2.0 INTRODUCTION

The review of related literature enables the researcher to define the objectives of her field. It helps the researcher to define the problem. To use an analogy given by Ary et.al., (1972, pg56) a researcher might say: The work of A,B and C has discovered this much about my question; the investigator of D have added this much to our knowledge. I propose to go beyond D’s work in the following manner. Hence the researcher goes beyond the knowledge of related literature and brought the up-to date on the work which others have not done and stated the objectives clearly and concisely. Even though the effect of Mind map teaching strategy on achievement in mathematics and some variables of High school students were found out earlier, the researcher makes the difference in variables and the selection of sample.

Since library is the place where the researcher finds the primary and secondary sources, the researcher felt the extensive use of libraries and investigated the related literature properly and did the essential planning and carried out the research in a fruitful manner.

It has been already stated in the previous chapter that the present study is an attempt to develop Mind map teaching strategy in Mathematics to 9th std. students. Hence this chapter is devoted to the review of related literature. Also the reviews for the other variables are presented lavishly. The reviews have been grouped into the following topical sequence.

2.1 REVIEWS RELATED TO MIND MAP METHODOLOGY

2.1.1 INDIAN STUDIES

Indumati, Bharambe. (2012). Conducted study on effectiveness of mind mapping in educational psychology.
Objectives: To study the effectiveness of mind mapping in teaching Educational Psychology.

Methods: For the study, 40 M. Ed. Student-teachers were selected. 'Pre-test Post-test Single Group Design' was used. The unit 'Growth and Development' was selected for teaching through mind mapping. The points namely, concept of growth and development, principles of development, fields of development, stages of development, theories of development and role of teacher and parent in growth and development of child were linked by using concept map and each concept was again presented by using mind map. Then each point and sub point related to it is also joined each other. The content test was prepared on the selected content. It was used as pre-test and post-test before and after teaching through mind mapping respectively. The data was collected through pre-test and post-test which is analyzed by using ‘t’-test.

Findings: The results revealed that there is a significant difference between pre-test and post-test mean scores of M. Ed. Student teachers. Mind mapping was found effective in teaching Educational Psychology.


Objectives: To design the model of mind mapping strategy orientation and to test the effect of mind mapping strategy orientation on achievement in Science among the upper primary students.

Methods: Experimental method was used. Single group pre-test, progressive test and post design was adopted. Students of upper primary level of 6th to 8th std. students from S.Vallampatty PUM school Sanarpatty block was selected as a sample.
Findings: The Female students (75.56) achievement in upper primary level is higher than that of male students (71.92) achievement in upper primary level and the post test scores (75.56) of female students in upper primary level is higher than that of pre test scores (51.11) of female students in upper primary level.

**Mani, A. (2011).** Conducted study on effectiveness of digital mind mapping over paper-based mind mapping on students’ academic achievement in Environmental Science.

Objectives: To examine the effects of digital mind mapping over paper-based mind mapping and conventional teaching method on students’ achievement in Environmental Science.

Methods: For the study, 120 B.Ed trainees of a teacher training institute in Noida were selected. The participants were randomly allocated to three groups: experimental group, control group 1 and control group 2. The teaching method used for the experimental group was digital mind mapping, conventional method for control group 1, and paper-based mind mapping method for control group 2 respectively. A pre-test and post-test control group research design was used.

Findings: The experimental results suggested that adopting mind mapping strategy can significantly improve students’ achievement in Environmental Science as compared to using conventional method. Furthermore, most of the students were satisfied with using mind mapping to learn Environmental Science. Findings indicated that Digital mind mapping produced the best outcomes, especially in the activities like brainstorming and group discussion.

**Valarmathi, K. E. (2011).** Conducted study on the Impact of Computer Mind Mapping technique on teaching the concept Sound in Physics for standard IX students.
Objectives: To develop a computer mind map for the topic “Sound” in Physics to find the academic achievement of the experimental group students and to find the correlation between mind mapping attitude and achievement of the standard IX students.

Methods: Sixty students of standard IX from Subbiah Vidyalayam Girls’ Higher Secondary School, Tuticorin were taken as the sample for this study. Experimental study was taken for the research. Data was analyzed with ‘t’-test and correlation analysis.

Findings: The Computer Mind Mapping has the positive impact on the achievement of standard IX students in their science subject. There is significant difference between the performance of the standard IX students in control group and experimental group. The computer mind map for the topic “Sound” in Physics was developed and the academic achievement of one group of students was tested and the result shows that Computer Mind Mapping is a better teaching strategy. There is correlation between mind mapping attitude and achievement of standard IX students with respect to the variables Medium, Locality of the residence, Parent’s occupation, Parent’s educational qualification, Kindergarten education, Reading habit, and Basic knowledge in Science.

**Thangarajathi, S. (2008).** Conducted a study on effectiveness of Mind mapping technique in teaching Mathematics at High school level in terms of sex, parental educational qualification and parental income.

Objectives: To study the effectiveness of Mind mapping technique in teaching Mathematics.

Methods: The sample of the study comprised sixty 9\(^{th}\) std. students in Tuticorin Dist. Mind maps and Achievement tests (pre and post tests) were developed and two equivalent groups pre test, post test experimental design was employed for this study.
Findings: In analysis, the study reveals that the Mind mapping technique is more effective than the conventional method.

2.1.2 FOREIGN STUDIES


Objectives: To propose a mind map based collaborative learning approach for supporting creative learning activities and enhancing students' innovative performance and to evaluate the effectiveness of the proposed method.

Methods: In this study, three classes constituting a total of 137 students taking an undergraduate Business Planning course at a university in northern Taiwan were assigned to three groups. Experimental group one included 44 students who adopted a mobile-based Mind tools application embedded in mobile devices with a collaborative learning approach; experimental group two included 47 students who adopted computer based Mind tools with a collaborative learning approach but did not use mobile devices; the control group included 46 students who adopted a conventional collaborative learning approach with neither the use of Mind tools nor mobile technology. After the experimental procedure the data was analyzed using ANOVA.

Findings: The experimental results show that the proposed approach significantly enhanced the students' innovative performance in a project-based learning task. The two experimental groups are significantly superior to those of the control group, implying that the mind mapping mechanism embedded in the learning activity was definitely beneficial to the experimental group students. Also the mind mapping tool allowed the students to experience
divergent creative thinking by drawing, and also allowed them to come up with convergent ideas via the use of graphic representations.

**Brett, D., Jones, Chloe Ruff, Jennifer Dee Snyder, Britta Petrich and Chelsea Koonce. (2012).** Conducted study on the Effects of Mind Mapping Activities on Students’ Motivation.

Objectives: To examine how students’ motivation differed when they participated in three different types of mind mapping activities: one activity that was completed individually outside of class time, one that was completed individually in class with the instructor available for help, and one that was completed in class with other students and the instructor available for help.

Methods: Using the MUSIC Model of Academic Motivation (Jones, 2009) as a framework, it was implemented a concurrent mixed methods design using identical samples whereby the quantitative component was dominant over the qualitative component. Participants included 40 undergraduate students enrolled in an educational psychology course at a U.S. university. After each of the mind mapping activities, study participants completed questionnaires that included open- and closed-ended items.

Findings: Although the three activities had similar effects on students’ motivation-related beliefs, some differences were documented in their preferences of mind mapping activities. Instructional implications are provided.

**Egitim, Bilim. (2012).** Conducted study on the effects of using mind mapping in English course on students’ academic achievement, retention, views and attitudes towards the course.

Objectives: To examine the effects of mind mapping on academic achievement, attitudes and retention in teaching English to primary school pupils and to determine the views of English teacher and the students towards the experiment.
Methods: The research was administered on sixty grade students enrolled at Yücel Elementary School in Elazığ city. Both quantitative and qualitative data were utilized in the study. In quantitative part, pretest-posttest control group was used. In qualitative part of the study interview and observation techniques were used. The study included one experimental and one control group. While mind mapping was used in experimental group, traditional teaching method was used in control group. An achievement test, attitude scale, interview and observation forms were utilized in the study as the data collection tool. Validity and reliability of the tools and data collected were calculated.

Findings: The mean score of the achievement test was calculated to be 0.65, KR-20 reliability coefficient was measured to be 0.74. KMO of the scale was calculated to be 0.75, Bartlett’s test was measured to be 1053.799. Cronbach’s Alpha reliability coefficient was calculated to be 0.82. NVIVO program was used to analyze qualitative data and the results were interpreted. With the study, it was determined that using mind mapping increased students’ academic achievement in learning English and affected their attitudes positively. The results of interview and observation proved that mind mapping helped students English better.


Objectives: To investigate elementary teachers’ views on mind mapping by using interviews.

Methods: In this line, the study group of the research was composed of 24 elementary teachers experience periods in their job between two and 21 who were enrolled in a “Teaching Thinking Science Consulting Course”. In the implementation phase of the study, the teachers were primarily instructed about the application of the mind mapping technique. In the interviews open-ended six questions were asked to teachers about mind mapping and
the use of this technique in the classroom. Interviews were analyzed using qualitative research methods.

Findings: It showed that using mind mappings in instruction helps teachers improve their instruction, planning and evaluating lessons and makes the lecture more entertaining. The technique can be suggested to extend by analyzing its relation with different variables like different lessons and participants.


Objectives: The main objective of this study was aimed to identify whether the use of Mind Mapping strategy was effective in improving the students’ writing achievement.

Methods: Non-equivalent group pretest-posttest design was used in this study. The population was the First year students of SMAN 3 Bengkulu Town in academic year of 2011/2012 with a total number of 234 students. Out of this population, 66 students were taken as sample. There were two groups, each of which consisted of 33 students. The data was collected by using writing test.

Findings: The data obtained was analyzed by using t-test formula. From the t-test calculation of the pre test result was known that t obtained was 0.25 by using t table p level and 64 df results in a figure of 2.0, so t obtained < t table (0.25 < 2.0). it meant that there was not a statistically, the average of two groups were the same grade. Then after giving the treatment for sixteen meetings the post test was given to the two groups. The mean score of the experimental group was 68.1212 and the control group was 62.7727. In testing the significant difference between these two group means; t obtained was 2.7 and t table value at 0.05 p level and the 64 df was 2.0. So that t obtained > t table (2.7 > 2.0). It meant that there was a
significance difference on students writing achievement which was taught through Mind Mapping Strategy. Therefore, it can be concluded that Mind Mapping Strategy improved students’ writing achievement.


Objectives: To create a colorful and organized mind map using their typed speech outline to use as they prepare their speech.

Methods: Students are first introduced to the concept of mind mapping and provided with rationale for the activity. Teachers are encouraged to highlight mind mapping examples and/or online video clips which effectively synthesize the technique and instruct students how to engage in the technique. Once students are familiar with the concept of mind mapping, the class then reviews a mind map and corresponding typed speech outline. The teacher may use an LCD projector or a document camera to display the resources. Once the teacher has illustrated how the student speech outline is reflected on the mind map, students are asked to study the map for two minutes. The teacher then conceals the mind map and asks for a volunteer to provide an speech describing the mind map. As the volunteer delivers the speech from memory, someone else should follow the mind map to see which main points and sub-points are discussed and overlooked. Volunteers usually retain a great deal of information from the mind map, which illustrates the value of the technique. The class may then discuss the concept of mind mapping as a speech preparation technique. Students will often comment on how they remember colors and symbols from textbooks and PowerPoint presentations which enable them to better perform on examinations. Similarly, students will draw the same parallel to the ability of mind mapping to reinforce large amounts of linear speech information using colors and symbols. As a capstone, students can be asked to mind map
their own upcoming speech. Hence, students should bring their typed speech outline to class that day. The workshop should be scheduled approximately three to seven days before students are scheduled to deliver a speech; this will ensure that outlines are complete and that students can use their mind map throughout the coming days to prepare for their speech. The teacher will need to bring at least one sheet of white paper for each student and a variety of colored pens and markers. Pass the paper out to students then let the pens and markers circulate throughout the class so students can choose the colors that best fit their speech topics. Provide students with a generous amount of time (at least 15 minutes) to mind map their speech. Since the classroom will be fairly quiet this can be a fun time to play music in the background.

