CHAPTER III

REVIEW OF RELATED STUDIES

3.1 Studies related to 4MAT System of Instructional Design

3.2 Studies related to Learning Styles

3.3 Studies related to Hemispheric Preferences

3.4 Studies related to Achievement in Physics

3.5 Conclusion
Review of related studies is an important pre-requisite of actual planning and execution of any research work. The availability and utilization of adequate source of related information enable the researcher to have a clear picture of various aspects of the problem area to carry out the work successfully. Since the problem under investigation is “Effectiveness of 4MAT System of Instructional Design on Learning Styles, Hemispheric Preferences and Achievement in Physics of students at Secondary Level”, the investigator tried to collect studies related to 4MAT System of Instructional Design, Learning Styles, Hemispheric Preferences and Achievement in Physics and the related variables which are relevant for the present study. The related studies thus examined have been classified into four sections as follows:

3.1 Studies related to 4MAT System of Instructional Design
3.2 Studies related to Learning Styles
3.3 Studies related to Hemispheric Preferences
3.4 Studies related to Achievement in Physics

3.1 Studies related to 4MAT System of Instructional Design

The 4MAT proposes that students learn in different ways and that high quality instruction integrates all these different learning methods. It is based on different ways that people perceive and process information. One key issue for teachers in working to differentiate instruction is that they will have to reach each student differently and individually. 4MAT offers a framework for actively differentiating instruction within an entire class, all in the context of a single unit. Studies related to 4MAT System of Instructional Design and the related variables are presented below.

Khumwong and Singmuang (2013) aimed to find student’s learning achievement after learning using 4MAT lesson plans, and student’s satisfaction after learning using 4MAT lesson plans. Students had learned about addition, subtraction, multiplication and division combined for a total of 18 hours. The results revealed that the student’s learning achievement after using 4MAT lesson plans was statistically significant, which was higher than that before using lesson plans at the level 0.05. The student’s satisfactions towards the 4MAT learning activities were at the highest level. The results indicated that 4MAT learning activities could be effective in order to enhance student’s Mathematics achievement on several topics.
Nikolaou and Koutsouba (2013) in their study aimed to introduce an innovative way of creating and designing distance learning instructional material incorporating McCarthy’s 4MAT Model based on learning styles. The application of the 4MAT Model in distance instructional material suggested a balanced method of delivering new information in a total of learners having different characteristics and learning styles. Moreover, the teacher’s physical absence and the consequent absence of direct contact between teacher and learners are almost extinguished.

Ovez (2012) studied the effectiveness of 4MAT Teaching Model in Overcoming Learning Difficulties in the Perimeter and Area of Circle and Perpendicular Cylinder among the Seventh year students. The findings of the study indicated that students had learning difficulties about the perimeter and area of circle and perpendicular cylinder, and 4MAT based teaching was effective in overcoming these difficulties, whereas, traditional method was not effective in overcoming learning difficulties.

Uyangor (2011) examined the influence of the 4MAT teaching model which depends on Learning Styles that have been generated by the help of the relationship between the brain and learning; and focuses on the learning loop as a centre upon students’ level of Mathematics course Achievement; and the level of attitude towards Mathematics in the unit of the Hoop and Circle. It has been determined that 4MAT method of instruction was more efficient than the traditional method.

Silva, Sabino, Adina, Lanuza and Baluyot (2011) aimed to find out the influence of the 4MAT Cycle of Learning on the behaviour, attitude and academic performance of the students. The results gathered from survey questionnaires, rating scale, observations and interviews showed that with the 4MAT cycle of learning, the students developed certain habits of mind and attitude. These habits included openness and respect for the opinion of others, creativity and perseverance in finding solutions to problem, patience in finding additional information to solve the problem, and commitment to learning and responsibility for one’s learning. Finally, the study guided teachers and school administrators to develop appropriate programs particularly on how to assist students in developing a learning repertoire.

Nowacki (2010) applied the 4MAT theoretical framework to educational planning to transform a biostatistics course into a problem-based learning experience. It was found that student satisfaction and perception increased significantly following implementation of the new curriculum as compared to previous ratings. The results
indicated that students felt more strongly that the seminars were well-organized, encouraged participation or discussion and integrated concepts across the curriculum.

Lee and Hung (2009) in their research report wrote McCarthy constructed the 4MAT teaching model, an eight step instrument developed in 1980, by synthesizing Dewey's experiential learning, Kolb's four Learning Styles, Jung's personality types, as well as Bogen's left mode and right mode of brain processing preferences. An important implication of this model is that learning retention is improved in the whole brain treatment group and thus this model is effective in retaining learning information as long term memory. Specifically, when examined the effectiveness of student scoring levels (high, medium, and low), the results indicated that retention improved across all levels in the treatment group while results were inconsistent in the control group. When examined academic Achievement and attitudes, interaction factor of both school and method showed a statistically significant difference.

Nicoll-Senft and Seider (2009) assessed the Impact of the 4MAT Teaching Model across Multiple Disciplines in Higher Education. As part of a Scholarship of Teaching and Learning (SoTL) project, six faculty members representing the university’s Schools of Arts and Sciences, Business, Education and Professional Studies, and Engineering and Technology implemented the 4MAT model in the respective classes during the fall 2007 semester. Faculty engaged in the SoTL project at the completion of the semester asked their students to complete a Likert scale survey comparing their redesigned courses to comparable college courses. A meta-analysis of these data indicated significant findings for six out of the eight comparative statements measured.

Enver and Ramazan (2008) determined the efficiency of 4MAT Method of instruction in which Learning Styles and Cerebral hemispheres are taken into account in teaching the binary operation and its properties in Mathematics. It has been determined that 4MAT Method of instruction was more efficient than the traditional method in teaching of the Binary Operations in Mathematics.

Piyalux (2004) studied the development of instructional activities for tenth-grade covalent molecule subject based on the 4MAT cycle of learning. The findings showed that, as a result of organizing instructional activities based on the 4MAT cycle, the students were able to pass the schools’ passing criterion in chemistry. The students also showed a positive attitude toward chemistry subject. In addition, the students enjoyed activities as organized.
Erawan (2004) studied the effects of organizing instructional activities for teaching basic science process skills based on the 4MAT learning model. The findings showed that after the experiment, the students passed seven basic science skills. The students found the content to be easier to learn and classes were enjoyable. They also showed a development in thinking skill.

Nitita (2002) compared the effects of McCarthy’s 4MAT and Group Dynamics on creativity of prathomsuska II students of Sawasdeewittaya School in Khet Vadhana, Bankgok. The results showed that the creativity of the students exposed to McCarthy’s 4MAT and Group Dynamics were significantly increased than before the experiment at .01 levels. There were no significant differences in creativity of students exposed to McCarthy’s 4MAT and students exposed to Group Dynamics.

Dounghathai (2001) studied the effects of using the 4MAT lesson plan on learning achievement, responsibility and learning attitude in the education population unit and the occupations unit, prathomsuska V. Findings of the study showed that the learning achievement of students using the 4MAT lesson plan and of the students using the lesson plan of the department of curriculum were not significantly different. The learning responsibility and the learning attitude of students taught using the 4MAT lesson plan and of the students using the lesson plan of the department of curriculum were, however, different.

Hancock (2000) evaluated the effects of the 4MAT Lesson Planning System on the number of times a teacher off-task in a fifth, sixth or seventh grade classroom. Teacher off-task behaviour has been tied to students’ off-task behaviours which consumes teacher time and attention during class. Students’ off-task disruptive behaviour was reduced when students are actively engaged in lessons. This study demonstrated a reduction in the number of off-task behaviour in the classroom where the teachers were using the 4MAT Lesson Planning System.

Huitt (2000) used the 4MAT System to design web-based instruction. He suggested that student learning can be enhanced by using the 4MAT System of instruction. Moreover, he suggested that the 4MAT System can engage higher order thinking in students throughout the lesson.

Palmer (1999) in his thesis suggested a practical model for fulfilling all learning style preferences identified in the 4MAT System through a web based course and the work demonstrated that a learner-centric model, such as 4MAT can be applied to a Web-Based course.
Kaplan (1998) wrote that the 4MAT instructional model provides a user-friendly, research-based structure for principals to design powerful retreats and workshops aimed at increasing leadership behavior among all professional staff.

According to McCarthy (1997), the 4MAT System honors the distinctive style that each student brings to the classroom, while helping all students grow by mastering the entire cycle of Learning Styles. The learner makes meaning by moving through a natural cycle— from feeling to reflecting to thinking and, finally, to acting. Teachers need not label learners by style; instead, they must help them work for balance and wholeness.

Lenna (1997) investigated the relationship between teachers’ participation in 4MAT Fundamentals Training and Teachers’ Perception of Teacher Efficacy. The results showed that the training had no significant impact on external teacher efficacy scores. An interaction was found between teachers’ level of previous knowledge and the reported gain in internal teacher efficacy. Those teachers with little previous knowledge of learning style theory and methodology showed higher levels of gain in internal teacher efficacy immediately after the workshop and on the one-month follow-up survey.

