: a) to find out the level of achievement of teacher training students, b) to find out whether there was any significant difference in the achievement of teacher trainees with respect to sex, family type and locality, and c) to find out the relationship between achievement and emotional maturity of teacher trainees. Three hundred teacher trainees were selected as sample. Proportionate stratified random sampling technique was used. Descriptive survey method was employed to collect the data. t-test and Pearson product moment correlation were used as statistical techniques. The findings were: a) the achievement level of the teacher trainees was average, b) male and female, nuclear and joint family, and rural and urban institutional teacher trainees did not differ significantly in their achievement level, and c) there was a significant positive relationship between achievement and emotional maturity in teacher trainees of Thanjavur district.

**Mahmoud (2012)** conducted a study on critical thinking dispositions and learning styles of baccalaureate nursing students and its relation to their achievement. The objective of the study was to determine baccalaureate nursing students’ critical thinking dispositions and learning styles and its relation to their achievement.
Descriptive correctional study design was used in this study. The sample consisted of 102 nursing students from fourth level, 63 nursing students from level six and 43 nursing students from level eight in King Khalid University, Saudi Arabia. Mean, SD and ANOVA statistical techniques were used to analyse the data. The findings of the study were: a) a statistically significant difference was found total critical thinking disposition among nursing student in different levels, b) a significant difference was found in truth seeking, systematicity, self-confidence and critical thinking inquisitiveness, c) no significant relationship was found between overall critical thinking dispositions and nursing students’ achievement with active/reflective learning style, d) critical thinking inquisitiveness was significantly correlated with sensitive/intuitive learning style and e) there was no significant relationship between overall critical thinking dispositions and learning styles with nursing students’ achievement, f) the highest score achieved by students on the subscale of truth-seeking and open-mindedness revealed that active/reflective was negatively correlated with truth seeking, open-mindedness, and analyticity. However, maturity was highly significantly correlated.

Udeani and Okafor (2012) conducted a study on the effect of concept mapping instructional strategy on the biology achievement of senior secondary school slow learners. The objective of the study was to investigate the comparative effectiveness of the expository and concept mapping instructional strategy of presenting secondary school biology concepts to slow learners. One hundred and twenty four biology slow learners were identified and randomly assigned to the expository group and concept mapping group and were taught the concept of photosynthesis. An experimental method was used. The findings showed that the concept mapping instructional strategy performed significantly better than their expository group counterparts. Female slow learners taught with the concept mapping instructional strategy performed significantly better than their male counterparts taught by the same method.

Antonyraj and Amalraj (2011) conducted a study on cognitive style and academic achievement of outgoing undergraduate history students. The objective of the study was to find out the relationship between cognitive style and academic achievement of outgoing undergraduate history students in colleges affiliated to Manonmaniam Sundaranar University, Tirunelveli. Random sampling technique was used for selecting 760 final year undergraduate history students from Tirunelveli, Thoothukudi
and Kanyakumari districts. Survey method was used. Mean, standard deviation, t-test and correlation as the statistical techniques for analyse the data. The findings showed a significant difference between autonomous and non-autonomous college students in their cognitive style. A significant difference was found between cognitive style and academic achievement of female students. There was a significant relationship between cognitive style and academic achievement of the female students as well as urban students.

**Devaki and Pushpham (2011)** conducted a study on metacognitive ability and academic achievement in chemistry among XI standard students. The objectives of the study were: a) to assess the association between metacognition ability and academic achievement in chemistry among XI standard students, and b) to study the metacognitive ability of the samples, with respect to sex, locality of school, medium of instruction, type of school, mother education and fathers’ education. A sample of 244 students of XI standard belonging to science group from Coimbatore district was selected in this study. For analyzing the data correlation, t-test and ANOVA were used. The findings of the study were: a) there was a significant association between metacognitive ability and academic achievement in chemistry, b) there was a significant difference in the metacognitive ability of boys and girls, and the rural and urban school students, c) there was no significant difference in the metacognitive ability of the students with respect to the variables medium of instruction, group taken and family income, d) the students whose fathers were uneducated were found to have a higher metacognitive ability, whereas students whose mothers were in government jobs had a lower metacognitive ability, and e) there was a significant difference in the metacognitive ability of boys’ school students and girls’ school students and co-education school students, and also in government, aided and corporation school students.

