CHAPTER - II
REVIEW OF RELATED STUDIES

INTRODUCTION

Review of related studies allows the researcher to acquaint with correct knowledge in the field or area in which the investigator is going to conduct research. The review of related studies enables the researcher to define the units in his field. It helps the researcher to delimit and define his problem.

Meaning of the Related Studies

It is a brief summary of previous research and writings of recognized experts. It provides evidence that the researcher is familiar with what is already known and with what is still unknown and untested. Thus it helps in avoiding duplication and provides helpful suggestions for future investigation. It also helps in the formulation of hypothesis and in the selection of methods and tools to be employed. They are used in the interpretation of obtained results.

Definitions of the Related Studies

In the words of John W Best (2009), it is “A brief summary of previous research and the writings of recognized experts which provide evidence that the researcher is familiar with what is already known and with what is still unknown and untested”.

“The study of related studies implies locating, reading and evaluating reports of research as well as reports of observation and opinion that are related to the individual’s planned research project” Aggarwal (2007).

PURPOSE OF THE REVIEW

Review of related studies, besides allowing the researcher to acquaint himself with current knowledge in the field in which the researcher is going to conduct their research, serves the following specific purposes:

i) It enables the researcher to define his problem. The knowledge of related studies brings the researcher up-to-date on the work which others have done and thus to state the objectives clearly used concisely.

ii) It helps the researcher to avoid unfruitful and useless problem area.

iii) It helps the researcher to avoid duplication of well-established facts.

iv) It helps the researcher to understand the research methodology, which refers to the way the study is to be conducted.
v) It helps the researcher to know about tool and instruments, which proved to be useful in the previous studies.

vi) The final and important specific reason for reviewing the related studies are to know about the recommendations of previous researchers listed in their studies for further research.

One of the essential aspects of research process is the review of related studies. It plays a crucial role in planning of the study.

To quote Adiseshiah and Sulochana Sekar (1997) “The survey approach is for the collections of information relevant to the problem of investigate”. Hence a review of previous studies in the relevant areas of the present study is attempted here.

**OBJECTIVES OF RELATED STUDIES**

i. To provide the sources for hypotheses. The researcher can formulate research hypotheses on the basis of available studies.

ii. To indicate whether the evidence already available solves the problem adequately without requiring investigation. It avoids the replication.

iii. To locate comparative data and findings useful in the interpretation and discussion of the results. The conclusions drawn in the related studies may be significantly compared and be used as the subject for the findings of the study.

iv. To suggest methods, procedure, sources of the data and statistical techniques that are appropriate to the solution of the problem.

v. To provide theories, ideas, explanations or hypothesis. This may prove useful in the formulation of a new problem.

**CLASSIFICATION OF RELATED STUDIES**

The investigator has classified the studies into three major sections namely.

a) Studies related to metacognition

b) Studies related to learning styles

c) Studies related to problem solving skill
A) STUDIES RELATED TO METACOGNITION

Jirapa Abhakorn (2014) conducted a study on investigating the use of student portfolios to develop students’ metacognition in English as a foreign language learning.

The results indicated that the understanding of metacognition development through a mediated tool in language learning, and suggest EFL teachers and language educators to be aware of the importance of metacognition and reflective skills training in order to reach the full potential of the portfolio approach in language learning to be realized.

Claudia, Roebers Saskia Krebs and Thomas Roderer (2014) conducted a study on metacognitive monitoring and control in elementary school children: their interrelations and their role for test performance.

The results indicated that the factorial structure of monitoring, control and mastery motivation was invariant across the two age groups. There were age-dependent structural links between monitoring, control, and test performance with high confidence yielding a direct and positive effect on test performance and a direct and negative effect on adequate control behaviour in the achievement test. Mastery-oriented motivation was not found to be substantially associated with monitoring, control, or test performance underlining the importance of proximal metacognitive factors for test performance in elementary school children.

Medine Baran, Hulya Aslan Efe and Mukadder Baran (2014) conducted a study on an investigation of high school students cognitive learning styles with respect to certain variables.

The findings showed that the cognitive learning styles of the study group students were mostly observed to be the style of introversion-intuitiveness-thinking-judgement with a rate of 13.9% and that the lowest cognitive learning styles of the students belonged to the extrovert-intuitive-sensual-perceptive style with a rate of 2.1%. The students demographic information and their attitude scores regarding computers were examined, it was seen that these variables did not had any influence on the students’ cognitive learning styles.
Vijayakumari and Myrtle Joyce (2013) conducted a study on metacognitive co-operative learning approach to enhance mathematics achievement.

The findings were metacognitive co-operative learning approach had positive effect on the achievement and metacognitive co-operative learning approach was more effective than the traditional method with respect to the low and high achievers.

Priya and Celene (2013) conducted a study on metacognitive ability of adolescent students and its relation with academic achievement.