Findings: Once students have completed their mind maps the class should convene to discuss student experiences and final products. Doing so allows students to engage in peer to-peer dialogue synthesizing the benefits of mind mapping and some justifications as to why it seems to work so well. After giving a speech using this technique to prepare, students report that their speech anxiety is lower and their ability to retain the information is higher. Students enjoy the opportunity to engage in a fun and creative activity. Many students remark on their increased ability to retain information from their mind map. As a result, students who use mind mapping as a speech preparation method generally rely less on their note cards, provide smoother and more extemporaneous delivery, and utilize greater amounts of eye contact during their speeches; thereby exuding greater poise and confidence. This activity can also empower students to excel in a variety of other spheres. As mentioned earlier, mind maps are commonly used as a mode of preparation for examinations. Similarly, mind mapping can be used to brainstorm and outline ideas. Therefore, students may employ this technique in a variety of courses. For example, students working as a team in a Small Group Communication course may use this method to map out project objectives or action items.
Likewise, students enrolled in a Communication Research Methods course may use this technique to map out their research paper and clarify the relationship between a chosen theory and variables; thus elucidating the phenomena of interest.

**Joeran Beel, and Stefan Langer. (2011).** Conducted a study on an Exploratory Analysis of Mind Maps.

Objectives: To find out how mind maps are structured and which information they contain.

Methods: The results presented in this paper come from an exploratory study of 19,379 mind maps created by 11,179 users from the mind mapping applications in Germany.

Findings: A typical mind map is rather small, with 31 nodes on average (median), whereas each node usually contains between one to three words. In 66.12% of cases there are few notes, if any, and the number of hyperlinks tends to be rather low, too, but depends upon the mind mapping application. Most mind maps are edited only on one (60.76%) or two days (18.41%). A typical user creates around 2.7 mind maps (mean) a year. However, there are exceptions which create a long tail. One user created 243 mind maps, the largest mind map contained 52,182 nodes, one node contained 7,497 words and one mind map was edited on 142 days.

**Reima, Al-Jarf. (2011).** Conducted study on Teaching Spelling Skills and enhancing freshman students’ writing skills with a mind-mapping software.

Objectives: To show how mind-mapping software can be integrated in EFL courses to help students discriminate different pronunciation of the vowel letters a, i, o, e, u; adding a final silent e; pronunciation of vowel digraphs; consonant letters with more than one sound; different pronunciations of consonant letters c, cc, g, ch, s; double consonants; homophones;
homographs; hidden sounds; rules for adding affixes; assimilation; elision; acronyms and abbreviations.

Methods: Two groups of freshman students, enrolled in their first writing course in EFL, participated in the study. Both groups were exposed to the same in-class writing instruction. Since students have difficulty generating ideas in EFL, writing paragraphs with topic sentences and supporting details, mind-mapping software was used to help students’ brainstorm, generate ideas; relate main ideas and supporting details. The mind-mapping software uses lines, colors, arrows, branches to show connections between the ideas generated on the mind map. Every week the software was used to create mind maps for the essays they had to write.

Findings: 1) Before instruction, no significant differences were found between both groups in their writing ability. 2) Post-test results showed that experimental students who used the mind-mapping software, made higher gains in writing.


Objectives: The present study deals with the use of mind maps as an assessment tools.

Methods: In the study, the mind maps prepared for the special teaching methods course by 30 pre-service teachers studying in the Department of Science Teacher Training of a university in Turkey in academic year 2008-2009 were assessed by using a scoring system to assess mind maps for pre-service science teachers. To ensure the reliability of the scoring system, the mind maps prepared by the pre-service teachers for the special teaching methods course were assessed by two expert raters and the assessment was repeated one week later. The
reliability process for the scoring system was calculated by using inter- and intra-rater reliability values, intra-cluster correlation analysis, and variance analysis.

Findings: The findings obtained from the first rater’s mind map analyses suggest that there is a high-level correlation between two measurements for all sub-dimensions and that this correlation is significant (p=.000<.05). Furthermore, the analyses also demonstrated that the agreement between the scoring of images, symbols, and other visuals, and examples and the scoring of cross links was relatively lower than the other sub-dimensions. As a result of the intra-cluster analysis performed on the total scores for the first rater’s intra-rater reliability, the correlation was calculated as .995 (95% CI=.989-997), while the intra-cluster correlation for the second rater’s intra-rater reliability was .987 (95% CI=.973-.994). The analyses revealed no significant difference between the two measurements (F(1-29)=.732, p=.399>.05). Furthermore, the eta square effect size value calculated also confirms that the independent variable (measurements) did not cause a significant difference upon the dependent variable (score). Moreover, the Pearson product moment for the two measurements was computed to be .995. As a result of inter-rater agreement calculations performed for the scoring of mind maps, it was determined that inter-rater agreement was relatively lower for the scoring of examples, relationships, images, symbols and similar elements in particular, when compared to the other sub-dimensions. Furthermore, in the intra-cluster correlation analyses on total scores, inter-rater agreement was calculated to be .967 (95% CI=.932-.984). The dependent groups t-test revealed no significant difference between the raters (t=1.06; p=.298>.05). What is more, the correlation between the two data sets was calculated as .967 according to the Pearson product moment analysis.

**Harkirat, S., Dhinds, Makarimi, Kasim, O., & Roger Anderson. (2010).** Conducted study on Constructivist-Visual Mind Map Teaching Approach and the Quality of Students’ Cognitive Structures.
Objectives: To compare the effects of a constructivist-visual mind map teaching approach (CMA) and of a traditional teaching approach (TTA) on (a) the quality and richness of students’ knowledge structures and (b) TTA and CMA students’ perceptions of the extent that a constructivist learning environment (CLE) was created in their classes.

Methods: The sample of the study consisted of six classes (140 Form 3 students of 13–15 years old) selected from a typical coeducational school in Brunei. Three classes (40 boys and 30 girls) were taught using the TTA while three other classes (41 boys and 29 girls) used the CMA, enriched with PowerPoint presentations. After the interventions (lessons on magnetism), the students in both groups were asked to describe in writing their understanding of magnetism accrued from the lessons. Their written descriptions were analyzed using flow map analyses to assess their content knowledge and its organization in memory as evidence of cognitive structure. The extent of CLE was measured using a published CLE survey.

Findings: The results showed that the cognitive structures of the CMA students were more extensive, thematically organized and richer in interconnectedness of thoughts than those of TTA students. Moreover, CMA students also perceived their classroom learning environment to be more constructivist than their counterparts.


Objectives: To investigate into the effectiveness of using mind mapping skills as a prewriting planning strategy in enhancing the quality of writing.

Methods: Students were trained in the use of mind mapping in planning before writing their English compositions. Student compositions after the use of mind mapping were holistically rated by three experienced markers.
Findings: It reveals that the application of mind mapping in planning is a useful writing strategy that can improve students' writing.


Objectives: To determine the effects of note taking during their science courses through the technique of mind mapping by primary education students, on their attitudes, academic achievement and concept learning.

Methods: In the study, both quantitative and qualitative research methods were used. In the quantitative research area, the pre-test and post-test assessment model with experiment and control groups was used. In the qualitative research area, document analyses were made. The research was performed on 81 randomly chosen 6th (ages 11 and 12) grade students from public schools in the district of Fatih, Istanbul during the scholastic year 2004-2005. The application period took 21 course hours in total. The reliability coefficient of the academic achievement test, which was one the three measurement instruments, was calculated as KR20=0, 73. The Cronbach of the scale for the attitudes towards science courses, developed by Akinoglu (2001). is α= 0, 89. The open-ended questions used in the research were qualitatively encoded by means of open-codification method.

Findings: On the basis of the data obtained in the research, it was determined that there was a significant positive difference in students’ concept learning, overcoming misconceptions, academic achievement and attitudes towards science courses by taking notes through the mind mapping method.

Objectives: To investigate the usability and usefulness of interactive tabletop technologies to support group creativity.

Methods: Implemented a tabletop interface enabling 6 groups of 4 participants each group included students, professors and/or employees to build mind-maps (a tool for associative thinking). Overall, users’ age ranged from 20 to 52 years old (mean = 28.7; SD = 7.9) and each group was composed of 2 male and 2 female participants. With 24 users in a within-group design, compared its use to traditional paper-and-pencil mind-mapping sessions. Each group had to build 2 mind-maps on different topics: 1 in the tabletop condition and 1 in the control condition. The order of conditions and the assignment of topics were counterbalanced across the whole sample. Inferential analyses were performed by means of ANOVAs using SPSS software. Three dimensions were investigated: the performance in mind-mapping, the subjective experience of users, and the collaborative behaviors.

Findings: The results showed no difference in idea production, but the tabletop condition significantly improved both subjective and collaborative dimensions, especially by leading to better-balanced contributions from the group members. No significant difference appeared between tabletop and control conditions on the index of exhaustiveness of mind-maps (F (1/5) = 0.92, NS). There was no significant effect of the condition (tabletop vs. control) on easiness (F (1/20) < 0.1, NS) and efficiency (F (1/20) = 1.02, NS) of mind-map building. However, the tabletop was rated as significantly more pleasant to use (F(1/20) = 10.43, p = 0.004), enabling a more pleasant communication between participants (F(1/20) = 5.01, p = 0.037), more efficient group work (F(1/20) = 3.56, p = 0.074) and more pleasant group work
(F(1/20) = 4.23, p = 0.053). Users’ gender and category had no influence on any of the previous results.

**Cunningham, Glennis Edge. (2006).** Conducted study on Mind mapping: Its effects on student achievement in high school biology.

Objectives: To determine the achievement in High school science courses could be enhanced utilizing mind mapping.

Methods: The subjects were primarily 9th and 10th graders (n = 147) at a suburban South Texas high school. A pretest-posttest control group design was selected to determine the effects of mind mapping on student achievement as measured by a teacher-developed, panel-validated instrument. Follow-up interviews were conducted with the teacher and a purposive sample of students (n = 7) to determine their perceptions of mind mapping and its effects on teaching and learning. An independent samples t-test and a one-way analysis of covariance (ANCOVA) were determined.

Findings: There is no significant difference in achievement between the groups. The experimental group improved in achievement at least as much as the control group.

**Cynthia Treviño, B. S. M. S. (2005).** Conducted study on mind mapping and outlining: comparing two types of graphic organizers for learning seventh-grade life science.

Objectives: To determine effects of mind mapping and outlining on learning Life Science in the seventh grade.

Methods: This study evaluated unit test scores, one-week delayed comprehensive posttest scores, and attitudes of students toward the strategy implemented on a Life Science Unit on cellular biology. Permission was obtained from the Texas Tech Institutional Review Board and Hobbs (NM) Municipal Schools to conduct this study. Consent was received and each
participant was randomly assigned to one of three groups (control, outlining, and mind mapping) to assure equal distribution of difference between these groups (Gall, Borg, & Gall, 1996). A one-way ANOVA was conducted to determine effects of groups in unit test scores and one-week delayed comprehensive posttest scores. A MANOVA was utilized to evaluate effects of groups’ attitude survey scores.