**Opara (2011)** conducted a study on inquiry method and student academic achievement in biology: lessons and policy implications. The objectives of the study were: a) to compare the mean achievement scores of students taught through inquiry teaching method and those taught using the conventional method, b) to compare the mean achievement scores of male and female students taught using inquiry teaching method, and c) to compare the mean achievement scores of students taught using inquiry method in the urban and the rural areas. Quasi experimental design method
was employed for this study. Sample consisted of 120 senior secondary school students randomly selected in Ogba State. Mean, Standard deviation, Z test were used as statistical techniques. The findings showed that the use of inquiry teaching method favours the males more than the females in biology achievement. Boys’ school performed better than girls’ school and co-educational schools. Students who were taught using inquiry teaching method in the urban schools had a higher rate of achievement in biology than those in the rural areas.

**Rani and Porgio (2010)** conducted a study on the effect of multiple intelligence on the academic achievement of higher secondary students. The objectives of the study were: a) to find out the level of academic achievement in higher secondary students, b) to find out the level of multiple intelligence in higher secondary students, and c) to find out whether there was any significance relationship between multiple intelligence and academic achievement of higher secondary students. The sample consisted of 1092 students from various higher secondary schools of Pattanamthitta, Kollam, Trivandrum and Alappuzha districts of Kerala selected by multi-stage random design. Mean, SD, t-test and correlation were used to analyse the data. The findings were: a) there was a significant difference between plus one and plus two students in their logical mathematical intelligence. The plus one students showed more logical mathematical intelligence than plus two students, b) co-educational school students had more interpersonal intelligence than girl’s school students, and c) there was a significant relationship between verbal and logical mathematical intelligence and achievement of higher secondary students.

**Araoye and Ivie (2009)** conducted a study on redressing students’ motivation and academic achievement in biology education at the Federal College of Education (special) Oyo Oyo State, Nigeria. The objectives of the study were: a) to find out whether there was any significant effect of students background in biology on their performance in the subject, b) to find out whether there was any significant difference between ‘high teacher-low student’ ratio and student performance in biology, c) to find out whether there was any significant effect of students’ attitude on their performance in biology, and d) to find out whether there was any significant effect of teachers methodology on students performance in biology. The research design employed a descriptive survey method. Seventy students were randomly selected based on simple random sampling techniques. Data obtained were analyzed with the
use of chi-square and simple percentage. The findings of the study were: a) the students’ knowledge background in biology would have a significant effect on students’ performance, b) there was no significant difference between ‘high teacher-low student’ ratio and students performance in biology, c) there was no significant effect of students’ attitude on their performance in biology, and d) teachers’ methodology had a significant effect on student performance in biology.

Manivannan (2006) conducted a study on cognitive strategies and academic achievement of the students at secondary level. The purposes of the study were: a) to study the impact of gender on cognitive strategies and academic achievement of students, and b) to investigate the relationship between the cognitive strategies and academic achievement of the students. The sample consisted of 320 secondary level students in Erode district, Tamilnadu. Mean, SD, t-test, ANVOA, and correlation coefficient were used as the statistical techniques to analyse the data. The results showed that girls had higher attitude scores than the boys with regard to cognitive strategies and there was no significant relationship between the scores of cognitive strategies and academic achievement.