Klenetsky (1997) conducted a study to determine if 4MAT training had an impact on teachers’ attitude towards students’ behaviours associated with creativity. Specifically, this study analysed the relationship between the dependent variable of attitude towards creativity, and the independent variables of levels of training, grade level, years of teaching experience, and subject area. Based on the findings of the study, none of the demographic variables had a significant relationship to change in attitude towards creativity, beyond what could normally be expected by chance. However, the 4MAT group had a statistically significant higher attitude score than the control group, and there was a statistically significant difference between groups for control and levels of training.

Although modest in number, independent, long-term controlled comparison studies have been carried out using the 4MAT Model. In these studies, the practice associated with 4MAT was compared to the practice recommended by standard textbooks. All but one of the eight studies available reported significantly greater gains in achievement and long term retention in the 4MAT group (Sanborn, 1994; Appell, 1991; Bowers, 1987; Spatz, 1987; Szewczyk, 1987).
Scott (1994) conducted an information analysis of 4MAT Model. 4MAT is an eight step sequential instructional model based on two theoretical constructs, Kolb’s model of Learning Style and the concept of Brain Hemisphericity. A review of professional literature on research with 4MAT Model indicates that 4MAT Model is capable of comprehensive use of developing instructional units for discursive as well as non-discursive disciplines, for secondary as well as elementary education.

Dwyer (1993) wrote that the 4MAT system (an eight-step cycle of instruction that combines four Learning Style types and students' preferences for right-brain or left-brain modes of learning) can guide instructors in planning teaching strategies to meet students' diverse learning needs. Each of the eight steps of the system emphasizes one of the learning types and alternatives from right- to left-mode information processing. After a communication instructor used the system to develop teaching strategies for numerous units of study, she noted an increase in student interest and better overall student performance. One such unit teaches students how to prepare effective call-to-action persuasive speeches and consists of four "quadrants" that: connect new concepts or processes with personal meaning to create a reason for learning; correlate learners' previous experience with concept formulation; provide students with an opportunity to practice and personalize the new concepts; and allow students to take action, teach themselves, and share what they have learned with others.

Hinds (1992) studied the effects of 4MAT on students’ achievement. The results suggested that 4MAT students showed a statistical significance in the area of higher level thinking skills and responded more favorably to the lessons. The students preferred higher level thinking skills over textbook knowledge and applications.

Murray (1992) had undertaken a study to assess the outcomes of a teacher training programme whose goal was application of the 4MAT Learning Style Model to design of lessons which foster student creativity. Results derived from the analysis of data indicated that the training programme met its objectives of content mastery, attitudinal change, and application of theory, within the context of a case study involving 27 subjects undergoing 36 hours of training.

McCarthy (1991) in a report described about the 4MAT system of instructional change. The 4MAT system is an eight-step cycle of instruction that capitalizes on individual Learning Styles and brain-dominance processing preference. Four major Learning Styles are recognized: (1) imaginative; (2) analytic; (3) common
sense; and (4) dynamic. Because in each style there are people with right-mode, left-mode, and whole-brain dominance, the 4MAT system uses techniques for each mode throughout the Learning Styles. The 4MAT system is conceptualized as a four-quadrant circle that makes an eight-step learning cycle. It is recommended that the cycle be used in school districts for at least two years to see benefits for students and teachers. Moving through the cycle, teachers examine their own Learning Style preferences, and in so doing they become more sensitive to student Learning Styles and instructional needs.

Vaughn (1991) conducted a study to determine if the 4MAT System of Instruction would improve the achievement, retention and creative products of gifted third graders in a pull-out program when compared to the traditional method of instruction based on Bloom’s Taxonomy. The results revealed no differences between the 4MAT group and the group receiving the traditional method of instruction on achievement or retention but it did appear to influence the factor of creativity in the final student products.

McCarthy (1990) in a report wrote 4MAT is an eight-step instructional cycle that capitalizes on individual Learning Styles and brain dominance processing preferences. The four major learners (imaginative, analytic, commonsense, and dynamic) can use 4MAT to engage their whole brain. Learners use their most comfortable style while being challenged to function in less comfortable modes.

Weber and Weber (1990) in their report writes when two upstate New York teachers analyzed the problems attending student presentations, it became clear that only students with Quadrant 2 (analytical) Learning Styles were comfortable listening to an oral report. After their gifted fifth and seventh graders created a 4MAT wheel, their new insights helped generate possible solutions to common communication problems.

Leiberman (1988) reported that students in the Fairfax County schools who were taught by 4MAT had a greater knowledge of geometry at the middle school and high school level than did students in control groups. They also evidenced greater knowledge of math application and a better overall attitude.

Wilkerson and White (1988) evaluated the effects of the 4MAT system on Achievement and retention of learning. Results revealed that 4MAT students had significantly better overall achievement and long term retention as measured on an unannounced test.
Bowers (1987) investigated the effects of the 4MAT instructional system on Achievement and attitudes in science. Significant differences favoring the 4MAT group were found for overall Achievement. No significant differences were found on knowledge-level questions. The dependent variables for investigating the instructional effect on attitudes were the ratings on unit-specific statements and statements about science in general. Significant differences favouring the 4MAT group were found when analyzing the unit-specific statements. Significant differences favoring the Restricted-Textbook group were found when analyzing the unit-specific statements and when analyzing the statements about science in general.

Benezra (1985) determined the effect of the 4MAT System on the achievement performance of Middle school students. Comparison of Pre and Post achievement scores on a district criterion-referenced test indicated an improvement in science achievement for all groups. Results of these comparisons also indicated an increase in positive student comments and greater elaboration of projects.

Mills (1983) presented research results comparing students’ course content mastery in two study skills classes, one using traditional teaching methods and one utilizing McCarthy's 4MAT teaching model. 4MAT takes brain dominance into consideration and suggests specific instructor roles for students grouped according to Learning Style.

**Conclusion**

The following conclusion can be made from the review of related studies conducted on 4MAT System of Instructional Design.

Khumwong and Singmuang (2013) found that 4MAT learning activities could be effective in order to enhance student’s Mathematics achievement on several topics. Similar result was obtained in studies conducted by Ovez (2012), Uyangor (2011), Enver and Ramazan (2008) and Leiberman (1998). In their study, Nikolaou and Koutsouba (2013) suggested that the teacher’s physical absence and the consequent absence of direct contact between teacher and learners are almost extinguished with the application of 4MAT Model in distance instructional material. According to Silva, Sabino, Adina, Lanuza and Baluyot (2011), the students developed certain habits of mind and attitude with the use of 4MAT cycle of learning. The study guided teachers and school administrators to develop appropriate programs particularly on how to assist students in developing a learning repertoire.
When applied the 4MAT theoretical framework to educational planning, Nowacki (2010) found that student satisfaction and perception increased significantly following implementation of the new curriculum as compared to previous ratings. Studies conducted by Lee and Hung (2009), Wilkerson and White (1988), Sanborn (1994), Appell (1991), Bowers (1987), Spatz (1987) and Szewczyk (1987) reported that students’ retention is improved while using 4MAT System. When assessed the impact of the 4MAT Teaching Model across Multiple Disciplines in Higher Education, Nicoll-Senft and Seider (2009) indicated that in higher education, 4MAT can successfully collaborate to improve pedagogical approaches to meet the diverse learning styles of students across different disciplines. The findings by Piyalux (2004) indicated that when instructional activities are organized using 4MAT cycle, the students’ were able to pass the schools’ passing criterion in chemistry. A positive attitude towards chemistry subject was also developed among the students. The study conducted by Erawan (2004) showed that the students passed seven basic science skills when instructional activities for teaching basic science process skills are organized based on the 4MAT learning model. Nitita (2002) found that the creativity of the students exposed to McCarthy’s 4MAT was significantly increased. Results of the study by Doungathai (2001) showed that even though the learning achievement of students using the 4MAT lesson plan and of the students using the lesson plans of the department of curriculum were not significantly different, the learning responsibility and learning attitude of students however, differ.

The study by Hancock (2000) reported a reduction in the number of off-task behaviour in the classroom where the teachers were using the 4MAT Lesson Planning System. According to Huitt (2000) and Hinds (1992), 4MAT can engage higher order thinking in students. The work conducted by Palmer (1999) suggested that 4MAT can be applied to a Web-Based course. Kaplan (1998) wrote that the 4MAT instructional model provides a user-friendly, research-based structure for principals to design powerful retreats and workshops aimed at increasing leadership behaviour among all professional staff.