Findings: Results of the study demonstrated a significant difference in means of unit test scores. A post-hoc test was conducted to evaluate which groups were different. A significant difference existed for students who used the outlining strategy to answer unit test questions on cellular biology when compared to the control and mind-mapping groups. In evaluation of one-week delayed comprehensive posttest results on cellular biology, a significant difference did not exist between groups. Attitudes toward the strategy being implemented differed between means of groups for survey questions two and seven. The mind-mapping group indicated significant agreement regarding the statement “I enjoyed creating an (outline, mind map, writing information) for the cell block.” Ancillary data was compiled of basic and application questions of unit test and one-week delayed comprehensive posttest. In unit test basic questions, the outlining group performed significantly better than the mind-mapping group. In the one-week delayed comprehensive posttest, the outlining group performed significantly better than the control group.


Objectives: To look at an example of collaborative activity in primary schools and aims to explore the ways visual material helps children establish shared meanings.
Findings: An exercise involving mind mapping software provided a useful focus for pupils to organize their thoughts, to present information clearly and attractively, and facilitate communication.


Objectives: To present a review of the literature and survey results of student satisfaction after using the mind map learning technique.

Methods: Study conducted at New church Community Primary School for 14 students, Warrington.

Findings: It showed that although the subject pool was limited to 14 students, 10 out of 14 agreed that the mind map learning technique enabled them to better organize/integrate material presented in the course, while only 2 disagreed. The final 2 students responded neutrally when asked if the mind map learning technique assisted them in organizing/integrating course material. However, these 2 students did agree the technique enabled them to recognize areas in which further study was necessary for them to adequately master the course material.

2.1.3 STUDIES RELATED TO MEDICAL FIELD


Objectives: To investigate whether a relationship existed between mind mapping and critical thinking, as measured by the Health Sciences Reasoning Test (HSRT), and whether a relationship existed between mind mapping and recall of domain-based information.
Methods: In this quasi-experimental study, 131 first-year medical students were randomly assigned to a standard note-taking (SNT) group or mind map (MM) group during orientation. Subjects were given a demographic survey and pre-HSRT. They were then given an unfamiliar text passage, a pre-quiz based upon the passage, and a 30-minute break, during which time subjects in the MM group were given a presentation on mind mapping. After the break, subjects were given the same passage and wrote notes based on their group (SNT or MM) assignment. A post-quiz based upon the passage was administered, followed by a post-HSRT. Differences in mean pre- and post-quiz scores between groups were analyzed using independent samples t-tests, whereas differences in mean pre- and post-HSRT total scores and sub scores between groups were analyzed using ANOVA. Mind map depth was assessed using the Mind Map Assessment Rubric (MMAR).

Findings: 1) There were no significant differences in mean scores on both the pre- and post-quizzes between note-taking groups. 2) And, no significant differences were found between pre- and post-HSRT means total scores and sub scores.


Objectives: Currently, there is no valid and reliable rubric to grade mind maps and this may contribute to their underutilization in medicine. Because concept maps and mind maps engage learners similarly at a Meta cognitive level, a valid and reliable concept map assessment scoring system was adapted to form the mind map assessment rubric (MMAR). The MMAR can assess mind map depth based upon concept-links, cross-links, hierarchies, examples, pictures, and colors. The purpose of this study was to examine inter rater reliability of the MMAR.
Methods: This exploratory study was conducted at a US medical school as part of a larger investigation on learning strategies. Sixty-six ($N = 66$) first-year medical students were given a 394-word text passage followed by a 30-minute presentation on mind mapping. After the presentation, subjects were again given the text passage and instructed to create mind maps based upon the passage. The mind maps were collected and independently scored using the MMAR by 3 examiners. Interrater reliability was measured using the intra class correlation coefficient (ICC) statistic. Statistics were calculated using SPSS version 12.0 (Chicago, IL).

Findings: Analysis of the mind maps revealed the following: concept-links ICC = .05 (95% CI, -.42 to .38), cross-links ICC = .58 (95% CI, .37 to .73), hierarchies ICC = .23 (95% CI, -.15 to .50), examples ICC = .53 (95% CI, .29 to .69), pictures ICC = .86 (95% CI, .79 to .91), colors ICC = .73 (95% CI, .59 to .82), and total score ICC = .86 (95% CI, .79 to .91). The high ICC value for total mind map score indicates strong MMAR inter rater reliability. Pictures and colors demonstrated moderate to strong inter rater reliability. We conclude that the MMAR may be a valid and reliable tool to assess mind maps in medicine.


Objectives: To determine the effectiveness of a pictorial ‘mind map’ together with the Arthritis Research Campaign (ARC) booklet for imparting knowledge to participants with rheumatoid arthritis (RA) and to relate this to their reading ability.

Methods: We studied 363 participants with RA. Reading ability was assessed using the REALM, and knowledge was assessed using the Knowledge Scale Questionnaire (KSQ). Information on educational attainment, disease state and levels of anxiety and depression was
also collected. Participants were randomly assigned to receive either the ARC booklet alone or the booklet and the mind map together.

Findings: A significant minority (15%) of participants were functionally illiterate. There was a statistically significant increase in knowledge across both groups from baseline to reassessment after they were given the literature, but there was no difference in attainment between the groups. The more literate participants gained more knowledge regardless of the information they were given. They were also significantly less anxious and less depressed.

**Michelini, C. A. (2006).** Conducted study on mind map: A new way to teach patients and staff.

Findings: By marrying mind mapping with care planning, we have encouraged the use of critical, whole-brained, holistic thinking when applying the nursing process and using nursing diagnoses. Standardized language is still used, but the thinking that occurs has become more important than the language.

**Paul Farrand, Fearzana Hussain, and Enid Hennessy. (2002).** Conducted study on the efficacy of the `mind map' study technique.

Objectives: To examine the effectiveness of using the `mind map' study technique to improve factual recall from written information.

Methods: To obtain baseline data, 50 second- and third-year medical students B arts and the London School of Medicine and Dentistry, University of London were selected. Subjects completed a short test based on a 600-word passage of text prior to being randomly allocated to form two groups: `self-selected study technique' and `mind map'. After a 30-minute interval the self-selected study technique groups were exposed to the same passage of text previously seen and told to apply existing study techniques. Subjects in the mind map group
were trained in the mind map technique and told to apply it to the passage of text. Recall was measured after an interfering task and a week later. Measures of motivation were taken.

Findings: Recall of factual material improved for both the mind map and self-selected study technique groups at immediate test compared with baseline. However this improvement was only robust after a week for those in the mind map group. At 1 week, the factual knowledge in the mind map group was greater by 10% (adjusting for baseline) (95% CI –1% to 22%). However motivation for the technique used was lower in the mind map group; if motivation could have been made equal in the groups, the improvement with mind mapping would have been 15% (95% CI 3% to 27%). Mind maps provide an effective study technique when applied to written material.

2.2 REVIEWS RELATED TO ACADEMIC ACHIEVEMENT

2.2.1 INDIAN STUDIES


Objectives: To analyze the Academic self image and Academic achievement of the higher secondary students in terms of some variables and to study the relationship between Academic self- image and Academic Achievement.

Methods: Survey method was used. Academic self-image scale developed and validated by B.Delphin (2006). 246 Higher secondary students from Central Educational district was taken as sample. The data was collected and t-test and Correlational analysis was applied for the data.

Findings: There was significant difference between academic self- image of higher secondary students with respect to sex, class and locality of the students. There was significant
difference between academic achievement of higher secondary students with respect to sex, class and locality of the students and there is significant correlation between academic self-image and academic achievement of higher secondary students.

**Hemalatha, G. (2013).** Conducted study on Learning styles and their influence on Academic Achievement.

Objectives: To present the frequency distribution of the various levels of learning styles and to find out the level of academic achievement of college students and to find out the relationship between learning styles and achievement.

Methods: The study is an ex-post facto research with 1 x 1 design in which data for the study has been collected by applying stratified random sampling technique from 600 college students studying at U.G and P.G levels in selected colleges of Chennai district. Learning style Inventory constructed and Validated by Venkataraman (1999) was used to measure the various types of learning styles. Academic Achievement scores are the scores of the sample in Chemistry of the semester Exam.

Findings: The collected data were scrutinized and appropriate techniques were applied to identify the learning style and the differences in their learning style with respect to course and gender. Students differ in the ways they approach learning. The way in which the students approach the learning tasks and the behavior in learning situations determines the learning style. Students with different learning styles understand and try to solve problems in different, relatively stable ways.
Randeep Pannu. (2013). Conducted study on Academic Achievement in relation to cognitive styles, Location and Gender of Adolescent students.

Objectives: To study the influence of location, gender and cognitive styles (systematic and intuitive) and their various interactions on academic achievement of adolescents.

Methods: The study was conducted on a sample of 1246 students of 10 + 1 from senior secondary schools of Amritsar district affiliated to P.S.E.B. Mohali. The sample was selected through cluster sampling technique. Descriptive survey method of research was employed. Cognitive style inventory was used. Data from students was collected at the terminal stage of the academic session.

Findings: Results revealed that there was no influence of interaction between location and cognition style, location and systematic cognitive style, location and intuitive cognitive style, gender on academic achievement of adolescents. There was significant influence of interaction between gender and intuitive cognitive style on academic achievement of adolescents.


Objectives: To develop and standardized an integrated instructional plan in calculus for Mathematics students and to study the significant differences in the achievement in calculus among the comparable group of mathematics students who had taught by traditional method and integrated instructional plan.

Methods: The study followed pre-test- treatment – post-test equivalent two groups experimental design. Fifty students from St. Theresa Girl’s Higher Secondary school,
Thiruthuraipoondi and fifty students from St. Antony’s Higher Secondary school, Thiruthuraipoondi were selected for experimental group and control group respectively. Purposive sampling technique was adopted in the study. The tools used were Achievement test, Study habit scale and Scale of integrated skills constructed and validated by the investigator. t-test, F-test and correlation analysis were used to analyze the data.

Findings: There was a significant difference between the control group and the experimental group in the whole post test. Further it is interpreted here that the experimental group performed better than the control group in the overall post test in calculus.


Objectives: To develop instructional material for class IX on the topic (“cell structure and function and Tissues) for traditional teaching (laboratory experiences). To select and develop instructional material for class IX Biology. Through CAI (simulated laboratory experience) and to compare the effectiveness of teaching Biology through traditional teaching and CAI (simulated laboratory experiences).

Methods: The experimental method was adopted. A sample of 58 students of class IX of S.D Adarsh Public school of Karnal having a good computer laboratory was taken randomly. Computer based teaching package for CAI(prepared by the investigators and software selected from the school), Teaching package for traditional laboratory experiences in the form of lesson plan, chart, models, slides and various apparatus for performing the experiments. Previous class report cards of class VIII to know their academic achievement were used in the study. The t-test was used to find out the significant differences.
Findings: The result of the study indicated that there exists significant difference in students’ achievement in Biology when taught through CAI (simulated laboratory experiences) and traditional (laboratory experiences). The effectiveness of teaching Biology through CAI is higher than that of traditional teaching.

**Kumod Kumar Jha, Yadida Bhutia. (2012).** Conducted study on Study habits and achievement of students in Mathematics in secondary schools.

Objectives: To study the study habits and achievement of students in Mathematics in secondary schools and to determine the relationship between the study habits and achievement in Mathematics of students at secondary level in west Siang district.

Methods: Descriptive survey design was used. 155 students were selected from secondary level of west Siang district in A.P. Study habits inventory by Prof. M. Mukhopadhyaya (New Delhi) and Prof. D.N. Sansanwal (Indore) was used. The scores of students of class IX and X and summative Assessment I in Mathematics were used to assess achievement.

Findings: Descriptive analysis was used. As a result it was agreed that the study habits has strong relationship with academic achievement of students in Mathematics.