2.6 Critical Review

Several voluminous literatures concerning metacognition, critical thinking and academic achievement have been reviewed by the investigator. The investigator presented 113 reviewed studies in this chapter, out of which 17 foreign studies and 25 Indian studies related to metacognition, 22 foreign studies and 10 Indian studies related to critical thinking and 16 foreign studies and 23 Indian studies related to achievement. Most of the studies have employed survey method, quasi-experimental, experimental design and exploratory qualitative case study method. Random sampling, non-probability sampling, stratified random sampling, cluster sampling were the sampling techniques followed in these studies. Mean, SD, minimum, maximum, t-test, ANOVA, ANCOVA, MANOVA, Skeness, Kurtosis, Chi-square, percentage analysis, linear regression, regression, Pearsons product moment correlation, one sample Kolmogorov Smirmov, Kruskal Wallis test, Levene’s test of equality of error variance and factorial analysis were the statistical techniques used in the studies.
2.6.1 Metacognition. The investigator would like to add the following comments pertaining to the variable metacognition. After a critical evaluation of the studies related to metacognition, the researcher has made the following observations:

Studies related to metacognition by Indian authors, Prasadh and Sankareswari (2014) found that a significant relationship exists between metacognition and problem solving style of women’s college students. Minikutty and Gopinath (2014) reported that student teachers studied in government aided and unaided teacher education colleges, language and science subjects, rural and urban students had equal level of metacognitive awareness in teaching. Jena and Ahmad (2014) reported that a significant positive relationship was found between metacognition and epistemological beliefs of primary school teacher trainees. Sasikumar (2014) concluded that a significant positive correlation was found between the metacognitive awareness and students’ mathematics achievement. Sheeja (2014) reported that metacognitive skills had a significant relation with study habits in relation to their home environment. Kumari and Jinto (2014) reported that metacognitive ability was significantly effective in enhancing the achievement in social science among standard nine students. Vijayakumari and D’Souza (2014) found that metacognitive-cooperative learning approach had significantly more effect than traditional method on achievement in mathematics. Yogaraj and Selvaraju (2014) argued that there was a significant influence of metacognition, learning styles on problem solving skills of B.Ed., trainees. Shetty (2014) observed that the student teachers with the learning style introversion and thinking were found to be significantly higher in metacognition than the student teachers with the learning style extroversion and feeling.

Tali and Dar (2014) found that the teacher trainees differ significantly in the use of knowledge of cognition. Male teacher trainees were found better than female teacher trainees in the use of knowledge of cognition. Narang and Saini (2013) reported that metacognitive components namely knowledge of cognition and regulation of cognition had a significant influence on the academic achievement of rural students. Khan and Khan (2013) revealed a positive relationship between metacognitive reading strategies and scholastic achievement in science of IX standard students. Kunjivaru and Rajagopalan (2013) concluded that a significant difference was found between male and female teachers in their metacognitive awareness. Mathew and Joseph (2013) concluded that significant a positive correlation was found
between metacognitive ability and academic achievement of adolescent students. Rani and Govil (2013) revealed that the high and the low achieving undergraduate students differ significantly in their metacognitive level. Kapadia and Garg (2012) reported that female students possess higher metacognition than male secondary school students. Titus and Annaraja (2012) reported that female secondary students were better in their regulation of cognition and metacognition. Unaided college and urban college secondary teacher education students are better in their regulation of cognition. Sekar (2012) reported that the male D.T.Ed. teacher trainees were better than the female D.T.Ed. teacher trainees, and significant relationship found between metacognition and teaching competency of D.T.Ed. teacher trainees.