The findings showed that there was positive correlation between metacognitive ability and academic achievement. There was significant correlation between boys and girls in metacognitive ability and academic achievement. There was significant correlation between state and CBSE school students in metacognitive ability and academic achievement.

Rodnunsky (2013) conducted a study on understanding metacognition and critical components of thinking and learning in public education contexts; An exploratory study.

The survey revealed that over half (51%) of the participants were able to develop their metacognitive awareness during post-secondary education or on the job. In rest of the participants, smaller percentage of participants (13.5%) indicated that their metacognitive development was facilitated during their grade school experience or from the support of a grade school teacher (10.6%). Less than a third (31.7%) identified that metacognitive awareness occurred during their K-12 grade school years.

Chellamani (2013) conducted a study on activating metacognitive strategies on enhancing reading skill among high school students

The significant correlation between the awareness on metacognitive strategies and their reading comprehension indicated the developed self-awareness and reading comprehension.

Carol Dabarera et al., (2013) conducted a study on the impact of metacognitive scaffolding and monitoring on reading comprehension.

The findings showed that there was a relationship between metacognitive awareness raising and reading comprehension improvement. Metacognitive strategy instruction was found to be effective in increasing metacognitive awareness but linked to small manner.
Chiejina and Ebenebe (2013) conducted a study on relationships between the metacognitive strategies adopted by nursing students.

The findings showed that the significant correlations between the learning strategies of the students in their self-reinforcement behaviour and the self-evaluation strategies they adopted. Significant relationship was observed among the students in government and private universities with regard to the learning strategies they adopt in the clinical setting.

Ryan Hargrove (2013) conducted a study on assessing the long-term impact of a metacognitive approach to creative skill development.

The findings showed that students who participated in one or both interventions finished with significantly higher levels of metacognitive applications in creative thinking.

Devrim Erginosy Osmanoglu (2013) conducted a study on the degree of relationship between the secondary education students’ learning styles and their metacognitive awareness.

There was a statistical meaningful relationship between the awareness and the evaluation of the students. There was a statistical meaningful relationship between awareness and points of metacognitive strategies in the dimension of evaluation.

Ghazali Yusri et al., (2013) conducted a study on cognitive and metacognitive learning strategies among arabic language students.

The study revealed that (i) all UITM students used cognitive and metacognitive strategies at a moderate level (ii) SWE scored significantly higher than SNE in all five components of cognitive and metacognitive strategies (iii) females scored significantly higher than males in rehearsal, organization, and metacognitive strategies and (iv) there were no statistically significant differences noted in all components between students with the interaction of prior experience and gender.

Fatemeh Bidi et al., (2012) conducted a study on the mediating role of metacognition in the relationship between internet addiction and general health.

The results indicated that the significant positive relationship between all aspects of metacognition and internet addiction. A significant positive relationship was observed between internet addiction and general health. Path analysis revealed the mediating role of metacognition in the relationship between low general health and internet addiction.
**Weaver Stefanie (2012)** conducted a study on the effects of metacognitive strategies on academic achievement, metacognitive awareness, and satisfaction in an undergraduate online education course.

The findings of the study revealed no statistically significant differences in the academic achievement, metacognitive awareness, or satisfaction between the metacognitive strategies and control groups.

**Dilek Sezgin Memnun and Lynn Cecilia Hart (2012)** conducted a study on elementary school mathematics teacher trainees' metacognitive awareness levels: turkey case.

The findings showed that the most of the mathematics teacher trainees had a high level of metacognitive awareness. There was no significant difference between the metacognitive awareness levels of mathematics teacher trainees by gender and class levels. There was a low level, positive relationship between their metacognitive awareness levels and their overall performance on university course grades.

**Behzad Ghonsooly and Zahra Loghmani (2012)** conducted a study on the relationship between EFL learners’ reading anxiety levels and their metacognitive reading strategy use.

The results indicated that there was no significant relationship between their FLRAS scores and SORS scores. There were some differences in their reading strategy use. There was no significant relationship between the possible effects of gender on RA and reading strategy used.

**Jordan (2011)** conducted a study on teacher practices and high school chemistry students' metacognitive skillfulness.

The results indicated that teacher practices that did not encourage students to reflect deeply on their knowledge which instill a passive and task accomplishment approach to learning. The study provided additional insight into promising teacher practices that enhance students' development of metacognition and, in turn, help students become more conscientious learners.

**Timothy (2011)** conducted a study on science inquiry as knowledge transformation: investigating metacognitive and self-regulation strategies to assist students in writing about scientific inquiry tasks.

The results found that the student self-efficacy for the process of scientific inquiry was positive and did not change over the course of the study while student
scores on the science inquiry tasks rose significantly. The metacognitive prompts and instruction in goal setting had any effect on student inquiry scores.