**Soosairaj, J., and Mohanasundaram, K. (2012).** Conducted study on the effectiveness of web-based class room instruction in learning Mathematics and web skills of higher secondary students.

Objectives: To find out the difference in achievement between higher secondary students learning mathematics through web based classroom instruction and through conventional method.

Methods: pre-test – treatment - post-test equivalent groups experimental design was used. Achievement test in Mathematics and scale of web skills were constructed and validated by
the investigators. Forty students (22 boys & 18 girls) from Findlay Hr. Sec. school, Mannargudi and 40 students (20 boys & 20 girls) from National Hr. Sec. school, Mannargudi were selected for experimental group and control group respectively. Gain score analysis, correlation analysis and t-test were used to analyze the data.

Findings: The experimental group learning through web-based class room instruction method gained more on the achievement test in Mathematics as compared to students of the control group. It is concluded that the web-based class room instruction method is more effective than the conventional method in improving the achievement of students in Mathematics.

**Harish, G. C. (2011).** Conducted study on the impact of integrated critical thinking skills on Achievement in Mathematics of secondary school students.

Objectives: To study the impact of integrated critical thinking skills on achievement in Mathematics. To determine the relationship between the integrated critical thinking skills and achievement in Mathematics with respect to gender. To find out the differences in the integrated critical thinking skills and achievement scores based on gender.

Methods: The randomized pre test, post test control group design was used with a purposive sampling technique. 140 students were selected as sample. ANOVA, ANCOVA and factorial design techniques were used to analyze the data.

Findings: There is significant difference between the post test achievement of control and experimental groups. The study revealed that the package of integrated critical thinking skills has helped the 9th std. students to enhance their academic achievement in Mathematics. This means, package of integrated critical thinking skills has a significant impact on the achievement of 9th std. students in Mathematics.

Objectives: To find out the relationship between Emotional Quotient and academic achievement of boys and girls and to find out the relationship between Spiritual Quotient and academic achievement of boys and girls.

Methods: Descriptive survey method was used. The multistage randomization of cluster technique was used to select 140 students studying in class XI from four schools of district Hoshiarpur as a sample. Seven fold emotional intelligence scale by Khera, Ahuja and sarabjit (2001) and Six fold Spiritual intelligence scale by Khera and Amandeep (2002) were used to collect the data. B-Variate coefficient of correlation and t-test were applied to analyze the data.

Findings: There exists positive and significant relationship between academic achievement and emotional intelligence of boys and girls. There exists positive and significant relationship between academic achievement and spiritual intelligence of boys and girls.


Objectives: To find out the significant relationship, if any, between self-esteem and the academic achievement of biology students at the higher secondary level with reference to background variables.

Methods: Survey method was used. The population of this study was the higher secondary school students studying in Kanyakumari, Tirunelveli and Thoothukudi districts in Tamil Nadu. Stratified random sampling technique was used to select a sample of 925 students. The self-esteem Inventory for adolescents prepared by Karunanidhi (1996) was used. The marks
in biology in their half yearly exams conducted by the school as recorded in the respective school registers were taken as the achievement scores in biology.

Findings: The data was collected and t-test and correlation analysis were applied. It was found that there was significant relationship between self-esteem and academic achievement with reference to background variables. The academic development is attained because of imbibing the values like self-esteeem and hence the presence of self-esteem has positive influence on academic achievement.

**Surinder Kaur, Aruna Sharma. (2011).** Conducted study on the effect of Abacus Technique on Achievement in Mathematics at elementary stage.

Objectives: To study the effectiveness of abacus technique in improving mathematical achievement of 5th grade students.

Methods: Equated group design was used. Random and representative technique was used to select the 120 students as a sample. Intelligent test by J.C. Raven (1958) was used. Pre test and post test were prepared from the tests of selected topic for teaching of Mathematics to 5th grade students. Data was collected and t-test, F test and correlation analysis were applied to the data.

Findings: Results reveal that Mean achievement scores of experimental group and control group for 5th grade and their difference is in favor of experimental group.

**Sutherman, S., and Vasanthi, A. (2011).** Conducted study on Study habits and academic achievement of XI-standard students in Palani Educational district.

Objectives: To study the study habits of higher secondary students and to study the academic achievement of higher secondary students.
Methods: Simple survey method was used. Study habits scale developed and standardized by M. Mukopadhyaya (1982) was used. The investigator collected the Achievement marks of the students from school records.

Findings: Results showed that the means scores of girls’ study habits and their academic achievement are more than boys. This may be due to the hard work and sincerity of girls when compared to boys. The effect of certain factors on the study habits of standard XI students were analyzed and found to be higher.


Objectives: To study the level of multiple intelligence and Academic achievement of the High school students

Methods: The investigator used random sampling technique to select the sample of 240 students from two schools. The tool used was “multiple intelligence inventory” by Howard Gardner. The tool prepared by the investigator deals with six dimensions among the eight dimensions of the multiple intelligence.

Findings: Data was collected and analyzed by t-test. It revealed that there is a significant difference between 9th and 10th High school students in linguistic and mathematical intelligences and there is significant difference between 9th and 10th std. students in their academic achievement.


Objectives: The purpose of this study was to examine the relationship between teacher variables on academic achievement of secondary school students.
Methods: This study collected data from 150 teachers and 450 students of 68 secondary schools in Karnataka State using questionnaires that were composed of background information related to teacher variable tools like Kundu’s Introversion / Extroversion Inventory (1976), Ahluwalias, teacher attitude Inventory(1974) and Deshpande’s students ratings of teaching effectiveness scale (2001) and for Assessment of academic achievement of students it was decided to construct standardized test for students.

Findings: The data was analyzed by ANOVA. It was found that there was significant relationship between Teacher’s personality, Attitude towards profession and Teaching Effectiveness on Academic achievement of the students.

Jeeva, P. (2010). Conducted a study on interest in Mathematical achievement in mathematics of tenth class students in Thanjavur taluk.

Objectives: To find out whether there is significant difference between the variables selected like sex, type of school, gender, socio economic status and the academic achievement in Mathematics of High school students.

Methods: Random sampling technique was used in the selection of sample of 200 tenth class students in Thanjavur taluk. Five schools were selected by lottery method. The tool namely “Mathematical interest inventory” constructed and standardized by L. N. Dubey (1982) and the achievement test constructed by the investigator were used.

Findings: Data was collected and analyzed by t-test and correlation analysis. It was found that there is a significant difference between school level and college level educational fathers of X std. in respect of their achievement in Mathematics and other variables like caste, occupation of parents have no significance difference in respect of their achievement in mathematics.

Objectives: To find out the differences in Mathematics Scholastic achievement test (MSAT) in relation to sex, caste, type of school, nativity and medium of instruction at secondary school level.

Methods: Survey method was used. The tool used was Mathematics Scholastic achievement test constructed by the investigator. Simple random sampling technique was employed in the selection of 480 students from various private and government High schools of Warangal city.

Findings: Data collected was analyzed. It was found that girls’ performance is better than boys; caste has no influence on performance; type of school influences performance; locality influences performance and English medium students perform better than Telugu medium students.


Objectives: To find out the relationship between self-acceptance and academic achievement.

Methods: Survey method was used for the study. The sample for the study constitutes 200 High school students from 4 High and Higher secondary schools of Thiruviyaru Taluk in Thanjavur Educational district, selected at random.

Findings: Data was collected and analyzed by t-test and correlation analysis. It was found that there is association among the High school students in their academic achievement with regard to fathers’ education and there is no significant relationship between self-acceptance and academic achievement among High school students.

Objectives: To find out the relation between Anxiety level and level of academic achievement of IX std. students and to find out relation between level of Self confidence and level of academic achievement of IX std. students.

Methods: Six High school students of Chamrajnagar taluk in Karnataka were selected randomly. Totally 300 students were selected. The tools used were: Self-confidence check list (M.Basavanna); Anxiety scale (Prof. D. N. Srivastasva & Dr. Govind Tiwari) and school records for academic achievement.

Findings: t-test and Pearson’s product moment correlation technique were used to analyze the data. It was found that there was significant correlation between Anxiety and academic achievement and there was significant correlation between self confidence and academic achievement.


Objectives: The main objective was to find out the academic achievement and learning styles of X std. students.

Methods: The survey method was adopted for the study. A sample of 200 X std. students from seven schools of virudhnagar Educational district was selected. A general data sheet and learning style inventory were used as tools.

Findings: Percentage analysis and t-test were the statistical techniques used. The major finding was the level of learning styles and the level of academic achievement of X std. students are average.

Objectives: To find the relationship between study habits and students achievement in relation to socioeconomic status, learning environment, school adjustment and intelligence.

Methods: Stratified purposive random sampling technique was used to select the sample of X std. students from Kendriya vidyalayas, private school, government schools, private aided, and private unaided schools in Bangalore north district. The tools used in the study were: Non verbal test of intelligence by Dr. Premalatha, M. G.; Study habits inventory by Sri Mukhopadhyaya, M.; Socioeconomic status scale by Dr. Puranik, S. D.; The school adjustment inventory by Bhagia, M. N and Learning environment in the family scale by Dr. Parthasarathy.

Findings: Data was analyzed by ANOVA. It was found out that there was significant relationship between study habits and students achievement in relation to socioeconomic status, learning environment, school adjustment and intelligence.


Objectives: To determine the relative contribution of the Mathematical creativity, test-anxiety, attitude towards Mathematics and achievement motivation to the prediction of achievement in Mathematics.

Methods: Using the stratified random sampling technique 800 boys and girls were selected from 20 secondary schools giving due representation to sex, type of management and medium of instruction. Tools used were: Achievement test in Mathematics constructed by the investigator; Mathematical creativity test; (Singh, 1988); Test anxiety scale (Najma, 1977);
Attitude scale to measure attitude towards Mathematics (Sunny, 1987) and Achievement motivation inventory (Mehta, 1969).

Findings: Correlation analysis, t-test and multiple regression analysis were used to analyze the data. It was found that Mathematical creativity and achievement in Mathematics; Attitude towards Mathematics and achievement in Mathematics; Achievement Motivation and achievement in Mathematics are significantly correlated. It was concluded that many factors like mathematical creativity, attitude towards mathematics, achievement motivation and a low level of anxiety influence the academic achievement in mathematics of secondary stage.

**Usha, V. (2008).** Conducted a study on self-concept, adjustment and achievement in Mathematics of pupils with special needs.

Objectives: To assess the level of improvement of pupils with special needs in their achievement in Mathematics and also to see whether their self-concept and school adjustment have come up to the levels of normal pupils under inclusive education.

Methods: Self concept questionnaire (SCQ), School adjustment inventory (SAI) and an Achievement test in Mathematics developed by the investigator have been administered to a random sample of 500 normal and 530 pupils with special needs studying in std. IX, in an inclusive system of education in Kerala.

Findings: Data collected was analyzed by ANOVA. There exists significant difference at 0.01 level in their achievement in mathematics by the interaction of student-type (normal and pupil with special needs).
2.2.2 FOREIGN STUDIES

**Joseph, and Eme, U. (2012).** Conducted study on Psycho – Academic variables and Mathematics Achievement of 9th grade students in Nigeria.

Objectives: The aim of this study was to examine the role of students’ five psycho academic variables in predicting their academic achievement in mathematics.

Methods: Participants included a total of 853 9th grade students (407 males and 446 females) randomly sampled from 20 secondary schools in Akwa Ibom State, Nigeria, who answered a 40-item Mathematics Standardized Test and a Psycho-academic Questionnaire constructed with five variables.