According to McCarthy (1997, 1991, 1990), the 4MAT System honors the distinctive style that each student brings to the classroom, while helping all students grow by mastering the entire cycle of Learning Styles. The 4MAT system is an eight-step cycle of instruction that capitalizes on individual Learning Styles and brain-dominance processing preference. The four major learners (Imaginative, Analytic, Common Sense, and Dynamic) can use 4MAT to engage their whole brain. When
investigated the relationship between teachers’ participation in 4MAT Fundamentals Training and Teachers’ Perception of Teacher Efficacy, Lenna (1997) found that those teachers with little previous knowledge of learning style theory and methodology showed higher levels of gain in internal teacher efficacy immediately after the workshop and on the one-month follow-up survey. Findings of the study by Klenetsky (1997) reported that none of the demographic variables had a significant relationship to change in attitude towards creativity, beyond what could normally be expected by chance. However, the 4MAT group had a statistically significant higher attitude score than the control group. An information analysis of the 4MAT Model by Scott (1994) indicated that 4MAT Model is capable of comprehensive use of developing instructional units for discursive as well as non-discursive disciplines, for secondary as well as elementary education. Dwyer (1993) noted an increase in student interest and better overall student performance when used 4MAT System to develop teaching strategies for numerous units of study.

The study undertaken by Murray (1992) assessed the outcomes of a teacher training programme whose goal was application of the 4MAT Learning Style Model to design of lessons which foster student creativity and the results derived from the analysis of data indicated that the training programme met its objectives. The results of the study by Vaughn (1991) revealed no differences between the 4MAT group and the group receiving the traditional method of instruction on achievement or retention but it did appear to influence the factor of creativity in the final student products.

In their report, Weber and Weber (1990) wrote that possible solutions are generated to common communication problems when the fifth and seventh graders created a 4MAT wheel. Leiberman (1988) reported greater knowledge of math application and a better overall attitude for students who were taught by 4MAT. Significant differences favouring the 4MAT group were found for overall achievement when Bowers (1987) investigated the effects of the 4MAT instructional system on Achievement in science. Comparison of Pre and Post achievement scores on a district criterion-referenced test by Benezra (1985) indicated an improvement in science achievement for all groups. According to the research results after comparing students' course content mastery in two study skills classes, Mills (1983) reported that 4MAT takes brain dominance into consideration and suggests specific instructor roles for students grouped according to Learning Style.
The studies reviewed about 4MAT System of Instructional Design thus reveals that so many studies are conducted on 4MAT and its effect on achievement, long term retention etc. But there were no studies which checked the effectiveness of 4MAT System of Instructional Design on Learning Styles and Hemispheric Preferences conducted in Kerala. Studies on how 4MAT System of Instructional Design affects Physics achievement are also rare.

3.2 Studies related to Learning Styles

The term "Learning Style" first appeared in research literature in the 1950's. Since then, educators have adopted it to describe a variety of "typical differences" in individual attributes and learning strategies that are believed to affect learning outcomes. Proponents of the learning style construct argue that students' predispositions shape their responses to instructional environments. Learning Style is related to individual characteristics and preferences. Learning Style reflects the students’ preferences on how they perceive the environment, interact with this environment, react and experience learning in this process. Learning Styles describe a student in terms of those educational conditions under which he/she is most likely to learn. An understanding of Learning Styles of the students can be seen as fostering an awareness and appreciation for the multitude of experiences represented in the classroom. The investigator went through certain reviews and research findings related to learning styles of students. This section is classified as three parts; one part focuses on studies related to Learning Styles and the second part focus on how Learning Styles and Achievement of students are related and the remaining part focuses on studies related to Learning Styles and Hemispheric Preferences of students.

Sarabdeen (2013) analysed the major theories on learning styles and applied one of them to the students in Dubai to understand their various learning styles. The research applied Fleming’s VARK theory. The results indicated that there are variations in learning preferences. Most of the students fall within reader or writer and kinaesthetic categories. The research also confirmed that the students could possibly have more than one learning styles. Thus the research in theory confirmed the earlier research findings that learning styles must be taken into consideration for better learning outcome.

Liu, Hu and Gan (2013) conducted a study on the Learning Style Preferences with different academic backgrounds by taking Tujia EFL learners as
examples. Both quantitative and qualitative researches are applied in this study. The quantitative research indicated that minority students from different academic backgrounds have various learning styles. The results of the qualitative study indicated that most of the Tujia students and their teachers know little about ‘learning styles’ and some teachers thought the research of ‘Tujia EFL Learner’s learning styles’ is useless. The significant disharmony between teachers’ teaching styles and students’ learning styles was also discovered.

Markovic and Jovanovic (2012) investigated the factors affecting the acceptance and use of e-learning system. There are a number of implicit and explicit frameworks designed to inform e-learning practice. Some of them suggest key components that influence the quality of the e-learning experience: technology, pedagogy, organizational context and creativity. Instructor feedback and student learning styles, significantly affect the perceived learning outcomes of e-learning students. Quality of education will significantly be enhanced if instructors modify their teaching styles to accommodate the learning styles of all students in their classes. When the teacher creates the lesson plan, it is desirable that he or she puts as many activities as possible which will reflect different learning styles and teachers who are able to use various instructional strategies have been shown to be more effective than those who just use single strategies.

D’Amore, James and Mitchell (2012) investigated the learning styles of first-year undergraduate nursing and midwifery university students and analysed whether these learning styles are influenced by student demographic characteristics and found that Nursing and midwifery students are mainly of the diverger and assimilating learning styles. Some student demographic characteristics show a significant influence on learning styles.

Stephanie, Suhail and Nicholas (2012) compared dominant learning styles of pharmacy students and faculty members and between faculty members in different tracks and found that learning styles differed among respondents based on gender and faculty track.

Janie, Craig and Charles (2012) conducted a study to identify preceptors’ and students’ learning styles to determine how these impact students’ performance on pharmacy practice experience assessments. The significance of “matched” and “unmatched” learning styles between students and preceptors was evaluated based on performance on both subjective and objective practice experience assessments.
Results found that Sixty-one percent of 67 preceptors and Fifty-seven percent of 72 students who participated reported “assimilator” as their dominant learning style. No differences were found between student and preceptor performance on evaluations, regardless of learning style match. The study concluded that determination of learning styles may encourage preceptors to use teaching methods to challenge students during pharmacy practice experiences; however, this does not appear to impact student or preceptor performance.

Bayrack (2012) determined the effect of some personal characteristics such as age, gender of the secondary school students on their learning styles. The learning styles of students' preferences were analysed by frequency (f) and percentages (%). Students’ learning styles preference was compared with gender, class level by using Chi-square Test. According to the results of the study; it was found that 48.2% of the secondary school students participating in the study have competitive, 29.2% of them have collaborative, 10.9% independent, 4.5% avoidant, 4.5% participant and 2.7% dependent learning styles. There was a significant difference between the students’ learning styles and student's gender. There wasn’t a significant difference between the students’ learning styles and class level.

Oflaz and Turunc (2012) examined the learning styles of the students. Groups formed by the researchers considering the learning styles of the students show how learning styles affect the performance on group work activities in language learning. The study suggested that by finding out the learning styles of the students and giving activities according to them, the teacher might improve the efficiency of his or her own teaching and increase the success rate. By targeting all learning styles and forming groups with students who have different learning styles, the teacher is also able to help the students develop their less dominant styles.

Shatalebi, Sharifi and Saeedian (2012) examined the relationship between Emotional Intelligence and Learning Styles. Findings imply that among 15 components of emotional intelligence, only 3 components including intrapersonal relationships, impulse control, and happiness have been compatible with learning style. There was no relationship between other components of emotional intelligence and learning styles involving divergent, convergent, adaptive, and attractive. In a general explanation it can be said that emotional intelligence indicates individuals’ ability whereas learning style indicates individual preferences. So lack of relationship between these two variables can be justified.
Molsbee (2011) examined the association between the dominant learning styles and demographics of nursing students in Walden University. Results showed a statistical association between learning styles and gender, however, there was no statistical association between learning styles and age groups.

Srijongjai (2011) conducted a study of learning styles of Thai English major students in an EFL writing class. The objectives of the study were to identify the learning styles of these students and to see whether there were significant differences of their learning styles based on their achievement levels in their English writing course. The participants of this study were 88 second-year English majors in the B.A. Program at the Faculty of Humanities, Srinakharinwirot University, Thailand. Data analysis showed that the average primary and secondary learning styles of the students were social and aural and there were no significant differences of the students’ learning styles based on their achievement levels in the writing class.

Bostrom (2010) compared teachers' and students’ Learning Styles profiles at the two major orientations (vocational and academic programs) in upper secondary school, to explore differences and similarities. Three groups were compared and analysed by using F-test and ANOVA. The statistical analysis of the data showed that the teachers have a greater need for light and temperature, are more motivated, more adaptable, have less need for structure and authority and are more alert in the morning and less in the afternoon compared with the students. The two student groups showed no statistically significant differences between them. The vocational students differed more from teachers than their academic peers. The results indicate the need for expanded educational strategies and an in-depth didactic discussion.