**Dilek and Meral (2011) conducted a study on metacognitive strategy usage and epistemological beliefs of primary school teacher trainees.**

The results revealed that the metacognitive strategies were used the most primary education teacher trainees used ‘self-control’, ‘cognitive strategy’, self-evaluation’ and ‘self-awareness respectively’. Significant differences were found among metacognitive strategies used in terms of gender, grade, and the university level attend while no significant relationship was found between academic achievement and metacognitive strategies. There was a significant relationship between primary education teacher trainees, epistemological beliefs and metacognitive strategy used.

**Parameswari (2011) conducted a study on effect of metacognitive orientation to B.Ed., physical science trainees on teaching competency and self-esteem.**

The findings showed that the enhancement of competency in teaching and to the self-esteem level of the trainees. It was proved appropriate instructional strategy like metacognitive orientation might be given to all the trainees and findings of the study might be considered for better framework in developing good teaching competency and high self-esteem level of the student teachers.

**Sheeja V. Titus and Annaraja (2011) conducted a study on relationship between metacognition and teaching competency of secondary teacher education students.**

The findings showed that female secondary teacher education students were better than male students in their metacognition and teaching competency. There was significant relationship between metacognition and teaching competency of secondary teacher education students.

**Devaki and Marylilypushpam (2010) conducted a study on metacognitive ability and academic achievement in chemistry among XI standard students.**

The findings showed that there was positive correlation between metacognitive ability and achievement in chemistry among XI standard students.
Ramadevi and Visakh Kumar (2010) conducted a study on relation between metacognitive awareness of achievement in physical science at higher secondary level.

The finding showed that the male and female students of higher secondary schools differed significantly in their metacognitive awareness. Male students are superior to female students in their metacognitive awareness.

Mahamood Shihab (2010) explored a study on metacognitive learning in social science education - an experiment.

The results indicated that the metacognitive learning strategies were more effective than traditional methods and no gender difference exists in social science education.

Krassi and Rhonda Varder (2010) conducted a study on the role of metacognitive strategy use to second grade students with learning disabilities during written spelling tasks.

The results indicated that all their metacognitive strategies were emerging, they had difficulty reporting consistently and accurately what spelling strategies they used. The findings indicated that the error of second grade student with learning disabilities used limited metacognitive strategies of monitoring regulating and reflecting.

Rothwachs Yisrael (2010) conducted a study on analysis of educational setting, teacher training, and the modeling and instruction of metacognitive strategies for students with learning disabilities in Jewish day schools.

The results indicated that there was no significant difference regarding the degree to which metacognitive strategies were instructed and modeled between those-teachers who had earned master’s degrees in education and those who had not, who had attend professional development seminars targeting the modeling and instruction of metacognitive strategies were more likely to instruct accordingly than those who had not attend such seminars additionally teachers who instructed to model and instruct.

Nancy Barbara (2010) conducted a study on the influence of a metacognitive learning system on the writing achievement of elementary school students.

The findings showed that the significant influence on writing achievement for students who were not in instructed with LML the 2007-2008 school year. There was significant difference between low, social and economic students. There was statistically significantly better than those who were not instructed with LML.
2008-2009 school year data would shown significance to a higher degree than the results demonstrated in 2007-2008 school year.

**Ozden Demir and Ahmet Doganay (2010) conducted a study on the effect of metacognitive strategies instructed through cognitive coaching on the metacognitive skills and retention in 6th grade social studies lesson.**

The findings indicated that the significant difference was detected in experimental group’s favour regarding self-monitoring, evaluation, awareness, and cognitive strategies aspects in metacognition scale post-test. The retention scores, although a significant difference was detected in experimental group’s favour regarding awareness. No significant difference was found in experimental group’s favour regarding cognitive strategies and evaluation aspects. The second control group displayed a significant difference in retention test in self-monitoring aspect.

**Carlo Magno (2010) conducted study on the role of metacognitive skills in developing critical thinking.**

The findings indicated that the first model, metacognition was composed of two factors, in the second model, metacognition had eight factors as they affected in critical thinking. The results indicated that in both models, metacognition had a significant path to critical thinking. The analysis also showed that for both metacognition and critical thinking, all underlying factors were significant. The second model had a better goodness of fit as compared with the first as shown by the RMSEA value.

**Philip and Nelliayappan (2009) conducted a study on teacher trainee’s metacognitive awareness in relation to their attitude towards teaching.**

The findings showed that teacher trainees had low metacognitive awareness and had a favourable attitude towards teaching. There were significant difference in terms of gender, age and medium of study in their metacognitive awareness and attitude towards teaching. There was a low negative relationship between metacognitive awareness and attitude towards teaching.

**Stevens’s (2009) conducted a study on metacognition: developing self-knowledge through guided reflection.**

The findings showed that the metacognitive literacy was influenced the students to build their competency in learning.
Shin-Ting (2009) conducted a study on examining the relationship between metacognition, self-regulation and critical thinking in online socratic seminars for high school social studies students.