Findings: The results from multiple regression analysis indicated that only students’ study habits and attitude toward school were significant in contributing to mathematics achievement. The other three variables, test anxiety, test wiseness and attitude towards mathematics were not statistically significant at the individual level. The results highlighted the importance of certain psycho-academic variables on predicting mathematics achievement, and suggest the replication of these results across all areas of the curriculum.

**Seibu, Mary, and Jacob. (2012).** Conducted study on Mathematical achievement and critical thinking skills in asynchronous discussion forums.

Objectives: To explore the connection between critical thinking (CT) skills and mathematics scores of students of an engineering mathematics unit two batches of students.

Methods: Mathematical achievement was measured through final examination scores. Initial mathematics ability was measured through an initial test. A correlation analysis was performed between the dependent variable mathematical achievement and the independent variables which were the CAIS model scores, namely, CT1 and CT2. The DF postings
resulting from participation in two online Discussion Forum (DF) problem solving sessions were analyzed for CT skills through CAIS model and a weighted CT score was given to each student.

Findings: In Batch 1, CT1 was found to have no significant correlation with mathematical achievement (r = .131, p = 0.402). But CT2 was significantly correlated with mathematical achievement (r = .324, p= 0.034). In Batch 2, CT1 and CT2 were both correlated with mathematical achievement, with Pearson’s correlation of .517 (p < 0.005) and .644 (p = 0.003) respectively. Significant linear relationship was observed between CT and mathematical achievement. The initial mathematics ability and CT scores showed a significant linear relationship only for one batch of participants. The study concluded that CT skills, when properly encouraged, could result in improvement in mathematical achievement. The mathematical achievement of the students, measured using the final examination scores, was found to be significantly correlated with the CAIS model scores reflecting the CT skills of the students. The students who have exhibited fairly good CT skills have fared well in the final examination too. CT skills, when properly encouraged could result in improvement in mathematical achievement. Thus it is worth investing time to encourage CT skills, which will in turn help to improve the course results and the university stakeholders.


Objectives: To investigate the connection between language (i.e., word comprehension, reading comprehension and spelling skills) and mathematical performance.

Methods: The sample consisted of grade nine students (N = 810) in 14 lower secondary schools in the Swedish speaking areas of Finland. Standardized tests for reading and writing
skills, and mathematical performance were used. Based on the mathematics test the students were categorized into eight performance groups.

Findings: The ANOVA test revealed significant differences between the groups in word comprehension: $F(7, 802) = 56.35, p < .001, \eta^2 = .33$. Post-hoc comparisons using the Scheffe test indicated that there were significant differences in word comprehension tasks between groups 1 and 2, and groups 4–8 ($p < .001$). In addition, in word comprehension tasks group 3 performed worse than groups 6, 7 and 8 ($p < .001$), and groups 4, 5, 6 and 7 performed worse than group 8 ($p < .001$). In reading comprehension tasks there was a significant main effect for group in reading comprehension: $F(7, 802) = 41.95, p < .001, \eta^2 = .27$. Because of unequal variances in the groups post-hoc comparisons were conducted with Tamhane’s test. In reading comprehension tasks group 1 performed worse than all other groups ($p < .008$), groups 2 and 3 performed worse than groups 4–8 ($p < .008$), and groups 4, 5, 6 and 7 performed worse than group 8 ($p < .001$). In spelling tasks there were also significant differences between groups: $F(7, 802) = 19.61, p < .001, \eta^2 = .15$. Tamhane’s test revealed that group 1 performed worse than groups 4–8 ($p < .001$). In spelling tasks group 2 performed worse than groups 6, 7 and 8 ($p < .001$), group 3 performed worse than groups 7 and 8 ($p < .008$), and groups 4 and 5 performed worse than group 8 ($p < .001$). Many students had problems in both mathematics and language performance. On the whole data level reading skills were a powerful predictor for math performance, the reading factor explained 52% of the variance in the model. Hence, the reading skills focusing on understanding of the text are important in solving mathematical tasks at the end of compulsory school.

**Yara. (2009).** Conducted study on students Attitude towards Mathematics and Academic achievement in some selected secondary schools in southwestern Nigeria.
Objectives: To find out the relationship between Students Attitude and Academic achievement in Mathematics.

Methods: The study adopted the descriptive survey design using simple frequency and percentages in analysing the data. 1542 senior secondary two students randomly selected from 2 schools in each of the senatorial districts from the six states in the Southwestern part of Nigeria were used. One instrument (SAT) was used while three research questions were answered in the study.

Findings: The results showed that the students’ attitudes towards mathematics were positive and that many of them believed that mathematics is a worthwhile and necessary subject which can help them in their future career. It is recommended that the teacher should develop positive relationship with students and stress classroom activities that involve active teaching- learning process and students’ participation in the class. Stakeholders should organize periodic seminars and workshops for students, parents and teachers designed to promote positive attitudes towards Mathematics.

2.3 REVIEWS RELATED TO PROBLEM SOLVING ABILITY

2.3.1 INDIAN STUDIES


Objectives: To develop suitable learning materials based on Problem based learning strategy and to find out the correlation between process skills in Biological science and science interest in students taught through problem based learning strategy and to study the effects of the strategy on scientific attitude.
Methods: In the study pre-test-post-test non–equivalent group design and static group comparison design were followed. The tools used were: Raven’s progressive matrices to measure the intelligence, Kulshreshtha’s socioeconomic status scale, test on process skills in Biological science and scale of scientific attitude. The sample consisted of 140 students.

Findings: The significance of difference between Means, Analysis of variance, Pearson product moment correlation and standard error were used for data analysis. Analysis of data showed that Problem-based learning group students attained significantly higher scores than conventional group students for process skills. Process skills in Biological science and scientific attitude were positively correlated and Problem based learning strategy has significant bearing on enhancing scientific attitude.

**Thimothi Samuel Raju Yalla, and Ayodhya, P. (2010).** Conducted study on gender differences in Mathematical Problem- solving.

Objectives: To know the effectiveness of the Conventional method in developing Problem Solving skills among boys and girls and to know the relative effectiveness of the conventional and Polya’s Method in developing problem solving skills among male and female students.

Methods: Non – randomized pre test- post test experimental design was adopted. A sample of 380 ninth class students, drawn from five government schools, was assigned to conventional (192) and Polya’s method (188) groups.

Findings: The results show that the Polya’s method is more effective than the conventional method in developing problem solving skills in both male and female students. The girls made significant gains in the conventional group but there is no significant difference between boys and girls in the group taught by the Polya’s method. There is no significant
difference between boys and girls in implementing the Poly’s four steps of problem solving. The girls were better in devising a plan to solve a problem. The study therefore concluded that different pedagogical strategies equally affect both male and female students.

**Biswajit Behera. (2009).** Conducted study on problem solving skills in Mathematics learning.

Objectives: To investigate cognitive skills in solving mathematical problems of learners at the terminal stage of elementary education.

Methods: Sixty students of class VIII were selected by simple random sampling technique. Contrast group of achievers with equal number of boys and girls constituting higher ability (HA) and lower ability (LA) were selected on the basis of Mathematical ability test result. The mathematical problems were used to assess cognitive skills like knowledge, procedural knowledge, translation of information and mental computation.

Findings: The verbalization of the procedures and strategies of core problems of each student were rated through Coder’s interview schedule to ascertain the cognitive skills. The written works of both core and non-core problems were scored and the differences in performance of the two types of problems were analyzed using ANOVA and t-test. It revealed that HA groups were superior to LA groups irrespective of sex. The higher performance of high achievers over the low achievers in both core and non-core problems revealed that those who can verbalize the process of solution are better at solving problems.

**Madhavi Latha, M. (2008).** Conducted study on creating opportunities for improving problem solving skills in infants with developmental delays.

Objectives: Aims at emphasizing improving problem solving skills in children with developmental delays by designing a model called as Problem solving Interactive model.
Methods: The model was tested on 45 children with developmental delays. The efficacy of the Problem Solving Interactive Model (PSIM) was determined from Mental Age (MA), Mental Development Index (MDI) and Deviation Mental Quotient (DMeQ) derived from Bayleys Scale of Infant Development.

Findings: The pre and post test differences on all the intervention outcome indicators were highly significant in experimental group MA (t=5.70), MDI (t=4.099), Dmeq (t=2.64) and Battery of Problem Solving Tasks (t=27.93), indicating the efficacy of the Problem Solving Interactive Model. The variations in intervention outcomes with respect to chronological age of infants and toddlers with developmental delays showed that children in age group of 24-33 months showed the highest rate of gain of 0.99 in experimental group and 0.76 in control group. Lowest rate of gain of 0.77 and 0.24 in experimental and control group was seen in children from 4-13 months chronological age. This variation in intervention outcomes indicate the need to plan and implement specialized early interventions targeting specific child characteristics.


Objectives: Explores whether intuition is a form of higher mental ability or is something separate form it. The relationship between intuition, higher mental ability and creative problem solving has been explored.

Methods: Factor analysis was carried out to find the underlying factors. The test used are Goldberg’s test of intuition, Passi Usha test of creative problem solving, Sansanwal and Joshi’s test of higher mental ability.

Findings: The results show that intuition and mental ability are not related to each other.

Objectives: Examines whether visual imagery facilitated problems solving and how the extent to which participants’ ratings about usefulness of imagery differed for solved and unsolved problems.

Methods: Two studies were conducted. Study I showed that compared to the control group, the experimental group (which had received imagery instructions and practice trials on image generation) solved greater number of problems and gave higher ratings of imagery usefulness for solved as against unsolved problem. Study II showed higher imagery usefulness ratings for solved problems.

Findings: Results revealed that meeting with success resulted in a positive affect. It is argued that, in general, affective states generated by success and failures influence the usefulness ratings of imagery in solving problems.

2.3.2 FOREIGN STUDIES

Guven, B., and Cabakcor, B. O. (2013). Conducted study on Factors influencing mathematical Problem solving achievement of seventh grade Turkish students.

Objectives: In this study, the influence of seventh-grade students’ affective factors, their academic success, their gender and their families’ educational levels on their problem-solving achievement was examined.

Methods: To achieve this aim, problem solving attitude scale, Mathematics and problem solving belief scale, Mathematics anxiety scale, a Self-efficacy Perception for Mathematics Scale and a Problem-Solving Achievement test, which were developed according to the literature and the opinions of experts, were applied to one hundred fifteen seventh-grade
students. The data was analyzed using the correlation method. The direct and indirect factors affecting problem-solving achievement were examined.

Findings: In the results, a highly significant relationship between academic successes and problem-solving achievements was found, while a moderately significant relationship between students’ problem-solving attitudes, problem-solving beliefs, mathematics anxiety and self-efficacy perception for mathematics factors and their problem-solving achievements was observed. No significant relationship between the indirect factors and problem-solving achievements was found.


Objectives: To examine Meta cognition in collaborative problem-solving processes, that is, to identify and to investigate how Meta cognition appears as a socially shared phenomenon within collaborative mathematical word-problem solving processes of dyads of high-achieving pupils.

Methods: Four dyads solved problems of different difficulty levels. The pupils were 10 years old. The problem-solving activities were videotaped and transcribed in terms of verbal and nonverbal behaviours as well as of turns taken in communication (N ¼ 14 675).

Findings: Episodes of socially shared Meta cognition were identified and their function and focus analyzed. There were significantly more and longer episodes of socially shared Meta cognition in difficult as compared to moderately difficult and easy problems.
Azizah Ahmada, Rohani Ahmad Tarmizia, and Mokhtar Nawawia. (2010). Conducted study on Visual Representations in Mathematical Word Problem Solving among Form Four Students in Malacca.

Objectives: To identify the level of achievement of mathematical word problem solving and the students’ representations or visualization of the problems in the process of deriving solutions and to examine the use of visual representations which posed great difficulties in most mathematical tasks.