Hassan and Ahmed (2015), foreign authors conducting studies related to metacognition, reported that the metacognitive strategies had a significant influence on academic achievement of special education students. Aurah, et al (2014) concluded that metacognition and self efficacy had a significant influence on genetics problem-solving ability. Magno (2015) concluded metacognitive skills provide a significant path to critical thinking. But Sadeghi and Zamanian (2015) found that there existed a negative correlation between EFL learners’ metacognitive awareness and their reading comprehension. Huseyin Oz (2015) opined that both knowledge of cognition and regulation of cognition significantly contributed to the prediction of variation in students’ academic achievement. Himghaempanah et al. (2014) averred that a significant inverse relationship was found between Internet addiction and academic achievement, but the relationship between metacognitive skills and academic achievement was significant. Abu-Ameerh (2014) observed that the regulation of cognition and knowledge of cognition was positively related to the concreteness, reflective, abstractness and experimentation learning styles. Arslan and Akin (2014) reported that internal academic locus of control had a positive relation with metacognition; an external academic locus of control had a negative relation. Inomiesa, Achufusi and Mgbemena (2013) found no significant difference in the performance of male and female students in their self regulated and metacognitive learning cycle. Bozkurt (2013) found that there was a positive relation between metacognitive levels of the teacher candidates and independent, collaborative, dependent and participant learning styles and a negative relation between avoidant learning styles. Al-Zoubi (2013) observed a high level of metacognitive thinking in
favour of students with top academic achievement. Nasab and Motlagh (2015) observed that no relationship was there between different age groups, reading scores of males and females in metacognitive group. Sajjadi et al (2015) found a strong relationship between metacognition and self-efficacy on academic achievement, but moderate relation was found between metacognition and achievement. Sadeghi, Hassani and Rahmatkhah (2014) observed a positive correlation between metacognition and critical thinking.

2.6.2 Critical thinking. The variable critical thinking is another area of exploration and serious deliberation for the investigator. After a critical evaluation of the studies related to critical thinking, the investigator has made the following observations:

The Indian authors related to critical thinking, Lourduraj and Xavier (2015) observed that a significant relationship was found between decision-making and critical thinking of prospective teachers. Subramanian and Yogaraj (2014) found a significant difference between male and female B.Ed. trainees in their critical thinking disposition and learning style. Gurubasappa (2014) reported that there was a significant interactive effect of critical thinking and emotional intelligence on the academic achievement in science of secondary school students. Mary and Selvakumar (2013) observed that gender influences critical thinking dispositions in toto and its dimension; maturity and innovativeness. Female students had scored more than their counterparts and Tamil medium students had a high level of innovative critical thinking disposition than English medium students. Srinivasalu (2012) observed that critical thinking skills with an inquiry oriented approach over traditional method had a positive effect on experimental group. There was no significant difference in critical thinking between the experimental groups and control groups. Harish (2011) concluded that there was a significant difference between achievement in the post-test of control and experimental groups in their integrated critical thinking skills. Rani and Porgio (2010) observed that male students are better than female students in their total critical thinking, maturity, analyticity, systematic, self confidence and truth seeking, and also concluded that a significant relationship was found between critical thinking and academic achievement of higher secondary students. Sibichen and Annaraja (2010) observed that postgraduate secondary teacher education students were better than graduate secondary teacher education students in their critical thinking skills.
Karagoil and Bekmezci (2015) probing critical thinking dispositions of teacher candidates found that they did not differ according to gender, but academic achievement differed according to the gender, b) critical thinking dispositions and academic achievements of teacher candidates did not differ according to type of school, and there was a positive and weak relationship between critical thinking dispositions and academic achievements of teacher candidates. Nordin (2015) reported that there was no significant relationship between level of critical thinking skills and CGPA of students. Cetin (2014) reported that there were significant correlations between critical thinking tendencies and learning styles of the students. EL-Shaer and Gaber (2014) reported that there was no significant correlation between students’ total knowledge of experimental group and their critical thinking post intervention. Evens, Verburgh and Elen (2014) reported that the students in both academic and professional bachelor programmes were found to become better critical thinkers.