The findings showed that a multivariate analysis of covariance (MANCOVA) showed statistically significant effects of the two metacognitive tasks on students’ self-regulation, but not on their critical thinking skills and disposition.

Jayaprabha (2008) conducted a study on metacognition and achievement in biology of higher secondary students.

The findings of the study revealed that there were no significant between boys and girls in their metacognition and significant association between mother’s occupation and metacognition of higher secondary students. There was significant relationship between metacognition and achievement in biology of higher secondary students.

Wendy Shabu (2008) conducted a study on metacognition among students identified as gifted and non-gifted using the discover assessment.

The findings showed that there was no significant difference was found among the types of metacognitive gifted and non-gifted children. The gifted children demonstrated greater ability to articulate their metacognitive knowledge.

B) STUDIES RELATED TO LEARNING STYLES

Sonia Maldonado Torres (2014) conducted a study on the relationship between latino students' learning styles and their academic performance.

The results of the LSI showed no relationship between students' learning styles and their GPA. Results of the PEPS showed a relationship between four of the PEPS' elements and the Students' GPA. The elements of Responsible \( (r = .174, p = .015) \) and Design \( (r = .162, p = .009) \) positively correlated with participants' GPA. Conversely, the elements of Needs Mobility \( (r = -.137, p = .008) \) and \( (r = -.175, p = .039) \) negatively correlated with the participants' GPA. The study reinforced the premise that latino students' learning styles must be taken into consideration when developing educational approaches geared to support their academic performance and also clearly indicated that students' academic performance was related to the way they learn.
Hemalatha (2013) conducted a study on learning styles and their influence on academic achievement.

The findings showed that the male and female students differed significantly in their analytical learning style and dynamic learning style. The mean score of female student was found to be higher than the male students. The mean score of male students was found to be higher than female students in their dynamic learning style.

Roselit Micheal and Malykutty (2013) conducted a study on learning styles and socio-emotional competencies of adolescents.

The findings showed that the students with accommodating learning style were comparatively higher in number in relation with other learning style groups. Diverging learning style was less preferred by the adolescents. The adolescents showed above average socio-emotional competencies and the different learning styles categories were not significantly differ in the socio-emotional competencies.

Sreekala (2013) conducted a study on learning style preferences of X standard students.

The findings showed that the majority of X standard students prefer to auditory and visual learning style.

Lena Bostrom and Karin Hallin (2013) conducted a study on learning style differences between nursing and teaching students in Sweden.

The findings showed that the significant differences between nursing and teaching students groups. The comparison between nursing and teaching students, the more number of nursing students was highly motivated and persistent.

Jafar Sadegh Tabrizi and Omeleilan Alizadeh (2013) conducted a study on identifying students’ learning styles as a way to promote learning quality.

The findings showed that (69%) of the students were female and the dominant learning method was assimilator (42%). Other styles with a regard to their frequency were diverge (24%), coverage (22%) and accommodator (12%). There was no significant relationship was found in learning styles between the gender (p = 0.644) and average (p = 0.676) of the students.

Nora Lowy (2013) conducted a study on learning styles, critical thinking aptitudes, and immersion learning in physician assistant students.

The findings showed that both instruments were compared to explore for possible associations between immersion clinical experiences and learning style
preferences and critical thinking aptitudes. There were no significant differences between preclinical and clinical PA students with respect to learning styles and overall critical thinking aptitudes.

Tabe Bordbar and Fariba (2013) conducted a study on academic performance of virtual students based on their personality traits, learning styles and psychological well being.

The study revealed that the correlation between personality traits and learning styles which could lead learners to a higher level of learning.

Murat Gokalp (2013) conducted a study on the effect of students' learning styles to their academic success.

The results showed that the statistically significant differences between the results of the first and final applications of the sub-tests on learning styles and academic success; those sub-tests covered the items as learning, planned study, effective reading, listening, writing, note-taking, using the library, getting prepared for and taking exams, class participation and motivation.

Sabahattin Deniz (2013) conducted a study on an investigation of the learning styles and teacher self-efficacy levels of perception of pre-service teachers according to various variables.

The findings showed that the gender, faculty, learning styles, and learning strategies level differences existed on learning styles and self-efficacy perception.

Madhu Gupta and Meenu Kapoor (2012) conducted a study on the impact of learning styles and study habits of high school students on their scholastic achievement in English.

The findings revealed that significant difference was found in the scholastic achievement of high school students in English had different learning styles. The integrated hemisphericity students had more achievement in English than that of left hemisphericity. The significant interaction between the effect of learning styles and study habits of high school students with integrated hemisphericity and good study habit and the highest scholastic achievement in English.

Reena George and Archana (2012) conducted a study on learning styles and under achievement among students at secondary and higher secondary levels.

The findings revealed that the 51.2% of the students were visual learners, 23.9% were auditory learners, 22% were tactile learner and only 2.8% were identified at
kinesthetic learners. Learning styles were found to affect learners learning behaviours and determine the strength of the academic achievement. Learning style was significantly related to the academic achievement of students at the secondary and higher secondary level.