Methods: The subjects of study were from eight different schools (second cluster) in Melaka chosen from three different districts (first cluster) in Melaka, namely Jasin, Melaka Tengah and Alor Gajah. 381 students took part in this research using the multi-stage cluster sampling. Secondary students were given the 15 Mathematical Processing Instrument (MPI) adapted from Hegarty and Kozhevnikov (1999). Forty-five minutes were given to the students to answer the questions (with the maximum of 3 min per question). The students’ responses were analyzed.

Findings: Results indicated that less than two percent of the problems were solved using pictorial representation and most of the students preferred to use schematics solutions. Generally, findings indicated that students preference in solving the word problems were mixed or in combination form. This also suggest that, students normally choose any strategy that the easiest and less time consuming to solve the problem without prior analyzing the problems visually.

Objectives: To assess the role of meta-cognitive skills in mathematical problems solving (example of combinatorics).

Methods: In this study, one group of college students with thirty four members which had enrolled in discrete mathematics participated in this study. Participants in this study involved sixteen girls and eighteen boys. Mixed methodology (writing and self-questionnaire) was used which do not share the same source of error to provide a more reliable picture of the phenomena under investigation. In this research the students were asked to write their total mental processes in forty five minutes time during solving the two discrete mathematics problems. Immediately after solving the problems, the students were given a questionnaire to answer the questions accordingly to their mental processes during solving the second problem. The Problem solving protocols were initially analyzed using Foong’s model. Analyses of Variance design utilized to show the difference of meta-cognitive behaviours between three groups in first and second problems.

Findings: Eleven Students solved both problems correct (successful students), fourteen Students solved only first problem correct, nine Students failed in both problems (unsuccessful students). The student’s written descriptions about their thinking processes during solving problems divided into segments of behaviours. Each segment was then classified and encoded according to Foong’s taxonomy. The results showed, first, the mean difference of successful student’s Meta cognitive behaviors was significant in solving both problems compare to unsuccessful students at the 0.05 level, (F[2, 31]=34.015, p<0.05), (F[2,31]=65.764, p<0.05). And second, Meta-cognitive skills active on non-routine problems. One of the important results of this study was about student’s difficulties. The most prevalent of student’s difficulties in combinatorics problem solving as follow: 1) Inability to understand the problem exactly, 2) Inability to adapt the prior problems to task and subsequently choosing the wrong strategy for solving the problem, 3) Not having prior suitable information
and inability to recall the formulae, 4) Inability to be sure of the correctness of their find answers. Another remarkable result in this study was existence of a meta-cognitive framework in student’s writing. The comparison of student’s meta-cognitive behaviours shows that students with higher levels of meta-cognitive ability perform better in problem solving tasks.

Ismail, Hj, and Raduan. (2010). Conducted study on error analysis and the corresponding cognitive activities committed by year five primary students in solving mathematical word problems.

Objectives: To identify errors and the corresponding cognitive activities committed by the 374 year five primary school students in solving the mathematical word problems for the ‘Fraction’ topic.

Methods: This study combined both quantitative and the qualitative approaches. The quantitative data is analyzed descriptively based on percentage. The cognitive activities were synthesized from the qualitative data. The design of this study used Newman Error Analysis method and interviews. Data was collected from the document analysis procedures, interviews and checklist.

Findings: It showed that 52.91% of the errors made were due to lack of understanding, followed by transformation skills (22.37%), process skills (15.55%), encoding (8.84%) and reading (0.34 Based on these findings, the researchers proposed that teachers should ask students explicitly what problems they have in solving the mathematical word problems, observe students reactions and analyze errors committed by them.

Objectives: To determine the usage of self-regulated strategies among the students and how it helps the students in solving Mathematics’ problems. Besides that, the level of motivation among the students is also identified.

Methods: The sample included 249 students of Science Stream Form Four students. The students were randomly selected from four government secondary schools in Kinta Utara District, Perak. Data has been collected through Motivated Learning Strategies Questionnaire- Revised (MSLQ-R), reviewing of written answers of students (tests) and interviews. The students were given a test on Mathematical problem-solving. The test consists of nine items from three topics that are “Trigonometry”, “The Straight Line” and “Circles III”. Each items required certain skills, hence certain strategies should be applicable. The collected data was analyzed with Statistical Package for Social Science (SPSS), where the data was interpreted as descriptive and inferential statistics.

Findings: The research revealed the level of motivation and the existence of self-regulated learning strategies among the students. This research has shown that there is a strong relationship between the self regulated learning strategies and the students’ performance of problem-solving. The ability of students to solve the Mathematics’ problems showed that they had their own learning strategies. The result shows that there is a significant relationship between motivation and learning strategies. Hence, if the students’ motivation is high, then the students’ learning strategies are also high. However, the relationship of two variables is weak. The correlation is significant at probability value, p < 0.01. Findings show that the students’ skills in mathematical problem-solving are medium. The findings show that the
students gave positive responses towards motivation. Hence, the students have a high motivation in Mathematics’ learning especially in terms of intrinsic goal orientation, extrinsic goal orientation, control of learning belief and self efficacy for learning and performance; whereas the students have medium motivation in the aspects of task value and test anxiety. The results explained that the medium usage of learning strategies among the students lead to medium skills in solving Mathematics’ problems.

**Nedime Karasel, Orçun Ayda, and Murat Tezer. (2010).** Conducted study on the relationship between mathematics anxiety and mathematical problem solving skills among primary school students.

Objectives: To study the relationship between “mathematics anxiety” and “mathematical problem solving skills”.

Methods: In this study students studying in 9 different primary schools that joint to the Ministry of Education and Culture (MEC) in North Cyprus were taken into hand. The study group consists of 134 students studying in 9 different primary schools in the Turkish Republic of North Cyprus (TRNC) between 2009-2010 academic year. In this study, two different data collective measuring scales were administered. The first measuring scale was used to measure the “mathematical problem solving skills” which was formed of two sections. The first section consisted of 9 questions for demographic information and the other section consisted of 28 statements in a form of a 4-point likert scale to measure the problem solving skills. In order to collect data for the student mathematics anxiety 45 statements in a form of a 4-point likert scale was only used.

Findings: The measuring scales used to evaluate the values in this study are correlation together with SPSS17 Windows program. As a result of the study, there is a minor significant difference ($r=-0.28; p=0.01$) between the relationship of students mathematic anxiety points
and mathematical problem solving skill and are negative, though it shows a low level of relationship.


Objectives: To determine Filipino college students’ (n=336) positive and negative beliefs about mathematics and mathematical problem solving. The study was also aimed at analyzing possible significant differences in mathematics related beliefs related to gender, year level, and field of specialization.

Methods: Three hundred thirty six (336) students from a comprehensive university in the capital city of Manila, Philippines were randomly selected in the study. 36-item (six scales) self-report questionnaire was administered through stratified random sampling. Correlations, t tests and multiple analyses of variance were used for analysis.

Findings: Results showed positive beliefs that Filipino students valued effort in increasing one’s mathematical ability and considered mathematics as useful in their daily lives. On the contrary, Filipino students believed that all word problems can be solved by simple step by step procedure and word problems are not important. Statistical tests revealed that gender difference in positive beliefs that effort can increase mathematical ability and in the usefulness of mathematics is significant. This gender difference in the beliefs mentioned reflected also in all year levels and in various field of specializations. There were statistically significant inter correlations between several scales. The higher correlation was between belief that not all word problems can be solved by simple step by step procedures and belief that effort can increase mathematical ability (r = 0.90) and between belief that not all word problems can be solved by simple step by step procedures and belief in the usefulness of
mathematics (r = 0.88). Analysis of variance among six belief scales was significant [F (9, 30) =13.21, P<.01]. The results showed that how Filipino students valued mathematics and effort.


Objectives: To assess the cognitive strategies and Algebra problems solving performance among university students.

Methods: The design adopted for this study was a descriptive correlation design. The subjects of this study were selected from First Year mathematics students who took Algebra course in a public university in Malaysia. The Cognitive Strategy Questionnaire, which comprised of 18 items, was used to assess the students’ specific cognitive strategy for solving the given Algebra problems. Algebra problem solving performance was measured using a test which included routine and non-routine problems, based on the topics covered in the course.

Findings: The results showed that there is no significant correlation between Algebra problem solving performance with shallow cognition strategy (r = -.134, p>0.05). Similarly, there is no significant relationship between the students’ performance with deep cognitive strategy (r = .124, p>0.05). Results also showed that there is significant and strong relationship between students’ Algebra problem solving performance and overall performance in the course (r = .721, p<0.05). Findings also revealed that there was positive and moderate significant correlation between overall meta-cognitive strategies and performance of Algebra problem solving (r = 0.394, p<0.05). In addition, there was a significant positive and moderate relationship between overall meta-cognitive strategies with overall performance in the course (r = .390, p<0.05). Specifically, there is significant relationship between overall performance
in the course and all three subscales of meta-cognition (knowledge, planning and evaluation).

In conclusion, meta-cognitive strategies may have impact on mathematical performance among university students whilst cognitive strategies indicated minimal impact.

**Seher Avcu, and Ramazan Avcu. (2010).** Conducted study on pre-service elementary mathematics teachers’ use of strategies in mathematical problem solving.

Objectives: The purpose of this study was to examine pre-service elementary mathematics teachers’ strategies used in mathematical problem solving and to collect data about pre-service elementary mathematics teachers’ problem solving strategies.

Methods: Survey study design was used. Problem solving test which was developed by Arslan (2002) was used as a measuring instrument. There were ten open ended items in the test and each item check whether specific problem solving strategies were used or not. Participants’ performances were graded dichotomously and the strategies that students used to solve problem correctly were determined. The test was administered to 93 pre-service elementary mathematics teachers studying at Aksaray University in elementary mathematics education department. In sample choice, convenience sampling method was used. In this study, descriptive statistics was used. The demographic information was analyzed by using frequencies and percentages.

Findings: The results of the study revealed that pre-service elementary mathematics teachers have capability to use problem solving strategies and to solve problems; however the use of different strategies is rather limited. The results showed that students used making a drawing (18%), organizing data (15%), logical reasoning (5%) and working backwards strategy (3%). However, 59% of the students were not able to solve this item correctly. The results show more than half of the students were not able to use problem solving strategies.

Objectives: To discuss the major mathematics skills and cognitive abilities in learning that caused the difficulties in mathematics problems-solving among students from students’ point of view.

Methods: The study was carried out on three focused group samples that were selected through purposeful sampling. 107 students aged 14 years old were selected from Negeri Sembilan, Malaysia for the study A mixed qualitative and quantitative approach is used in order to have clearer understanding. Questionnaire consist of three section; section A- on demography; section B- related to mathematics skills; and section C- related to cognitive ability of learning (Garnett 1998; Stendall 2009) was given to the students. Apart from the questionnaire given, focused group interviews were carried out. Interviews were recorded and transcribed. Data finding was analyzed descriptively.

Findings: Data findings showed that respondents lacked in many mathematics skills such as number-fact, visual-spatial and information skills. Information skill was the most critical. The deficiency of these mathematics skills and also of cognitive abilities in learning inhibits the mathematics problem-solving. This understanding on how the deficits influenced the problem-solving is expected to give effective guide lines in preparing diagnostic instruments and learning modules in order to develop the mathematics skills. This study implies that, students’ difficulties in problem-solving might occur at any phases. In fact it might be caused by a deficiency in any of the skills either independently or cumulatively. The understanding of the difficulties faced by students in any particular area and phase is the strategy to respond to this issue.
**Ziqiang Xin, and Li Zhang. (2009).** Conducted study on cognitive holding power, fluid intelligence, and mathematical achievement as predictors of children's realistic problem solving.