Sadeghi and Malekian (2014) reported that teaching that performed in creative representation enhanced critical thinking skill. Sanavi and Tarighat (2014) reported that teaching critical thinking explicitly had a significantly positive impact on the speaking proficiency of female EFL learners. Slameto (2014) reported that primary school teachers who attended blended training programme had a high level of critical thinking skills. Cetin (2014) reported that significant correlations were there between critical thinking tendencies and learning styles of the students. Manshaee et al. (2014) reported that students interested in learning a second language had higher levels critical thinking than students uninterested in learning a second language, and female students had higher levels critical thinking than male students. Yuzainee and Imanina (2014) reported that the instructional approaches to teach critical thinking significantly improved students’ critical thinking skills. Dabaghi, Zabihi, and Rezazadeh (2013) reported that there was no significant correlation between complexity and drawing inferences and only recognizing assumptions had significance, Evens, Verburgh and Elen (2013) reported that students in a professional bachelor programme grow more in CT during the first year of higher education than students in an academic bachelor programme. Kondakci and Aydin (2013) reported that there was a positive significant relationship between chemistry self-efficacy for everyday applications and critical thinking of university students. Pai and Eng (2013) reported that there was a positive relationship between over-all critical thinking dispositions and caring behaviour of
student nurses. Shahin and Tork (2013) reported that teaching with problem solving approach increases levels of critical thinking and self-directed learning in KSA and Egypt countries without variation. Leist, Woolwine and Bays (2012) reported that the critical thinking post-rubric score mean was significantly higher than the critical thinking pre-rubric score mean of undergraduate students’ reading skills. Self confidence scores are higher than systematicity means scores of critical thinking disposition in nurses working in public hospitals. The higher educational level of nurses increased in critical thinking disposition. Lim et al. (2011) reported that asynchronous on line discussion had employed a variety of facilitation techniques rather than just utilise a few preferred ones in order to achieve higher levels of critical thinking.

2.6.3 Achievement in science. After the critical evaluation of the studies related to achievement in science, the investigator has made the following observations:

Ghamdi and Deraney (2013) examined academic achievement and they observed that there was no significant improvement in the overall critical thinking skills of the participants. Dabaghi, Zabihi, and Rezazadeh (2013) reported that no significant relationship was found between subscales of WGCTA and the CAF of learners’ narrative written task performance. Nordin (2015) recognizes no significant relationship between level of critical thinking skills and CGPA of students. Sadeghi and Malekian (2014) found that the result also approves the critical thinking and curriculum progression. Sepahi et al. (2014) found that the critical thinking disposition showed no significant correlation with academic achievement. Evens, Verburgh and Elen (2014) concluded the students in both academic and professional bachelor programmes were shown to become better critical thinkers during the first two years of study. Amiri and Sheikhy (2014) reported that no significant difference was found between the impact of autonomy and critical thinking on EFL learners’ writing achievement. Sanavi and Tarighat (2014) concluded that teaching critical thinking explicitly had a significantly positive impact on the speaking proficiency of female adult intermediate EFL learners. Sepahi et al. (2014) found that the critical thinking disposition showed no significant correlation with academic achievement. Mehar and Singh (2013) reported that the performance of students with different attitude towards biology group taught through concept mapping strategy was found significant.
Kosgei (2013) observed that teacher experience had a significant relationship with student academic achievement. Ali, Toriman and Gasim (2014) reported that 80% of the students in the selected schools had very good parental support and only 20% of them had poor parental support towards their academic ladder in learning biology. Samikwo (2013) reported that there was a relationship between students’ attitude towards Biology and their performance. Ikitde & Edet (2013) concluded that there was no significant influence of gender on biology students' achievement and their different learning styles. Opara (2011) was of the opinion that the use of inquiry teaching method favour the boys more than the girls in achievement in biology. Boys’ school performed better in achievement than girls’ school and co-educational schools. Students who were taught using inquiry teaching method in the urban schools had a high rate of achievement in biology than those in the rural areas. Aktas, Kurt, Oaksu and Ekici (2013) reported that both gender and experience positively influence education process self-efficacy perception and perception of responsibility from student success. Osuafor et al. (2013) observed that students from polygamous families achieved higher in biology than those from monogamous families and students whose parents were civil servants achieved higher in biology than those whose parents were traders. Ongowo and Hungi (2013) found that no significant gender differences in motivational beliefs and self-regulation in Biology learning. Samikwo (2013) reported that there was a relationship between students’ attitude towards biology and their performance. Students with a positive attitude towards biology subject registered a good performance than those with negative attitude. Mahmoud (2012) reported that no significant difference was found between CT disposition and nursing students achievement with active or reflective-learning style.