**Kiranjeet kaur (2012)** conducted a study on achievement in science in relation to study habits and learning styles.

The findings showed that the mean score of girls was higher in science as compared to the mean score of boys. Mean score of girls was greater than boys showed girls had better study habits than boys. The correlations were not significant for the relationship between achievement in science and study habits of the students.

**Shaw and Ruey-Shiang (2012)** conducted a study on relationship among learning styles, participation types and performance in programming language learning supported by online forums.

The findings showed that the different learning styles were associates with significantly different learning scores. Learning satisfaction was not significantly different among the different learning styles. There was no significant association between learning styles and participation types.

**Young and Arlene Shorter (2011)** conducted a study on a comparative study of first time international college students’ level of anxiety in relationship to awareness of their learning style.

The findings showed that the Asian students were clearly surprised by aspects of the American classroom that differed markedly from their prior learning experiences in Asia.

**Rafaelgarciaros et al., (2011)** conducted a study on assessment preferences of preservice teachers: analysis according to academic level and relationship with learning styles and motivational orientation.

The findings showed that there was also a sharp reduction in preferences for conventional procedures depending on the academic level considered, while a slight increase was observed in preferences for non-conventional ones. The preference for non-conventional procedures was associated with a deep learning style, methodical study, and elaborative learning, as well as an intrinsic orientation towards learning, the task value, and academic self-efficacy. Preference for conventional procedures was
associated with elaborative processing, an extrinsic orientation towards learning, the task value, and an internal locus of control.

**Lillie Lum, Pat Bradley and Nikhat Rasheed (2011) conducted a study on accommodating learning styles in international bridging education programs.**

The findings showed that there were found in the divergent quadrant of the Kolb Learning Style Inventory. A recent adult immigrant had a stronger effect upon preferred style of learning in bridging education than profession-specific factors.

**Morrow and Vanessa Mae (2011) conducted a study on the relationship between the learning styles of middle school students and the teaching and learning styles of middle school teachers and the effects on student achievement of students’ learning styles and teachers’ learning and teaching styles.**

The findings showed that there was a relationship between the learning and teaching styles of teacher’s, as well as determining if students’ learning styles impact their achievement. There was no significant relationship between student achievement and students’ learning (or) between students’ achievement score and the teaching and learning styles of teachers. Seventh grade English was the only time a significant difference was found in student achievement when teachers had different styles of learning.

**Crocker and Catherine (2011) conducted a study on influence of teacher’s learning style on implementation of developmentally appropriate practices.**

The findings showed that, the teacher’s learning style did not influence the choice and frequency of DAP implementation.

**Wilson and Mary Lynne (2011) conducted a study on students’ learning style preferences and teachers’ instructional strategies: correlations between matched styles and academic achievement.**

The findings showed that a lack of significant and correlation between matched styles and academic achievement of students learning style and teachers instructional strategies.

**Adam and Joshua (2011) conducted a study on the relationship between supplemental instruction leader learning style and study session design.**

The findings showed that the supplemental instruction leader learning style influences out-of-class study session.
Naser-Nick Manochr (2011) conducted a study on the influence of learning styles on learners in e-learning environments.

The results revealed that for the instructor-based learning class (traditional), the learning style was irrelevant, but for the web-based learning class (e-learning) and the learning style was significantly important. The students with the assimilator learning style (these learn best through lecture, papers and analogies) and the converged learning style (these learn best through laboratories, field work and observations) achieved a better result with the e-learning (web-based) method.

Sarikcioglu et al., (2011) conducted a study on correlation of the summary method with learning styles.

The findings showed that there was no significant difference between learning styles and summary method should be incorporated into neuro-anatomy lessons. Since anatomy had a large amount of visual material and it was ideally suited for the summary method.

Sunila Thomas (2011) conducted a study on impact of collaborative learning on mathematical attitude of different learning style groups at secondary level.

The findings showed that the mathematical attitude of students belonging to aided sector was comparatively higher than that of the government sector. Mathematical attitude varied with their learning styles and the theories seemed had their mathematical attitude than the other learning styles groups. Collaborative learning had a great impact in developing positive attitude towards mathematics.

Rashmi Agarwal and Deepak Jaiswal (2011) conducted a study on learning style preferences among students of urban and rural locality.

The findings showed that the rural as well as urban students showed similar preferences they showed more preferences for dependent, competitive and participant learning styles over independent, collaborative and avoidant learning styles. The locality of the student was not a determining factor for learning style preferences in the rural and urban students.

Sibichen and Anisha (2011) conducted a study on identification of learning styles for better curriculum transaction.

The findings showed that the convergent style was the pre-dominant style found among B.Ed students. There was significant relationship between assimilating and accommodating styles and self-efficacy of B.Ed students.