Objectives: To explore whether first and second order cognitive holding power perceived by children in mathematical classrooms, fluid intelligence, and mathematical achievement predicted their performance on standard problems, and especially realistic problems.

Methods: A sample of 119 Chinese 4–6th graders were administered the word problem test, the cognitive holding power questionnaire, and Raven's standard progressive matrices.

Findings: Results showed that: (1) children's fluid intelligence and general mathematical achievement significantly predicted their performance on both realistic and standard problems, however, second order cognitive holding power predicted their performance on realistic problems but not standard problems; (2) the relationship between first order cognitive holding power and children's correct answers to realistic problems was mediated by second order cognitive holding power; (3) children's performance on standard problems was significantly better than that on realistic problems, and children's performance on both types of problems improved with their grades.


Objectives: To investigated the influence of self-efficacy beliefs and working memory capacity on mathematical problem-solving performance, response time, and efficiency (i.e., the ratio of problems solved correctly to time).
Methods: Students completed a letter-recoding task (Experiment 1) or an operation span task (Experiment 2), rated their self-efficacy for solving mental multiplication problems, and then solved similar problems of varying complexity.

Findings: Motivational efficiency hypothesis was tested, which predicted that motivational beliefs, such as self-efficacy, increase problem-solving efficiency through focused effort and strategy use. Experiments 1 and 2 reported a significant effect for self-efficacy on problem-solving performance and efficiency, but limited effects for time. A self-efficacy by working memory interaction occurred in Experiment 1, suggesting self-efficacy is beneficial as demands on working memory increase. These findings suggested that self-efficacy increased problem-solving efficiency through strategic performance rather than faster solution times, and were consistent with the motivational efficiency hypothesis.


Objectives: To investigate the effects of type of question prompt and level of prior knowledge on non-routine mathematical problem solving.

Methods: A computer game was blended within the pattern reasoning tasks, along with question prompts, in order to demonstrate and enhance the connections between viable problem-solving strategies and the content knowledge in a visible manner. Seventy-eight 9th graders from two classes in a public junior high school in northern Taiwan participated in the 6-week experimental instruction. Participants were randomly assigned to the specific-prompt group and the general-prompt group to receive the one-hour weekly treatment. Multivariate analysis of covariance (MANCOVA) was employed to examine the effects of question prompts and prior knowledge on non-routine problem-solving performances (reasoning for
one variable and reasoning for two variables) with the continuous-scaled comprehensive mathematical ability (CMA) as the covariate.

Findings: The results revealed that (a) the interaction of question prompts and prior knowledge was not significant, and (b) for the problem-solving performances, the specific-prompt group outperformed the general-prompt group and the high prior-knowledge group outperformed the low prior-knowledge group. Further, students receiving specific prompts outperformed those receiving general prompts in the problem-solving performance: reasoning for two variables. Students with high prior knowledge outperformed those with low prior knowledge in the two problem-solving performances: reasoning for one variable and reasoning for two variables. It was also found that prior knowledge and comprehensive mathematical ability were important predictors for the two problem solving performances: reasoning for one variable and reasoning for two variables. However question prompts and mathematics attitude were not significant predictors for predicting the problem-solving performance of reasoning for one variable. In general, students got higher scores in reasoning for one variable (M = 6.80, SD = .39) than reasoning for two variables (M = 5.32, SD = .56). Thus Task 2 is more difficult than Task 1. Further, students with high prior knowledge got higher scores in the two problem-solving performances of reasoning for one variable (M = 8.70, SD = .59) and reasoning for two variables (M = 6.61, SD = .62) than those with low prior knowledge did (M = 4.99, SD = .57; M = 3.89, SD = .80). Students receiving specific prompts got higher scores in the problem-solving performances of reasoning for two variables (M = 7.07, SD=.72) than those receiving general prompts did (M = 3.42, SD = .73). Although students in the specific-prompt group had higher scores in the problem-solving performance of reasoning for one variable (M = 7.22, SD = .51) than those in the general-prompt group (M = 6.65, SD = .52), between the means of both groups was very small.

Objectives: The purpose was to do a fine-grained analysis of students’ problem solving and the features of the applet that they utilized during their work. The problem used in this study is designed with an accompanying java applet to give students access to different possible solution strategies and representations for making sense of the problem. Although students can solve this problem using manipulative or paper-and-pencil, the intent of using the problem situation and applet is to allow students to enact different strategies and solution paths beyond a numerical or symbolic approach.

Methods: The data for the current project were collected as part of a larger study on pre service teachers’ learning to facilitate students’ problem solving of the Fish Farm problem (Lee, 2005). Each pre service teacher worked with a pair of eighth grade students (13–14-year-old) from below average ability “Math 8” classes (not algebra or pre-algebra) that include students from diverse backgrounds. The pre service teachers were juniors in an undergraduate secondary mathematics education class focused on learning to teach mathematics with technology. The pre service teachers and students were videotaped so as to capture the computer screen (PC-to-TV converter) as well as social interactions (webcam).

Findings: The findings are organized into two parts. The first part discusses the types of problem solving goals students employed and whether or not they made explicit use of a technological feature to pursue that type of goal. The second part is a more detailed analysis of the ways in which the different types of technological features supported students’ work toward their various problem solving goals. In our analysis, we examined the ways in which features in the applet supported students’ problem solving. The students had many instances of using various features to pursue implementation goals, with 85% of those instances being
supportive. The findings suggest that the features provided in the applet were appropriate for helping students implement a variety of heuristics.


Objectives: This study proposes a computer-assisted system named Math CAL, whose design is based on four problem-solving stages: (1) understanding the problem, (2) making a plan, (3) executing the plan and (4) reviewing the solution. The purpose is to improve student problem-solving skills in each stage.

Methods: We selected 49 students who met these criteria as participants in this study. Twenty-five of them were placed in the control group, practicing mathematical problem solving using the written method, and the other 24 students were placed in the experimental group using the computer-assisted problem-solving system. This study used a two-way mixed design. The between-group independent variable was group (or treatment), dichotomized into ‘‘not using the computer-assisted problem-solving system’’ (control group) and ‘‘using the computer-assisted problem-solving system’’ (experimental group). Participants are randomly assigned to two groups. The within-group independent variable is test, dichotomized into pre- and post-tests. The dependent variable was students’ scores in mathematical problem-solving pre- and post-tests. This experiment used a fifth-grade mathematics textbook, from which we selected problems from six units, namely ‘‘the addition and subtraction of real fractions,’’ ‘‘the multiplication of fractions,’’ ‘‘pi, sectors and capacity,’’ ‘‘the area of triangles,’’ ‘‘unit cost and vertical planes’’ and ‘‘the area of a trapezium’’. Related problems were collected, revised and compiled into a database of 80 problems as listed in for practicing with the Math CAL system.
Findings: The means and standard deviations of students’ scores of the mathematical problem-solving tests are listed. We conducted a two-way mixed design analysis of variance (ANOVA) on the pre- and post-test scores in the experimental and control groups. A significance level of 0.05 was adopted throughout the study. Bartlett’s homogeneity test was conducted and showed that the variances of the two groups were not heterogeneous (p > 0.05), from which we concluded that the variances were homogeneous. The results of ANOVA on the students mathematical problem-solving tests showed that the group factor was significant (F(1,47) = 5.91, p < 0.05), indicating possible differences in the scores between the two groups. The test factor was significant (F(1,47) = 4.22, p < 0.05), indicating that the pre- and post-test scores might be different. The interaction between groups and tests was also significant (F(1,47) = 4.22, p < 0.05), which indicated that the magnitude of differences varied with level. The simple main-effect analysis showed that there was a statistically significant difference between the two groups in the mathematical problem-solving post-test (F(1,94) = 7.54, p < 0.05) but not in the pre-test (F(1,94) = 2.89, p > 0.05). We could therefore conclude that at the post-test, the problem-solving ability in the experimental group (M = 9.18, SD = 2.72) was significantly better than that in the control group (M = 7.02, SD = 2.80). The simple-main effect comparison between pre- and post-tests revealed a significant difference in the experimental group (F(1,47) = 14.71, p < 0.05, M = 7.75, SD = 2.30 and M = 9.18, SD = 2.72 for the pre- and post-tests, respectively) but not in the control group (F(1,47) = 0.96, p > 0.05, M = 6.66, SD = 2.40 and M = 7.02, SD = 2.80 for the pre- and post-tests, respectively), indicating that the training had resulted in significant progress only in the experimental group. The empirical results showed that even though the experimental group practiced with about half as many problems as the control group, the intervention of a computer-assisted problem-solving system improved students’ problem-solving ability.

Objectives: To develop a web-based multimedia whiteboard system to help students learning with mathematical problem solving. The purpose is to promote a new online mathematical learning model that students not only use electronic whiteboard to write down their mathematical problem solving solutions but also use voice recording tool to give oral explanations about their thinking behind the solutions. To cultivate students'-critical thinking capability and encourage collaborative peer learning, the new learning model also requests students to criticize others'-solutions and reply to others'-arguments.

Methods: With the multimedia supporting tools, students can communicate easily with each other about what they think and how they solve mathematical problems. An experiment was conducted with 38 sixth grade primary school students for evaluation. After the experiment, a questionnaire about students’ attitude towards the multimedia whiteboard system for math learning was then held.

Findings: The collected data will be used to investigate the relationships among learning achievement and gender through statistical analysis. The results show that students were satisfied with the use of the multimedia whiteboard system for helping them with learning fractional division. Most students were interested in studying mathematics with the multimedia whiteboard system and thought this tool is particularly useful for doing collaborative learning. After analyzing the recorded solving processes, it was found that the performance of female students was superior to male. Moreover students in the higher achievement group perform better in the mathematical abilities of critique, judgments and explanations than those in the lower achievement group.

Objectives: To understand the functioning of the task-specific or micro meta-cognitive skills on mathematical problem solving and to investigate whether boys differ in meta-cognitive macro evaluations and performance calibrations from girls.

Methods: This paper focuses on the role of evaluation in mathematics in 749 elementary school students. The macro evaluative skills and calibration scores of high versus low mathematical problem solvers were contrasted as measures of meta cognition. To investigate the relationship between the mathematical problem-solving competence, macro evaluation and calibration, Pearson correlations were computed on all subjects (n ¼ 749). To look for age and gender related differences on mathematics, Univariate Analysis of Variance (ANOVA) was conducted on the total sample (n ¼ 749) with mathematics performance (on the CDR) as dependent variable and grade (grade 2, grade 3 and grade 4) and gender (boys, girls) as independent factors.

Findings: A significant relationship between mathematical problem-solving competence and macro evaluation (r ¼ 0.17, p < 0.01) and between mathematical problem-solving competence and calibration (r ¼ 0.27, p < 0.0005) was found. In addition a significant, but negative, relationship was found between the macro evaluations and the calibrations (r½= 0.68, p < 0.0005). No relevant calibration differences were found for gender. In addition, the performances of children with mathematics learning disabilities could not be explained according to the maturational lag hypothesis. Finally, although macro meta-cognitive evaluation and calibration seem attractive alternatives for time-consuming on-line meta-cognitive assessment techniques, our data show that a global and retrospective assessment of
the macro evaluation is not always enough to get the picture of mathematical problem solving in young children.

**Kai Fai Ho, John, G., and Hedberg. (2005).** Conducted study on Teachers’ pedagogies and their impact on students’ mathematical problem solving.

Objectives: To explore the teachers’ pedagogical experimentation in their teaching of mathematical problem solving.