Jeral and Kim (2010) examined the influence of visual, auditory and kinaesthetic learning opportunities on students. In the beginning of the study, students took a preferred Learning Style Survey which classified their preferred Learning Styles as visual, auditory and kinaesthetic or a mixture of two or more styles. During the course of the study, students read four short stories and one novel, after the completion of each story; students were given a choice of projects to demonstrate their mastery of the material. The results of the study suggested that students benefit from being able to choose activities to demonstrate their learning. The overall implication is that classroom teachers need to be aware of their students’ learning styles and should tailor their instruction according to the needs of specified learners whenever possible.
Gohel (2009) explored the effect of Learners’ Learning Style based instructional Strategy on Science Achievement of Secondary School students. He found out the impact of varied instructional strategies in accordance with their learning styles namely, visual, auditory and kinaesthetic.

Kocakoglu (2009) conducted a study on determining the Learning Styles of Elementary School (1st-8th Grade) Teachers. In this study, Learning Styles of 223 primary school teachers in different branches in Turkey were determined. Learning Styles were defined by Kolb’s Learning Style inventory and distributed based on branch. The correlation between teacher branches and Learning Styles was measured by Chi-Square test. The correlation with Learning Styles was also researched according to gender. Consequently while 48% of teachers have converger Learning Style, 24% of them have assimilator, 18% have accommodator, and 10% have diverger Learning Styles. When branches are examined, a similar distribution was observed. The correlation between Learning Styles and branches was measured by Chi-square test, and no correlation was seen. In the same way, no correlation between genders and Learning Styles was seen.

Penger, Tekavcic and Demovski (2008) conducted a study to explore the learning styles of students enrolled in Economics of Education at the University of Ljubljana, Faculty of Economics in Slovenia. The findings outlined that for the educators in higher education, the challenge is to provide metacognitive support for students enabling them to reflect not just on what they learn but also know and why.

Murat (2008) investigated the differences in the teaching anxiety of pre-service teachers in mathematics according to their Learning Style preferences. The LSI determined the participants’ Learning Style preference: divergent, assimilator, convergent, and accommodator. The MATAS found the participants’ mathematics teaching anxiety level. The study revealed that there were statistically significant differences in mathematics teaching anxiety between convergent and the other three types of learners: divergent, accommodator, and assimilator. The difference was in favour of convergent learners. That is, convergent learners had less mathematics teaching anxiety than the other types of learners. The study also found that divergent learners showed the highest level of mathematics teaching anxiety.

Nelson (2008) examined how African American students’ Learning Styles and their perceptions of teachers’ attitudes toward them and the learning environment
influenced their decision to become high truants. Additionally, the study sought to find if selected demographic factors had any relevance on the truancy rate of African American students. The results from the analysis suggested that students with low grade point averages; those who had siblings who left school without receiving a high school diploma; those who had been in legal troubles; those who were not involved in clubs/organizations; and gender in relation to females were more likely to be truant. The variable “grade point averages” was found to be the most significant with the dependent variable “unexcused days missed.” The variables together explained 32.5% of the variance in the dependent variable.

Hawk and Shah (2007) in their study indicated that students can and should develop their abilities that are not in their natural modes and preference. This is possible only if they are aware that Learning Styles do exist in individuals and that not all individuals learn in the same way.

Johnson and Johnson (2006) in their study on ‘Learning Style and Online Support’ found that among the four indices of Learning Styles of students (active-reflective, visual-verbal, sequential-global, sensing-intuitive) active learners expressed preference for face to face study groups rather than online study groups and for online quizzes rather than pencil and paper quizzes. Visual learners expressed preference for online quizzes rather than online study groups.

Hall and Moseley (2005) carried out an overview of learning-style models, identified 71 models of Learning Styles published between 1902 and 2002. They went on to analyze in depth 13 learning-style models and to group 50 of them along a continuum based on the extent to which the developers of the models and instruments believe that Learning Styles are fixed. However, at one extreme of the Hall and Moseley survey are theorists who believe in the influence of genetics, inherited traits and the interaction of personality and cognition, while at the other end are those who believe in the role of motivation and environmental factors such as cooperative or individual learning. The views contend that if Learning Styles are fixed, instructors could accommodate students more easily by tapping into their preferred Learning Style and teaching in a way that is compatible with each student’s ability to process information.

Hall (2005) suggested that instructors should make students aware of how they are currently processing information and sensitize them to approaches and strategies that would help them expand their repertoire of styles.
Cevriye (2004) identified the Learning Styles of preparatory school students from Gazi University and examined the relationship between students’ Learning Style Preferences (LSP) and faculty students study in, gender, proficiency level of English and Achievement scores on listening, reading, grammar, and writing in the English Course. The results indicated that there was no significant difference between students’ LSPs and faculty, gender, level and Achievement scores.

Tabanlioglu (2003) studied the Relationship between Learning Styles and Language Learning Strategies of Pre-intermediate EAP Students. The aims of the study were to identify the Learning Styles and strategies of students, to check whether there are significant differences in the Learning Style and strategy preferences between male and female learners, and to investigate whether there is a relationship between students’ Learning Style and strategy preferences. The study revealed that cognitive strategies were favoured the most. No significant difference was found in the preferences of learning strategies between males and females. The analysis with respect to the relationship between Learning Styles and strategies gave the results as visual styles had a significant relation with affective strategies; auditory styles had significant relationships with memory, cognitive, affective, and social strategies; there was a significant relationship between the individual Learning Style and compensation strategies; and none of the Learning Styles had a significant relationship with metacognitive strategies.

Al-Othman (2003) studied the relationship between gender and Learning Styles in internet-based teaching. It also tapped into the students' reactions to online education in TEFL as determined by (degree of satisfaction with regards to classes, degree of mastery of content, degree of applicability of content, and preferences for learning tools applied) the various online sessions they have taken in a TEFL methodology course. Findings revealed that there are obviously a multitude of factors that influence reactions to online learning and teaching. The study concluded that it is not possible to estimate the weighting of these factors that occur in a student's mind as he/she evaluates an online course.

Honigsfeld and Dunn (2003) investigated gender differences among the learning styles of adolescents from 5 countries – Bermuda, Brunei, Hungary, Sweden, and New Zealand. They aimed to explore if there were significant main effects for gender and nationality, if there were significant interactions between gender and nationality, and if there were significant country-specific differences in learning styles.
by gender. According to the results of MANOVA, there were significant main effects for gender, with medium effect sizes. On the basis of their findings, researchers concluded that when compared with female students, male students tended to prefer more peer interaction rather than learning alone and more kinesthetic activities. On the other hand, female students on average needed higher temperature and more self-motivated, parent motivated and teacher motivated; more persistent, and more responsible or confronting. When adolescents’ learning styles were compared by country, significant and more substantial differences emerged for all learning style variables except for auditory perceptual strength. Post hoc tests confirmed that there were larger country differences between the two genders than there were gender differences among the five countries.

Arslan (2003) aimed to assess learning style preferences of students in engineering departments at Middle East Technical University (METU). She claimed that awareness of the learning style could help instructors to be more sensitive toward individual differences in class and learning style affected both the classroom interaction and the success of the students in the class. Results of the study indicated that all engineering students indicated their preference towards visual learning. The main conclusion drawn from the study is that there was no significant difference between sex, department, CGPA and four learning style dimension. Male and female students’ learning style preferences and CGPA scores were not statistically different from each other.

Hillberg and Roland (2002) made a report which discusses two prominent definitions of Learning Styles. They conducted studies to find differences between the Learning Styles of American Indians/Alaska native students of other cultural groups. Research based on a variety of theoretical framework suggested that American Indians/Alaska native students show some tendency towards global/holistic style of organizing information, a visual style of mentally representing information in thinking, a preference in more reflective styles in processing information and a preference for a collaborative approach to task completion.

Hoerr (2002) focused on the benefits and details of using multiple intelligences in learning a skill or concept. He presents implications for learning styles in classroom environment and ways in understanding the learning style of a child.

Shrivastava (2002) studied the learning styles of secondary school students with scientific attitude and their achievement in science. He found that the most
popular learning styles of the students are accommodative learning style and second popular is convergent learning style.

Akgun (2002) investigated the learning styles of English learners at private English courses. She aimed to discover whether age, gender and education level influence the learners’ learning style. The results indicated that the most preferred learning style among learners was concrete learning style, and in order the others were communicative, authority-oriented and analytical learning styles. The study also revealed that participants’ learning styles did not differ according to their age and gender. However, in terms of level of education, there was a significant difference between university graduates and M.A. students and other learners because university graduates and M.A. students preferred analytical learning style more than others.

Research by Hardigan and Sisco (2001) support the idea that students’ preferred Learning Styles differ.

In his study, Henke (2001) aimed to describe how an aspect of learning theory, specifically learning styles, can be applied to the development of computer based training. He attempted to answer the question whether learning styles, as defined and measured by Kolb’s Learning Style Inventory be applied to the development of computer based training. He reached the conclusion that good course design must be developed to be flexible enough to meet each student’s preferred learning style.