The results revealed that the teaching aptitude and self-esteem influenced some cognitive and metacognitive strategies of learning of prospective secondary teachers in an independent manner. No interaction effect of the two variables was found on any cognitive and metacognitive strategy of learning.

Maness - Gill (2010) conducted a study on influences learning styles on cognitive presence in an online learning environment.

The results showed no significant differences on student learning style and scores on the cognitive presence. There were no significant differences between learning styles and the sub-scales of cognitive presence with one exception. Students classified as either accommodator or assimilation showed significant differences on the exploration phase of critical thinking.

Vijay Amirtharaj and Jesudoss (2010) conducted a study on learning styles and academic achievement of X standard students.

The findings revealed that the level of learning styles and their dimensions in X standard students with regard to sex was average. There was no significant difference between boys and girls in their musical and interpersonal learning styles. There was significant difference between boys and girls in linguistic, logical, spatial, bodily and intrapersonal. There was no significant difference between rural and urban students in their learning styles in the dimensions such as linguistic, logical, spatial, bodily, intrapersonal and interpersonal. There was significant difference between rural and urban students in their learning style.

Andya (2010) conducted a study on the effect co-operative learning model on the academic achievement in mathematics among students with different learning styles.

The results revealed that there was no significant difference in the pre-test scores on the academic achievement in mathematics of students from experimental and control groups. There was no significant difference in the post-test scores on the academic achievement in mathematics of student from experimental and control groups. There was significant interactive effect of co-operative learning model and the independent v/s dependent learning styles of students on academic achievement of students in mathematics. There was significant interactive effect of co-operative
learning model and the avoidant v/s participant learning styles of student on academic achievement learning in mathematics. There was significant interactive effect of co-operative learning model and the competitive v/s collaborative learning styles of students on academic achievement in mathematics.

Suhail Ahamed Khan and Veenakumari (2010) conducted a study on the preferences for learning environment with respect to the learning styles of class IX standard students of English medium schools in Bhopal city.

The findings of the study revealed that there was significant difference in their teacher support, involvement, task orientation, co-operation, equity, differentiation, young adult ethos and total preferred learning environment of students. There was no significant difference in student’s co-restiveness, investigation and computer usage of students on the basis of their learning style.

Indu (2010) conducted a study on hemispheric dominance and learning style of high school students.

The findings showed that more number of students had left brain hemisphericity. A relationship between brain hemisphericity and perceptual learning styles was found.

Malathi and Malini (2010) conducted a study on learning style of higher secondary students of Tamilnadu.

The findings showed that there was no significant difference in learning style of higher secondary students in terms of their class and type of school and there was high correlation between learning style and achievement.

Clarke, Tricia Lesh, and Jennifer (2010) conducted study on thinking styles: teaching and learning styles in graduate education students.

The findings revealed that several thinking styles from Sternberg’s theory of self-government were moderately correlated with Felder’s learning styles. Participants differed in their thinking styles in teaching and in their learning styles based on their major subject.

Corso and Keith (2010) conducted a study on learning styles for traditional college students does mode of learning improve performance outcome?

The results showed that students who used materials matching their dominant and sub-dominant learning style mode exhibited significant comprehension
improvement over those using material not matching their dominate and sub-dominant learning style mode.

**Williams and Judy (2010) conducted a study on reading comprehension, learning styles and seventh grade students.**

The results indicated that there was a relationship between VAK and reading comprehension levels. When comparing the learning styles of struggling readers and on-grade-level readers that there was a significantly different distribution of kinesthetic, auditory and visual learning styles.

**Koslo and Jenifer (2010) conducted a study on designing instruction to match learning style preferences in the online environment the effect on learner performance.**

The result showed that no statistically significant differences were found between the 16 pathways. Significant academic improvements were found for learners with a dominant learning style of iconic and direct experience when one or more sub-dominant learning styles were included in the pathway.

**Perkins and Kirsten Renee Shunk (2010) conducted a study on assessment of freshmen varsity student-athletes learning style preferences.**

The results showed one significant interaction in the active reflective preference based on gender, but overall, student athletes effectively used a variety of learning style preferences. There was no significant difference in learning styles preferences of student who participated in individual sports.

**Flamez and Brande Nicole (2010) conducted a study on a comprehension of online and traditional graduate counseling courses: learning style, instructional preferences and educational environment.**

The findings showed there was no statistically significant differences between learning styles of students enrolled in the face-to face courses and online courses.

**Almasa Mulalic, Parilah Mohd Shan and Fauziah Ahmad (2009) conducted a study on perceptual learning styles of ESL students.**

The result revealed that students preferred learning style was kinesthetic. They expressed minor preference for visual, auditory and group learning, while on the other hand students expressed negative preference towards individual and tactile learning styles. There was significant differences were found in all learning style among students from different ethnic background. Visual learning style was preferred way of
learning for Indian students. Chinese students expressed minor learning style while Malay students considered visual learning style as their negative learning style. Auditory learning style was major learning style for Indian students. Tactile learning style was reported to be negative learning style for the Malay, while Chinese and Indian students reported it as a minor learning style. The individual learning style was a minor learning style preference for Malay and Chinese students while Indian students expressed it as major learning style.