Ramdiah and Corebima (2014) reported that the students’ learning achievement, metacognitive, and critical thinking skills were similar or almost similar between the two genders, when the PQ4R strategy combined with the concept mapping strategy was applied. Udeani and Okafor (2012) observed female slow learners taught with the concept mapping instructional strategy performed significantly better than their male counterparts taught through the same method.

Dhar (2014) reported that the tree-chart was an effective tool for teaching botanical classifications at higher secondary level. Jayapraba and Kanmani (2014) observed that metacognitive strategy improves the students’ achievement in biology.
Thandavamoorthy (2014) reported that there was a positive relationship between emotional maturity and academic achievement of the biological science B.Ed., students. John (2014) concluded that no significant difference existed between the post test scores and PBLs group and AM group and no significant difference was there between the boys and girls in their post-test achievement. Sharma (2014) disclosed that higher intelligence experimental group was found to attain significantly higher achievement scores and retained more as compared to the lower intelligence experimental group of effectiveness of concept mapping strategy on student’s achievement and concept retention in organic chemistry. Sharma (2014) observed no significant correlation between emotional intelligence and academic achievement. Joshua and Yohannan (2013) reported that blended learning strategy was more effective than the activity oriented method on achievement in biology of secondary school students. Mehar and Singh (2013) concluded that performance of students taught through concept mapping strategy was found significant.

Dhar (2013) reported no significant difference in the relationship between school climate and achievement of male and female, rural and urban, government and private aided, Tamil and English medium students. Surapur (2012) observed that the urban students with an intense in science had a high score in academic achievement in science than the urban students with lower interest in science. Thilagavathy (2012) reported that there was a significant positive relationship between achievement and emotional maturity in teacher trainees. Meena (2012) reported that the pupil teachers under arts and science groups showed significant differences in mean scores in their academic achievement with average level of intelligence. According to Dhar (2012) no significant differences were found in sex, locality, income and community of effectiveness of field trip on teaching botany at higher secondary level.

Saravanakumar and Subbbiah (2012) observed that students who had been taught through effective stimulus variation on enhancing attention technique performed better in their achievement and also there was a significant relationship between systematic style and academic achievement, intuitive style and academic achievement of female biological science prospective teachers. Saroja and Amalraj (2012) observed no significant difference in systematic style of biological science prospective teachers using internet and those not using it, no significant difference between male and female, women and co-education college and internet using and not
using prospective teachers in their academic achievement whereas a significant difference was observed between PG and UG biological science prospective teachers. There was a significant relationship between systematic style and academic achievement, intuitive style and academic achievement of female biological science prospective teachers. Devaki and Pushpham (2011) reported a significant association between metacognitive ability and academic achievement in chemistry; there was a significant difference in the metacognitive ability of boys and girls, and the rural and urban school students. There was a significant difference in the metacognitive ability of boy’s school, girl’s school and co-education school students and also the government, aided and corporation school students.

After a cursory view on relevant literature culled out, it could be understood that the present study differs from the rest of the studies in several ways. Surveys of Indian research revealed that though there are a large number of studies that examined the relationship between psychological variables and achievement, the investigator could not locate adequate studies dealing with metacognition, critical thinking and achievement in biology independently and in combination. This made the investigator to carry out the research work on the influence of metacognition and critical thinking on academic achievement of higher secondary school students. It could be understood that there are many foreign studies that the deal with metacognition of students learning in different dimensions, but, unfortunately there are not much studies that directly deal with higher secondary students-especially XI standard students’ academic achievement.

Moreover, with regard to the variables metacognition and critical thinking, only a very few studies have been conducted among higher secondary students, even though they are combined with variables such as self-efficacy, learning styles, problem solving skill, cooperative learning, school climate, emotional maturity, self regulation, concept mapping instructional strategy, achievement in science, achievement in history, writing skill, attitude towards science and academic achievement in general. But this study is the first of its kind in this regard. Hence, it stands apart as a unique document of research work.