Wedeking (2000) identified the Learning Styles of practising public health nurses. The Learning Type Measure was used to assess the Learning Styles. Results showed that Type 1 Learning Style was selected by 44%, Type 2 Learning Style by 17%, Type 3 Learning Style by 19%, and type 4 Learning Style by 12% of the group. A small part of the group, 7.4%, did not make a single type selection; they opted for tie scores for two or more learning style types. The group was about evenly divided between Watching and Doing as an information-processing strategy, with 53% of the group selected Doing. Age, educational attainment, and experiences as a public health nurse were not statistically significant factors in nurses' selection of learning style. Experience as a registered nurse, however, was statistically significant.

Lian (2000) in a study intended to discover the type of learning styles practised by junior college students with respect to subsamples based on different levels of achievement, faculty of study and gender and found that there is no significant difference in the learning styles among the three achievement groups, different faculties and among gender.
Reed (2000) investigated the relationship between the laboratory environments and the learning styles of middle school technology education teachers in the Commonwealth of Virginia. It was hypothesized that teacher preference for one type of laboratory over another (conventional or modular) may be an issue of learning style. The study found that the self-perceived learning styles of respondents were significantly different when compared to McCarthy’s findings for secondary teachers and administrators in general. However, the learning styles of respondents in conventional laboratories were not significantly different than the learning styles of respondents in modular laboratories.

Diaz and Cartnal (1999) compared the student Learning Styles of two online health education classes (N = 68) with an equivalent on-campus class (N = 40) and found that students who enrolled in the distance education class were significantly more independent learners than students in the equivalent on-campus class. Students enrolled in the equivalent class were significantly more dependent learners than the distance group. Correlational analysis revealed that on-campus students displayed collaborative tendencies that were positively related to their needs to be competitive and to be good class citizens.

Dangwal and Mitra (1998) discussed the importance of Learning Styles for increasing the effectiveness of the learning process. It is pointed out that the use of Learning Style "aware" teaching-learning material is crucial to the heterogeneous learning profiles of today. They described the design, construction and validation of an adaptation of Kolb's original Learning Styles inventory.

Schroeder (1993) worked on new students-students that have been entering higher institutions for the past 15 years-and their new learning styles. Schroeder and his colleagues obtained a variety of information on approximately 4,000 new students entering their university by administering Myers Briggs Type Indicator (MBTI), a widely used instrument based on Jungian theory. According to the results, students differed with previous ones. The results indicated that approximately 60 percent of entering students prefer the sensing mode for perceiving compared to 40 percent who prefer the intuitive mode. Schroeder (1993) suggested that an overall understanding of how students learn and where they are in the process. Engaging in such a process will clearly indicate that there are many paths to excellence; and perhaps the greatest contributions that can be made to student learning is recognizing and affirming the paths that are different from one’s own.
Ryder (1992) conducted a study to determine the preferred Learning Style of post-secondary vocational students and whether there was a difference between various personal characteristics and/or a relationship between performance on the Myers-Briggs Type Indicator (MBTI), and the Multi-Modal Paired Associates Learning Test-Revised (MMPALT II). 100 adult subjects from an area technical centre located in central Florida participated in the study. Statistical analysis of the data revealed that the preferred Learning Style, as measured by the MMPALT II, for post-secondary vocational students was visual. There was no significant difference in mean scores on any of the MMPALT II subtests by age, educational level, or program. There was also a significant difference in mean scores by race/ethnicity. Whites recorded higher mean scores than non-whites on five of the seven subtests.

Buchanan (1992) conducted a comparative study of learning styles and math attitudes of remedial and college-level Math students and found that the remedial students were more concrete in their learning style where the college level students were more abstract. A significant relationship was found between learning styles and math attitudes for two groups, but was more pronounced in the remedial group.

Gee (1990) examined the influence of student Learning Style preference, in an on-campus or distance education remote classroom, on student Achievement in the following areas: course content, course completion rates, and attitudes about learning. Both distance and on-campus groups were taught simultaneously by the same instructor, received identical course content, and both groups met weekly. Results showed that people with the lowest scores in student Achievement in the distance learning course had a more social and conceptual Learning Style. Students with both social and applied Learning Style performed much better in the on-campus class. The outcomes of the study suggested that successful distance education students favoured an independent learning environment while successful on-campus students showed a preference for working with others.

Akins (1983) gathered data on the Learning Styles of the Dale Public School employees using the MMPALT II developed by Cherry (1981). It addressed the same Learning Styles used by Cherry. He says that the data gathered in this study can be used by the administrators, teachers, teacher’s aids, and support personnel in understanding their personal Learning Styles. In addition, people concerned with adult and continuing education will find the information useful in planning, designing, developing, and evaluating adult instructional programs.
Gilley (1975) conducted a study to identify a set of six theoretical styles of learning which have as their base, the individual’s preferential sensory input mode. Styles involved in the study were: visual, aural, haptic, interactive, print, and kinaesthetic. The study investigated questions dealing with the individual’s personal style of learning.

**Conclusion**

The following conclusion can be made from studies reviewed on Learning Styles.

Sarabdeen (2013) analysed the major theories on learning styles and the research in theory confirmed the earlier research findings that learning styles must be taken into consideration for better learning outcome. A significant disharmony between teachers’ teaching styles and students’ learning styles was discovered by Liu, Hu and Gan (2013). According to Markovic and Jovanovic (2012) and also by Jeral and Kim (2010), quality of education will significantly be enhanced if instructors modify their teaching styles to accommodate the learning styles of all students in their classes. Whereas, D’Amore, James and Mitchell (2012) found that Nursing and midwifery students are mainly of the diverger and assimilating learning styles. Some student demographic characteristics show a significant influence on learning styles. When compared the dominant learning styles of pharmacy students and faculty members and between faculty members in different tracks, Stephanie, Suhail and Nicholas (2012) found that learning styles differed among respondents based on gender and faculty track. Janie, Craig and Charles (2012) in their study concluded that determination of learning styles may encourage preceptors to use teaching methods to challenge students during pharmacy practice experiences.

A significant difference between the students’ learning styles and student's gender was found by Bayrack (2012). Similar results were also obtained by Preston (2011). He also obtained no statistical association between learning styles and age groups. The study by Oflaz and Turunc (2012) suggested that by finding out the learning styles of the students and giving activities according to them, the teacher might improve the efficiency of his or her own teaching and increase the success rate. Lack of relationship between learning styles and emotional intelligence was found by Shatalebi, Sharifi and Saeedian (2012). According to the results of the study by Srijongjai (2011), the average primary and secondary learning styles of the students were social and aural and there were no significant differences of the students’
learning styles based on their achievement levels in the writing class. The two student
groups showed no statistically significant differences between them when Boström
(2010) compared teachers' and students’ Learning Styles profiles at the two major
orientations (vocational and academic programs) in upper secondary school, to
explore differences and similarities. The study also revealed that the teachers have a
greater need for light and temperature, are more motivated, more adaptable, have less
need for structure and authority and are more alert in the morning and less in the
afternoon compared with the students. The vocational students differed more from
teachers than their academic peers.

When Gohel (2009) explored the effect of Learners’ Learning Style based
instructional Strategy on Science Achievement of Secondary School students, found
out the impact of varied instructional strategies in accordance with their learning
styles namely, visual, auditory and kinaesthetic. No correlation was seen when the
learning styles and branches of study, learning styles and gender of elementary school
teachers by Koçakoglu (2009). The findings of the study by Penger and Tekavcic
(2009) outlined that for the educators in higher Education, the challenge is to provide
metacognitive support for students enabling them to reflect not just on what they learn
but also know and why. Murat (2008) found that convergent learners had less
mathematics teaching anxiety than the other types of learners; divergent learners
showed the highest level of mathematics teaching anxiety.

The results of the study by Nelson and Kenyelta (2008) suggested that
students with low grade point averages; those who had siblings who left school
without receiving a high school diploma; those who had been in legal troubles; those
who were not involved in clubs/organizations; and gender in relation to females were
more likely to be truant. According to Hawk and Shah (2007), not all individuals learn
in the same way. Johnson and Johnson (2006) found that among the four indices of
Learning Styles of students (active-reflective, visual-verbal, sequential-global,
sensing-intuitive) active learners expressed preference for face to face study groups
rather than online study groups and for online quizzes rather than pencil and paper
quizzes. The views by Hall and Moseley (2005) contend that if Learning Styles are
fixed, instructors could accommodate students more easily by tapping into their
preferred Learning Style and teaching in a way that is compatible with each student’s
ability to process information. According to Hall (2005), instructors should make
students aware of how they are currently processing information and sensitize them to
approaches and strategies that would help them expand their repertoire of styles.
Castro and Peck (2005) claimed that that a student’s preferred Learning Style can help or hinder success in the foreign language classroom. No significant difference between students’ learning style preferences and faculty, gender, level and Achievement scores was found by Cevriye (2004). The study conducted by Tabanlioglu (2003) found that visual styles had a significant relation with affective strategies; auditory styles had significant relationships with memory, cognitive, affective, and social strategies; there was a significant relationship between the individual Learning Style and compensation strategies; and none of the Learning Styles had a significant relationship with metacognitive strategies.