C) STUDIES RELATED TO PROBLEM SOLVING SKILL

Madhumathi and Sayed (2014) conducted a study on assessing problem solving abilities based on Polya’s approach.

The findings of the study were the girls were better than boys in their problem solving ability. Slum area students were better than rural area students in their problem solving ability. Government school students were better than the private school students in their problem solving abilities based on polya’s approach.

Deniz Kaya, Dilek Izgiol and Cenk Kesan (2014) conducted a study on the investigation of elementary mathematics teacher candidates’ problem solving skills.

The findings showed that there was not a significant difference between male and female candidates’ perceptions of their problem solving skills. There was a significant difference on their problem solving skills and impulsive approach to problem solving according to grades. There was no significant difference between problem solving skills and the level of family income, settlement and region where they were lived before coming to the university.

Vuslat Oguz and Aysel Koksal Akyol (2014) conducted a study on problem solving skills of children attending nursery school.

The results indicated that gender, birth order, the duration of nursery school attendance and the number of children in the family did not affect the problem solving skills of children.

Ali Bicer et al., (2013) conducted a study on integrating writing into mathematics classroom to increase students’ problem solving skills.

The results provided evidence that the students from the writing process group were more likely to generate and apply better problem solving skills compared to the second group of students.
Gurcu Erdamar and Gulgun Alpan (2013) conducted a study on examining the epistemological beliefs and problem solving skills of pre-service teachers during teaching practice.

The results revealed that pre-service teachers’ most sophisticated epistemological belief was ‘Belief that learning depends on effort’. The problem solving approach in which teachers were most competent was the ‘evaluative’, ‘planned’, and ‘reserved’ approach. Epistemological beliefs were found to become more sophisticated with the help of teaching practice; the belief that learning depends on ability particularly became more sophisticated. Pre-service teachers whose epistemological beliefs were less sophisticated were affected positively by the teaching practice.

Ruhi Yigit (2013) conducted a study on examination of relationship between well-being of teacher candidates and levels of social problem solving skill.

There was a positive relationship between well-being of teacher candidates and sub-dimensions of social problem solving approaching the problem in a positive way, rational problem solving. There was a negative relationship between the well-being of teacher candidates and sub-dimension of approaching the problem negatively.

Lubin et al., (2012) conducted a study on investigating the influences of a LEAPS model on pre-service teacher problem solving, metacognition and motivation in educational technology course.

The findings revealed that LEAPS approach was beneficial in supporting students' problem-solving, motivation, and self-reflections, but only under specific conditions.

Ferreira, Maria Trudel and Anthony (2012) conducted a study on the impact of problem based learning (PBL) on student attitudes towards science, problems-solving skills, and sense of community in the classroom.

The findings showed that students answers to a survey questionnaire, journal entries approaches to solving a problem, and teacher classroom observations indicated a significant increase in students’ attitudes towards science, problem-solving and positive views of the learning environment.
Ahmed Bedel and Ramazan Ari (2012) conducted a study on the effect of interpersonal problem solving skills training on the adolescents' constructive problem-solving level and the level of trait anger. The results showed that interpersonal problem solving skills training increased the level of constructive problem-solving skills of the adolescents in the experimental group and reduced the level of trait anger significantly.

Shadle, Susan Brown et al., (2012) conducted a study on a rubric for assessing students’ experimental problem share solving ability. The results showed that the average, students are able to provide a “correct” answer before they were able to articulate a complete understanding of the problem or to justify their choices.

Voyer and Dominic (2011) conducted a study on performance in mathematical problem solving as a function of comprehension and arithmetic skills. The results showed that pupils with weaker arithmetic skills construct different representations, based on the information presented in the problem. Pupils who gave greater importance to situational information in a problem had greater success in solving the problem. The situation model influenced pupils' problem solving performance, but this influence depended on the type of information inducted in the problem statement, as well as on the arithmetic skills of each individual pupil.

Derya Sahin (2011) conducted a study on pre-schoolers, pre-school teachers, and interpersonal problem-solving skills: a comparative study in Turkey and Belgium pre-school education department. The findings showed that Turkish pre-school teachers tend to solve problems as soon as they emerge. Few Turkish and Flemish teachers had specific training in improving interpersonal problem-solving skills in their children.

Klegeris and Heather (2011) conducted a study on impact of problem based learning in a large classroom setting, student's perception and problem solving skills. The findings showed that the student responses indicated that PBL was superior to traditional lecture format with regard to the understanding of course content and retention of information. This also demonstrated that student problem-solving skills were significantly improved.
**Nisha and Rinal (2011)** conducted a study on problem solving ability and scholastic achievement of secondary school students. 