Methods: Using a video-coding scheme, a series of lessons was coded into relevant phases comprising problem solving, teaching concepts/skills, going over assigned work, and student activities. The classroom practices of three teachers teaching mathematics at the 5th grade level in three Singapore schools were examined. Following the collection of a systematic, evidence base describing current mathematics instruction practices, an intervention was designed to raise the teachers’ awareness of MPS ideas and processes and to support an increased emphasis on the centrality of problem solving in the Singapore Mathematics Program.

Findings: For the question of whether there had been an increase in students’ problem solving successes, a quantitative approach was used. Repeated paired-sample *t* tests of students’ responses in the pre- and post-tests are used to test for significant performance differences. The results suggest that the teachers had at least started to question their own views about problem solving and how it can be emphasized in their mathematics teaching. After an analysis of their current practices, it concludes with a review of the effects such changes have on students’ problem solving successes as reflected in pre- and post-problem-solving tests. Statistically there were significant improvements in students’ learning. Results suggest that with an emphasis on meta-cognitive strategies and working with an explicit planning approach, students can change their approach and experience greater success.

Objectives: To examine the solver’s mathematical exploration across a pair of open-ended tasks, the Billiard Ball and Number Array tasks.

Methods: The subjects of the study were two secondary mathematics education majors, one a student in the junior year (Gavin) and the other a graduate student in the Masters Program (Sarah). Students were interviewed and videotaped as they solved a pair of open-ended mathematics problems: the Billiard Ball task and the Number Array task. The students worked individually as they solved the problems and were given as much time as they wished to complete each task.

Findings: The data used in the analysis consisted of the videotaped protocols, the researchers’ field notes, and the subjects’ written work. Written transcriptions of the videotapes were generated and verbal protocol analytic techniques were used in the analysis. Individual differences in problem posing in the Billiard Ball task did not appear to be overly significant. The solvers were able to explore and develop greater range of mathematical relationships for the Number Array task than for the Billiard Ball task.

**Carol, M., and Lerch. (2004).** Conducted study on control decisions and personal beliefs: their effect on solving mathematical problems.

Objectives: To discuss how college students enrolled in a college level elementary algebra course exercised control decisions while working on routine and non-routine problems, and how their personal belief systems shaped those control decisions. To prepare students for success in mathematics and to understand the process steps the students use to solve homework or examination questions, in other words, understand how they “do” mathematics.
Methods: Thirty-two finished the course with 24 passing. Of those who finished the semester, 17 were male and 15 were female, with an average age of 23 years. Observations and field notes enhanced the recollections and provided the final source of information used in this study.

Findings: This study suggests that an individual’s belief system impacts how they approach a problem. Lack of confidence and previous lack of success combined to prompt swift decisions to stop working. Further findings indicate that students continue with unsuccessful strategies when working on unfamiliar problems due to a perceived dependence of solution strategies to specific problem types. Students presented with unfamiliar mathematics problems do not rely on a mathematics process model to guide their solutions.


Objectives: To assess the extent to which problem solving skills can be enhanced through the use of an intelligent computer-assisted program and to explore the impact of the guiding principles. This paper evaluates the effectiveness of two interactive computer programs for high school mathematics problem solving. Both programs, present students with problems accompanied by instruction on domain-specific knowledge required in different episodes of problem solving. The first program is based on a direct instructional approach to learning, the second on a constructivist view of learning. The latter approach is expected to be particularly beneficial to weak students.

Methods: The experiment was carried out in 2001 and involved 13 classes of students in the fourth level of Dutch secondary education. The target group was the population of students from classes of pre-university students aged 15–17. The effectiveness of both computer programs was evaluated by means of an experiment. Four classes worked with the
constructivist based computer program, and four worked with the direct instructional program. Five classes that had received traditional mathematics education served as the control group. The computer programs were used in three periods of two consecutive weeks each. Descriptive statistics were calculated for the use of hints in the computer program. The extent to which students’ problem-solving behavior improved was evaluated by means of multi level analysis models of variance. The dependent variables included the total test scores and test scores for analysis, planning and checking.

Findings: The results show that both computer programs improved problem-solving ability more strongly than had traditional mathematics instruction. Contrary to our expectations, both weak and skilled students benefited equally from both computer programs. Specifically, the programs helped the students to improve the quality of their analysis and verification skills during problem solving. Almost all students took part in a pre- and post-test. A few students in each condition missed one of the tests. The pre-test consisted of five context problems that could be solved using mathematics. The post-test consisted of five comparable problems. The reliability of the pre-test was α = 0.66. The reliability of the post-test was α = 0.64. The correlation between the pre-test and the post-test was 0.64. The pre-test scores of students in the various groups did not differ for analytical or verification activities during problem solving. The scores on the solution plan were somewhat lower in the control group. Comparison of the total scores of all three groups shows that the groups did not differ significantly from each other (F(2,12) = 2.11; p = 0.14). All effects were significant, with the exception of gender. Students who had used either the DI or the CGI program outperformed students in the control condition in all episodes. The largest effect was in the analysis episode. Students seem to have learned to analyze problems better. The CGI program did a better job enhancing analytical behavior and the selection of correct solution approaches than did the DI program.
Conducted study on the effects of individually personalized computer-based instructional program on solving mathematics problems.

Objectives: To investigate the effects of an individually personalized computer-based instructional program on the achievement and attitudes regarding mathematics computational problems and word problems.

Methods: 104 sixth to eighth grade middle school American students were taken for study. Students were blocked by math entering knowledge based on pre-test scores, then randomly assigned to a personalized or non-personalized version of the computer-based instructional program. The computer-based instructional program for this study was designed and developed by the authors using Macromedia Author ware software. Two parallel versions of a computerized instructional program (personalized and non-personalized) were developed for solving two-step word problems involving four different combinations of multiplication and division operations (multiply–multiply, multiply–divide, divide–multiply, divide–divide) using whole numbers. The 22-item student favorites survey was used to determine the personal backgrounds and interests of the students.

Findings: For math entering knowledge level, students with higher-level math entering knowledge significantly outscored students with lower-level math entering knowledge $M = 23.62$ and $M = 16.30$, respectively, $F(1, 100) = 48.82$, $MSE = 1394.51$, $p < .05$. For personalization level, the mean scores correct were 20.98 for the personalized subjects and 18.94 for the non-personalized subjects, $F(1, 100) = 3.79$, $MSE = 108.27$, $p = .054$. A significant two way interaction (treatment by math entering knowledge) reflected that personalized higher level math entering knowledge students and non-personalized higher-level math entering knowledge students had similar post-test scores but personalized lower-
level math entering knowledge students scored significantly higher on the post-test than non-personalized lower-level math entering knowledge students. Another significant two-way interaction (math entering knowledge by problem type) reflected that students with higher-level math entering knowledge scored considerably higher on the computational problems than on the word problems while students with lower-level math entering knowledge scored significantly higher.


Objectives: Identify to which U.S. and Chinese students’ selection of solution strategies and representations is related to their opportunity to learn algebra and to examine the impact of teachers’ beliefs on their students’ thinking through analyzing U.S. and Chinese teachers’ scoring of student responses.

Methods: The U.S. sample consists of 115 6th grade, 109 7th grade, and 110 8th grade students from four typical suburban schools in the Pittsburgh Metropolitan area. The Chinese sample consists of 196 4th grade, 213 5th grade, and 200 6th grade students from Jishou City, Wunan Province. The same number of the classes was tested in U.S. and China, but the Chinese sample has twice as many students because of the difference in class size between the United States and China. For both samples, there are similar numbers of male and female students in each grade level. Each student response to each task was analyzed for correctness of answers and use of solution strategies and representations. To ensure high reliability in the data analysis, 60 student responses were randomly selected (10 responses from each grade level in each nation) and were independently coded by two raters.
Findings: The results of the first study showed that, for the U.S. sample, students who have formally learned algebraic concepts are as likely to use visual representations as those who have not formally learned algebraic concepts in their problem solving. For the Chinese sample, students rarely used visual representations whether or not they had formally learned algebraic concepts. The findings of the second study clearly showed that U.S. and Chinese teachers view students’ responses involving concrete strategies and visual representations differently. For both samples, the higher the students’ grade level, the higher the percentage of students giving the correct answer for the problem. Similarly, as the grade level rises, a higher percentage of students show evidence of using appropriate solution strategies. Chi-square tests showed significant differences across the three grade levels for the solution strategies used by both the Chinese sample ($\chi^2(4, N = 490) = 25, P < .001$) and the U.S. sample ($\chi^2(4, N = 260) = 26.04, P < .001$). For students’ use of solution representations, chi-square tests also showed significant differences across the three grade levels for both the Chinese sample ($\chi^2(6, N = 567) = 25, P < .001$) and the U.S. sample ($\chi^2(6, N = 260) = 39.08, P < .001$). The research reported in this paper contributed to our understanding of the differences between U.S. and Chinese students’ mathematical thinking. Moreover, although both U.S. and Chinese teachers value responses involving more generalized strategies and symbolic representations equally high, Chinese teachers expect 6th graders to use the generalized strategies to solve problems while U.S. teachers do not. This research also established the feasibility of using teachers’ scoring of student responses as an alternative and effective way of examining teachers’ beliefs.

Objectives: To examine US and Chinese 6th grade students’ generalization skills in solving pattern-based problems, their generative thinking in problem posing, and the relationships between students’ performance on problem solving and problem posing tasks.

Methods: A total of 98 US and 155 Chinese 6th grade students participated in the study. The US sample was drawn from four public schools in suburban Pittsburgh. The Chinese sample was drawn from four schools in Guiyang City, Guizhou Province. Three pairs of problem solving and problem posing tasks were used in this study. Comparative analysis was used for the study.

Findings: The Chinese students had significantly higher success rates than did US students across all questions ($\chi^2(1, N = 253) = 6.22–18.27, P < .05$). The disparities appear to be related to students’ use of differing strategies. Chinese students tend to choose abstract strategies and symbolic representations while US students favor concrete strategies and drawing representations. If the analysis is limited to those students who used concrete strategies, the success rates between the two samples become almost identical. With regard to problem posing, the US and Chinese samples both produce problems of various types, though the types occur in differing sequences. Finally, this study revealed differential relationships between problem posing and problem solving for US and Chinese students. There was a much stronger link between problem solving and problem posing for the Chinese sample than there was for the US sample.


Objectives: To investigate solver’s use of sub goals in mathematical problem solving processes. To analyze, focus on how he established sub goals and how these sub goals affected his solving activity.
Methods: The subject was a graduate student of a Japanese university, the same person as the subject in Nunokawa. He participated in a series of problem solving sessions that consisted of nine sessions and whose aim was to analyze genuine mathematical problem solving processes from the perspective of solver’s understanding of problem situations. In each session, the subject was asked to solve one problem in the think-aloud fashion. After his solving activity, the researcher had an interview with the solver and the solver was asked to explain what he thought or noticed during his solving process. Diagrams drawn by the subject and his behaviors were added to this protocol using the video record. This protocol and the answer sheets written by the subject are the data to be analyzed here.

Findings: This analysis implied an interactive relation between sub goals established by the solver and his understanding of the problem situation. That is, his understanding of the situation supported his generation of sub goals, and those sub goals influenced his understanding positively or negatively. His use of sub goals will be also examined from the viewpoint of Meta cognition, and this examination will suggest the difficulty of escaping from the influence of a sub goal.

2.4 INSIGHT FROM THE REVIEW OF RELATED LITERATURE

The review of related literature reveals that some studies were reported related to Mind map strategy and Achievement in Mathematics of High school students. No studies were reported as per the knowledge of the investigator related to Mind map strategy and Achievement in Mathematics of High school students of Trichy Area.

So it is a felt need to find out what level of significant difference and relationship between Mind map strategy and Achievement in Mathematics of High school students of Trichy Area. Hence the present study has been taken by the investigator.