Al-Othman (2003) found that there are obviously a multitude of factors that influence reactions to online learning and teaching and concluded that it is not possible to estimate the weighting of these factors that occur in a student's mind as he/she evaluates an online course. Honigsfeld and Dunn (2003) investigated gender differences among the learning styles of adolescents from five countries and found significant and more substantial differences for all learning style variables except for auditory perceptual strength. Post hoc tests confirmed that there were larger country differences between the two genders than there were gender differences among the five countries. The main conclusion drawn from the study conducted by Arslan (2003) was that there was no significant difference between sex, department, CGPA and four learning style dimension. Male and female students’ learning style preferences and CGPA scores were not statistically different from each other. Hillberg and Roland (2002) reported that American Indians/Alaska native students show some tendency towards global/holistic style of organizing information, a visual style of mentally representing information in thinking, a preference in more reflective styles in processing information and a preference for a collaborative approach to task completion. Hoerr (2002) presents implications for learning styles in classroom environment and ways in understanding the learning style of a child. According to Shrivastava (2002), the most popular learning styles of the students are accommodative learning style and second popular is convergent learning style.

Results of the study by Akgun (2002) indicated that the most preferred learning style among learners was concrete learning style, and in order the others were communicative, authority-oriented and analytical learning styles. The study also revealed that participants’ learning styles did not differ according to their age and gender. Research by Hardigan and Sisco (2001) support the idea that students’ preferred Learning Styles differ. Henke (2001) concluded that good course design
must be developed to be flexible enough to meet each student’s preferred learning style. The study by Wedeking (2000) identified the Learning Styles of practising public health nurses and found that age, educational attainment, and experiences as a public health nurse were not statistically significant factors in nurses' selection of learning style. Experience as a registered nurse, however, was statistically significant.

Reed (2000) in his study found that the self-perceived learning styles of respondents were significantly different when compared to McCarthy’s findings for secondary teachers and administrators in general. Diaz and Cartnal (1999) found that students who enrolled in the distance education class were significantly more independent learners than students in the equivalent on-campus class. Students enrolled in the equivalent class were significantly more dependent learners than the distance group. Dangwal and Mitra (1998) pointed out that the use of Learning Style "aware" teaching-learning material is crucial to the heterogeneous learning profiles of today. According to Schroeder (1993), the greatest contributions that can be made to student learning is recognizing and affirming the paths that are different from one’s own. The study by Ryder (1992) revealed that the preferred Learning Style, as measured by the MMPALT II, for post-secondary vocational students was visual. There was no significant difference in mean scores on any of the MMPALT II subtests by age, educational level, or program. There was also a significant difference in mean scores by race/ethnicity.

Buchanan (1992) found that the remedial students were more concrete in their learning style where the college level students were more abstract. A significant relationship was found between learning styles and math attitudes for two groups, but was more pronounced in the remedial group. The outcomes of the study by Gee (1990) suggested that successful distance education students favoured an independent learning environment while successful on-campus students showed a preference for working with others. Akins (1983) gathered data on the Learning Styles of the Dale Public School employees using the MMPALT II and suggested that the gathered data can be used by the administrators, teachers, teacher’s aids, and support personnel in understanding their personal Learning Styles. The study by Gilley (1975) investigated questions dealing with the individual’s personal style of learning.

### 3.2.1 Studies Related to Learning Styles and Achievement

There have been many attempts made to enhance students’ academic achievements. It has always been the main concern of many dedicated teachers and
parents that their students and children be as much successful as possible. In relation to this, many teachers are convinced that students need the positive attitude to succeed academically. Often, one’s learning style is identified to determine strengths for academic achievement. Most students favour to learn in particular ways with each style of learning contributing to the success in retaining what they have learnt. As such, studies carried out conclude that students retain 10% of what they read, 26% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say, and 90% of what they say as they do something (Chuah Chong-Cheng, 1988). These facts reveal that each learning style has its own strengths and weaknesses. Some students learn in many ways, while others might only favour one or two. Those students with multiple learning styles tend to gain more and obtain higher scores compared to those who rely solely on one style (Dunn, Beaudry and Klavas, 1989). The studies related to learning styles and academic achievements of students are presented below.

Orhun (2012) examined the relationship between Learning Styles and Achievement in Calculus Course for Engineering Students. The purpose of this study was to raise the success level of the engineering students in calculus course which is an essential course in engineering education. Therefore it has been analyzed whether the success depends on the way of learning style or not. The data was gathered from David Kolb’s learning styles model and the students’ grades in their calculus course. A one-way analysis of variance (ANOVA) was conducted to evaluate the relationship between learning style and success for calculus course in engineering programmers. Consequently; based on the findings, a significant difference has been found among students’ learning styles and their performance on the calculus course. The results determined the discriminatory learning styles.

Jahanbakhsh (2012) investigated the relationship between learning styles of high school girl students and their academic achievement based on their majors (major course of study in high school). The target population was high school girl students of Isfahan city including 3483 students. According to the results, sensing-intuitive learning styles show significant correlations with academic achievement of students whose major was Mathematic science. Academic achievement of students whose major was speculative science shows significant correlation with active-reflective learning styles. In students with empirical science, academic achievement shows significant correlation with both input dimension (visual-verbal) and understand dimension (sequential-global) of learning.
Sriphai, Damrongpanit and Sakulku (2011) investigated the effect of learning styles, as well as compared the effect of two different variable structure models of learning styles on factors influencing mathematics achievement. The research sample was made up of 508 seventh-grade students. The findings were that the model including learning styles as factors influencing Mathematics achievement had a greater coefficient of determination than the one without learning styles; the effect of learning styles treated as exogenous variables had a greater coefficient of determination than learning styles treated as endogenous variables; and the changes in the regression coefficient (b) as well as changes in relations between factors influencing mathematics achievement showed that learning styles was a moderator variable.

Abidin, Rezaee, Abdullah and Singh (2011) investigated the relationship between Learning Styles and overall academic achievement. Results revealed that there is significant relationship between overall academic achievement and Learning Styles. It was also found that the high, moderate and low achievers have a similar preference pattern of learning in all Learning Styles. Moreover, the Learning Styles framework does not change with subjects, where it actually plays an important role across all the subjects.

Naimie, Siraj, Abduzaid and Shagholi (2010) studied the impact of teaching and learning style preferences and their match or mismatch on learners’ achievement and the proposed technology preferences for learners based on learning style dimension. The findings of the study suggested that it is crucial for teachers to have knowledge about learner preferences in their classes to consider in their teaching design. The students showed a positive response and higher achievement when their learning preferences and needs are accommodated by their lecturers. Based on findings, it is hypothesized that the different learning styles dimensions have their own preferences in terms of technology usage.

Tight (2007), in his study of English college students learning Spanish showed that students performed equally well on vocabulary tests regardless of perceptual Learning Style preference.

Thomas (2007) examined the effectiveness of Co-Operative Learning on learning styles and academic performance in Mathematics learning at the upper primary level. The results revealed that learning styles of students have an impact on Academic Achievement in Mathematics.
A study was conducted by Malathi and Malini (2006) on the relationship between Learning Style and Achievement among higher secondary students in Chennai. The study revealed that there is high correlation between Learning Style and Achievement, which implies that higher the Achievement better was the Learning Style among higher secondary students.

Rayneri, Gerber and Wiley (2006) in their study examined the Learning Styles of the gifted middle school students, student perceptions of the Classroom Environment and possible connections between Learning Style, Classroom Environment and Achievement levels. The study found that Learning Styles of gifted students have correlation with Achievement in all content areas.

Castro and Peck (2005) carried out a study on Learning Styles and learning difficulties that foreign language students face at the college level and claim that a student’s preferred Learning Style can help or hinder success in the foreign language classroom. However, when they analysed the distribution of grades according to Kolb’s Learning Style types, they found no significant correlation between Learning Style and grades.

Kopsovich (2001) conducted a study to find the correlation between Learning Styles of students and their Mathematics scores on the Texas Assessment of Academic Skills test. The major aim of the study was to determine whether Learning Styles of students affect their Math Achievement scores on the Texas Assessment of Academic Skills Test. Necessary data were collected from 500 fifth grade students attending a North Texas Intermediate school. The findings established that the Learning Style preferences of all students in the area of persistence significantly impacted their Math Achievement scores. Gender and ethnicity were mitigating factors in the findings. The author suggests that supplying the teachers with information concerning students’ Learning Style Preferences will benefit student Achievement.

Ross, Drysdale and Schulz (2001) in their study found that Learning Styles influence the types of learning experiences that students found effective, comfortable and growth promoting. They also found that the effect of Learning Styles on academic performance was significant in student performance with sequential learners performing significantly better than did random learners in two computer science courses.
Lefkowitz (2001) studied the effects of traditional presentation versus learning-style presentation of course content in medical/legal issues in health care on the achievement and attitudes of college students. The aims were to examine college students’ learning styles and to compare the achievements and the attitudes of them between Contract Activity Package and traditional instruction. The results revealed the differences among college students’ learning style and demonstrated statistically increased achievement test scores and attitude test scores when Contract Activity Package rather than traditional teaching is employed.