The finding showed that the boys had higher problem solving ability compared to girls. The rural and private school students had better problem solving ability than urban and government school students. There was significant relationship between problem solving ability and scholastic achievement with respect to locale and type of school. 

**Johnson and Ramganesh (2011)** conducted a study on self-regulatory awareness in physical science problem solving among the teacher trainees. 

The findings of the study revealed that the level of self-regulatory awareness among the student teachers was lower than male student teachers, urban students had better self-regulatory awareness than male student teachers, urban students had better self-regulatory awareness than rural student teachers, exposure of internet had influence in self-regulatory behaviour of student teachers. Age had no role to play as far as self-regulatory behaviour was concern. 

**Sobha (2010)** conducted a study on computer games and problem solving ability of the students. 

The finding showed that the students from computer games group possess a high problem solving ability than non gaming group. 

**Harris and Ambe Allmon (2009)** conducted a study on comparing effects of two grouping conditions to teach algebraic problem solving to students with mild disabilities in inclusive settings. 

The findings showed that there were no statistically significant differences in group abilities to generalize strategies to more strategies to more compare problem solving students in both treatment condition scored approximately eight points higher on post-test measure for solving to step algebraic equations. 

**John and Ramganesh (2009)** conducted a study on problem solving abilities in mathematics of IX standard students in Villupuram district. 

The findings showed that the problem solving abilities in mathematics was low. They did not possess the general ability of solving any type of problem in mathematics; sex, type of school, locality, subject group, extra-coaching had influences on problem solving abilities in mathematics. It was found that private school, urban computer sciences group students and students who went for tuition in mathematics had better
problem solving abilities in mathematics and the socio-economic factor namely community, parental educational qualification and parental occupation were influenced on problem solving abilities in mathematics.

CRITICAL REVIEW

The investigator has reviewed a total number of 92 studies. Among them 34 studies are related to metacognition 40 are related to learning styles 18 studies are related to problem solving skill.

After a thorough examination of the collected reviews, the investigator found some of the review studies are related to the present study to some extent. These studies helped the investigator in formulating the objectives, hypotheses, tool construction, dimensions of the tools and statistical techniques required for data analysis. After the critical evaluation of the studies related to metacognition, the investigator has made the following conclusions. Vijayakumari and Mystle Joyce (2014) identified that metacognition co-operative learning approach had positive effect on the achievement and metacognitive co-operative learning approach was more effective than the traditional method of low and high achievers in mathematics. Priya and Celene (2013) concluded that there was a positive correlation between metacognitive ability and academic achievement. There was significant correlation between boys and girls, state and CBSE school students in metacognitive ability and academic achievement. Nien Fatemah Bidi (2012) reported that there was a positive relationship between all aspects of metacognition and internet addiction. Mahamood Shitab (2010) concluded that metacognitive learning strategies were more effective than traditional methods and not gender difference exists. Sheeja V Titus (2011) reported that there was significant relationship between metacognition and teaching competency of secondary teacher education students.

After the critical evaluation of the studies related to learning styles, the investigator has made the following conclusions. Gender has no effect VAK learning styles but had an effect on problem solving styles. Reena George and Archana (2012) concluded that significant difference was found between learners in learning behaviours and determine the strength of academic achievement. Also significant difference related to academic achievement of students at the secondary and higher secondary level. Naser-Nick Manochehr (2011) reported that students with assimilator learning style and converged learning style achieved a better result with the e-learning method. Indu
(2010) concluded that more number of students had left brain hemisphericity. Also significant relationship was found between brain hemisphericity and perceptual learning styles. Williams and Judy (2010) reported that there was relationship between kinesthetic, auditory and visual learning styles and reading comprehension levels. Also significant difference distribution of kinesthetic, auditory and visual learning styles at seventh grade students.

After the critical evaluation of the studies related to the problem solving skill, the investigator has made the following conclusion. Ferreira, Maria Frudel & Anthony (2012) indicated a significant increase in students’ attitudes towards science, problem-solving and positive views of the learning environment and the use of PBL facilitated the development of community in the classroom. Nisha and Rinal (2011) concluded that there was significant relationship between problem solving ability and scholastic achievement with respect to locale and type of school. Johnson and Ramganesh (2011) reported that urban students had better self-regulatory awareness than rural student teachers, exposure of internet had influence in self-regulatory behaviours of student teachers.

The present study is different from the above studies in many ways. There has been no study, which has consisted of the three variables metacognition, learning styles and problem solving skill of B.Ed trainees. Especially, the tools of learning styles and problem solving skill were developed by the investigator and it is the original contribution of the investigator for this study. Therefore the present study is probably the first of its kind in this view. It is different from others in terms of population and sample. Hence, it is relevant for the investigator to study the influence of metacognition and learning styles on problem solving skill of B.Ed trainees. Thus the present investigation is not only an in-depth study but also unique in nature.

The ensuing chapter deals with methodology.