Lain and Linda (2000) studied the influence of Learning Styles on Achievement in hypertext. The results showed that benefits of hypertext are differentially distributed across Learning Styles.

Bada and Okan (2000) found that for students to achieve effective learning, teachers must give special consideration to the skills and assumptions of learners and to their individual learning preferences.

Fox and Bartholomae (1999) evaluated the academic performance of 419 undergraduate students in an individual financial management class in light of their learning style, demographic background, academic history and time allocation. Academic history and time use variables proved to be the only significant predictors of grades in the course. Student Learning Style, as measured using Kolb’s Learning Style Inventory, was not a strong predictor of success in this financial management class, and it appears that no single type of learner best grasps financial management concepts.

Dunn and Griggs (1998) mentioned in their study that although some gifted people may learn proficiently without using their learning style preferences, low achievers perform better when they do, rather than when they don’t. A decade of research demonstrates that both low and average achievers earn higher scores on standardized achievement tests and attitude tests when taught through their learning style preferences.

Griggs and Dunn (1996) claimed that students who learn from an approach compatible with their preferred learning style experience greater academic achievement and have a more positive attitude towards learning.

Based on the results of a meta-analysis of 42 experimental studies, Dunn et al. (1995) claimed that students who are taught by an approach compatible with their
learning do better than those whose learning styles are not matched to teaching approaches.

Harden (1992) explored the correlation between subtests of two Learning Style instruments being used to assess Learning Styles of adult vocational students and to estimate the correlations between these Learning Styles and Achievement levels (measured by a standardized Achievement test) of adult vocational students. This relationship, between the MMPALT II Learning Style instrument subtests and the TABE Achievement level instrument subtests, had statistically significant results.

Conclusion

Studies reviewed in section 3.2.1 can be concluded as follows:

Orhun (2012) evaluated the relationship between learning style and success for calculus course in engineering programmers and a significant difference has been found among students’ learning styles and their performance on the calculus course. When Jahanbakhsh (2012) investigated the relationship between learning styles of high school girls students and their academic achievement based on their majors, found that sensing-intuitive learning styles shows significant correlations with academic achievement of students whose major was Mathematic science. Academic achievement of students whose major was speculative science shows significant correlation with active-reflective learning styles. In students with empirical science, academic achievement shows significant correlation with both input dimension (visual-verbal) and understand dimension (sequential-global) of learning. The findings of the study conducted by Sriphai, Damrongpanit and Sakulku (2011) were that the model including learning styles as factors influencing Mathematics achievement had a greater coefficient of determination than the one without learning styles. When investigated the relationship between Learning Styles and overall Academic Achievement, Abidin, Rezaee, Abdullah and Singh (2011) revealed that there is significant relationship between overall Academic Achievement and Learning Styles.

The study by Naimie, Siraj, Abduzaid and Shagholi (2010) reported that students showed a positive response and higher achievement when their learning preferences and needs are accommodated by their lecturers. Tight (2007), in his study of English college students learning Spanish showed that students performed equally well on vocabulary tests regardless of perceptual Learning Style preference. The results of the study by Thomas (2007) revealed that learning styles of students have an
impact on academic achievement in Mathematics. Malathi and Malini (2006) revealed that there is high correlation between Learning Style and Achievement. The study of Rayneri et al. (2006) found that Learning Styles of gifted students have correlation with Achievement in all content areas. No significant correlation between Learning Style and grades was found by Castro and Peck (2005). The study conducted by Aree (2003) found that the Achievements of students were significantly different among Learning Styles. Kopsovich (2001) in his study found that the Learning Style preferences of all students in the area of persistence significantly impacted their Math Achievement scores and suggested that supplying the teachers with information concerning students’ Learning Style Preferences will benefit student Achievement. Ross, Drysdale and Schulz (2001) in their study found that the effect of Learning Styles on academic performance was significant in student performance with sequential learners performing significantly better than did random learners in two computer science courses.

The study by Lefkowitz (2001) revealed the differences among college students’ learning style and demonstrated statistically increased achievement test scores and attitude test scores when Contract Activity Package rather than traditional teaching is employed. The results of the study by Lain and Linda (2000) showed that benefits of hypertext are differentially distributed across Learning Styles. Lian (2000) discovered the type of learning styles practised by junior college students with respect to subsamples based on different levels of achievement, faculty of study and gender and found that there is no significant difference in the learning styles among the three achievement groups, different faculties and among gender. According to Bada and Okan (2000), for students to achieve effective learning, teachers must give special consideration to the skills and assumptions of learners and to their individual learning preferences.

Student Learning Style was not a strong predictor of success in the financial management class, and it appears that no single type of learner best grasps financial management concepts as suggested by Fox and Bartholomae (1999, 1996). Research by Dunn and Griggs (1998) demonstrated that both low and average achievers earn higher scores on standardized achievement tests and attitude tests when taught through their learning style preferences. They claimed that students who learn from an approach compatible with their preferred learning style experience greater academic achievement and have a more positive attitude towards learning. Dunn et al. (1995) claimed that students who are taught by an approach compatible with their learning do
better than those whose learning styles are not matched to teaching approaches. Harden (1992) explored the significant correlation between subtests of two Learning Style instruments and between these Learning Styles and Achievement levels (measured by a standardized Achievement test) of adult vocational students.

3.2.2 Studies Related to Learning Styles and Hemispheric Preference

Students with a particular learning style have either left or right hemisphere preference. Some of the studies related to Learning Styles and Hemispheric Preference are given below.

Mehrdad and Ahghar (2012) investigated whether difference in the brain dominance (left/right) is reflected in the learning style and therefore learning strategy differences between left handed and right handed EFL students. The results indicated that no significant difference in the brain dominance between right handers’ and left handers’. The difference between the groups on certain aspects of learning style as well as learning strategies were found to be statistically significant suggesting a rather different cognitive processing in left handed learners than right handed counterparts and bringing to light the need for the educators, researchers and syllabus designers to give the issue due consideration.

Chauhan (2009) studied the relationship between right and left cerebral hemisphere of boys and girls students belonging to high and low intelligence groups and found that there was no significant relationship between right and left hemispherical oriented boys as well as girls students belonging to high and low intelligence group.

Rosihan and Liew (2006) investigated the differences in Brain Hemisphericity and learning styles on students’ confidence in using the graphics calculator (GC) to learn Mathematics. Results revealed that the sample differ significantly in their hemispheric preference and learning styles. In addition, sequential-global and sensing-intuitive learning styles were found to associate significantly with brain hemisphericity. However, there was no significant association between brain hemisphericity with gender, race, and program of study. Finally, the study also revealed that GC confidence ratings are not significantly different across brain hemisphericity as well as learning styles.

Nussbaumer (2001) wrote in her article that students' learning experiences are affected by the way in which they are taught. The teacher's role in the classroom and
the teaching method will positively or negatively affect the learning experience. A theoretical framework was developed that utilizes Learning Styles and superimposes hemisphericity with emphasis on right-brain activities. This framework may be applied to various subjects within the interior design curriculum—particularly, those taught in the lecture format. The learning experience may become more exciting and challenging for students if all Learning Styles are accommodated. According to her, the emphasis on right-brain activities may encourage visual and creative thinking among interior design students with the result that students may grasp more and deepen their learning experience.

Seng and Yeo (2000) studied the relationship between learning styles and brain hemisphericity. Three instruments (Kolb’s Learning Style Inventory, McCarthy’s Hemispheric Mode Indicator, and Dailey’s Spatial Visualization Test) were administered to 192 students enrolled in a training centre in Singapore. Results indicated that there are no significant differences in learning style preferences from the three brain dominance groups.

Lian (2000) studied the relationship between Learning Styles and hemispheric preference for the three variables, namely academic Achievement, faculty and gender. He found that there is a significant relationship between Learning Style and hemispheric preference. For all the three variables, namely academic Achievement, faculty and gender, the Assimilator Learning Style is associated with left brain functioning while the Diverger Learning Style is associated with right brain functioning. On the whole too, the Converger and Accommodator Learning Styles are respectively associated with left and right brain functioning. The study brought the result that it is the brain functioning domain that distinguishes the Achievement groups, the faculties, and the gender.

Bitner (1996) conducted a study to determine whether hemisphericity and learning type are related to the concept mapping attributes of pre-service and in service teachers. Statistically significant interrelations were found between hemisphericity and learning type as well as between the attributes within the concept maps. However, concept mapping attributes did not correlate significantly with hemisphericity and learning type. The ANOVA indicated that the in service elementary/middle school teachers performed significantly better in concept mapping than the pre-service elementary/middle school secondary science teachers.

Petty and Holtzman (1991) conducted a study on adult students entering post-
secondary institutions and found that their brain dominance was significantly related to their learning styles. The positive relationship and the lack of a pattern among students indicated that they have different learning styles and individual instructional needs.

Clark (1984) in a study focused upon the measurement of hemispheric dominance and learning style dominance of a group of 38 fourteen- and fifteen-year old high school students. The factors considered in relationship to learning style dominance were sex, achievement, and hemispheric orientation. Results of the study revealed that Visual learning mode had a moderate correlation with the Gender, female subjects. t-test values displayed a significant difference between the scores of males and females on the haptic learning mode as the primary learning style for both males and females. Results again indicated that Interactive learning modality had a moderate correlation with high Achievement. Visual learning modality had a moderate correlation with low Achievement. Results of the mean rank orders of the MMPALT II recognized the visual learning mode as the primary style for both high achievers and low achievers. t-test values demonstrated significant differences between the scores of high achievers and low achievers in the interactive and haptic learning modalities. The study again found a significant difference between right and left-hemisphere subjects and the visual learning modality. Mean rank orders of the MMPALT II exhibited the visual learning modality as the primary learning style for both right and left-hemisphere subjects.

Conclusion

The following conclusion can be made from the studies reviewed in section 3.2.2.

When Mehrdad and Ahghar (2012) investigated the difference in the brain dominance (left/right) in the learning style and therefore learning strategy differences between left handed and right handed EFL students, no significant difference was found in the brain dominance between right handers’ and left handers’. Chauhan (2009) found no significant relationship between right and left hemispherical oriented boys as well as girls students belonging to high and low intelligence group.

Rosihan and Liew (2006) investigated the differences in Brain Hemisphericity and learning styles on students’ confidence in using the graphics calculator (GC) to learn Mathematics and found that GC confidence ratings are not significantly different across brain hemisphericity as well as learning styles. Nussbaumer (2001)
developed a theoretical framework that utilizes Learning Styles and superimposes hemisphericity with emphasis on right-brain activities. Results of the study by Seng and Yeo (2000) indicated that there are no significant differences in learning style preferences from the three brain dominance groups.

When Lian (2000) studied the relationship between Learning Styles and hemispheric preference, it was found that there is a significant relationship between Learning Style and hemispheric preference. Whereas Bitner (1996) conducted a study to determine whether hemisphericity and learning type are related to the concept mapping attributes of pre-service and in service teachers, statistically significant interrelations were found between hemisphericity and learning type as well as between the attributes within the concept maps. The study conducted by Petty and Holtzman (1991) on adult students entering post-secondary institutions found that their brain dominance was significantly related to their learning styles.

When Clark (1984) in a study focused upon the measurement of hemispheric dominance and learning style dominance of a group of 38 fourteen- and fifteen-year old high school students, found a significant difference between right and left-hemisphere subjects and the visual learning modality. Also visual learning modality was the primary learning style for both right and left-hemisphere subjects.

The studies reviewed about Learning Styles reveal that there are different learning style classifications and students have major preference for a particular style. Some student demographic characteristics show a significant influence on learning styles. It is revealed from the studies conducted on learning styles that quality of education will be enhanced if instructors modify their teaching styles to accommodate the learning styles of all students their classes. Most of the studies revealed that students’ learning style preferences will benefit student achievement. Studies reviewed also revealed that there is relation between learning styles and hemispheric preferences of students.

3.3 Studies related to Hemispheric Preferences

The human brain functions in many ways acts as two brains-right and left hemispheres-and that is the way in which we experience the world. Most people have a preferred (dominant) hemisphere, and that this preference affects personality, abilities and learning styles. This preference may be that if one hemisphere is more efficient than the other at developing within hemisphere networks and processing, then that hemisphere contributes more during cognitive processing. As a result,
hemispheric preference may arise. The preference for either hemisphere does not mean that we do not use both hemispheres. In doing a simple task, we use the hemisphere which specialises in that task. Studies related to Hemispheric Preferences are given below.

The purpose of the study conducted by Shen et al. (2013) was to investigate the hemispheric effect of creative insight. The study used high-density ERPs to record participants' brain activity while they performed an insight task. Results showed that the spatiotemporal pattern of brain activation associated with insight solutions supported the idea that the right hemispheric dominance theory of creative thinking also applies to creative insight.

Gupta, Dubey, Saxena and Pandey (2011) investigated how and to what extent individual difference in hemispheric preference relate to emotion regulation. The correlation between dimensions of hemispheric preference and difficulties in regulating emotions was computed. The findings revealed that greater preference for right hemispheric mode of information processing as compared to the left is associated with greater difficulties in regulating emotions.

Julieta (2000) conducted a study to determine the relationship between the Hemispheric Dominance (HD) and English Proficiency (EP) in the four macro skills of the college students of Western Mindanao State University viz-a-viz their age, gender and area of specialization. The study concluded that students’ hemispheric dominance did not affect their English proficiency both in the four macro skills and global level; however, it did influence their English proficiency when they were categorized according to age and area of specialization.

Oxford (1996), Kinsella (1995), and Oxford, Ehrman, and Lavine (1991) maintained that left hemispheric dominants are highly analytic, verbal, linear and logical learners, whereas right-hemispheric dominants are highly global, visual, relational, and intuitive learners. Whole brain dominants are those who process information through both hemispheres equally and exhibit characteristics of both hemispheres.

Research has demonstrated that students are capable of mastering new skills if they are taught through instructional methods that complement their hemispheric preference (Boyle and Dunn, 1998; Dunn, Sklar, Beaudry, and Bruno, 1990). Several studies have found that students taught through methods that matched their hemispheric styles achieved statistically significant higher test scores than when they
were taught through other teaching methods (Brennan, 1984; Dunn, Sklar, Beaudry, and Bruno, 1990; Jarsonbeck, 1984).

To Zenhausern (1982), individuals with a right hemisphere cognitive style tend to express their thoughts in pictorial form, and prefer deductive reasoning. Those with a left hemisphere cognitive style tend to express thoughts more abstractly, and prefer inductive reasoning. Hemisphericity is relative rather than absolute. It only emphasizes ‘differences’ in brain functioning and processing.

Torrance (1982) conducted an interdisciplinary research that recognized the importance of two kinds of information processing that seem to parallel the specialized cerebral functions of the left and right hemispheres.

Measures of creative style tend to be positively and significantly related to the right side of the brain (Gowan, 1979; Gazzaniga, 1975). The left hemisphere seems to be specialized for the logical, sequential processing style and deals primarily with verbal, analytical, temporal, and digital materials. The right cerebral hemisphere functions nonlinearly and holistically, simultaneously dealing with a variety of variables and different kinds of information. It is specialized for nonverbal, spatial, emotional, and aesthetic materials.

**Conclusion**

The studies in section 3.3 can be summarized as follows.

Study by Shen et al. (2013) supported the idea that the right hemispheric dominance theory of creative thinking also applies to creative insight. The findings of the study by Gupta, Dubey, Saxena and Pandey (2011) revealed that greater preference for right hemispheric mode of information processing as compared to the left is associated with greater difficulties in regulating emotions. Julieta (2000) in her study concluded that students’ hemispheric dominance did not affect their English Proficiency both in the four macro skills and global level; however, it did influence their English Proficiency when they were categorized according to age and area of specialization. Oxford (1996), Kinsella (1995), Oxford, Ehrman, and Lavine (1991), Gowan (1979), and Gazzaniga (1975) maintained that left hemispheric dominants are highly analytic, verbal, linear and logical learners, whereas right-hemispheric dominants are highly global, visual, relational, and intuitive learners. Whole brain dominants are those who process information through both hemispheres equally and exhibit characteristics of both hemispheres.
Research by Boyle and Dunn (1998) Dunn, Sklar, Beaudry, and Bruno (1990) demonstrated that students are capable of mastering new skills if they are taught through instructional methods that complement their hemispheric preference. According to Brennan (1984), Dunn, Sklar, Beaudry, and Bruno (1990), Jarsonbeck (1984), students taught through methods that matched their hemispheric styles achieved statistically significant higher test scores than when they were taught through other teaching methods. To Zenhausern (1982), Hemisphericity is relative rather than absolute. Torrance (1982) conducted an interdisciplinary research that recognized the importance of two kinds of information processing that seem to parallel the specialized cerebral functions of the left and right hemispheres.

3.3.1 Studies Related to Hemispheric Preferences and Gender

Venugopal and Mridula (2006) examined the hemispheric preferences for information processing and styles of learning and thinking in children. Results revealed that there was significant difference in the right and left (brain) hemisphere preference for information processing among children and boys were more right hemispheric oriented and girls were more left hemispheric oriented in information processing. Significant difference in the styles of learning and thinking and concept preference among right hemisphere and left hemisphere dominant children was also observed with respect to both genders.

Oxford (2002), postulates that males might usually process language learning information more readily through the left-hemispheric, analytic mode, but females might more often process language learning data through an integration of left-and right-hemispheric modes. However, other researchers (e.g., Fausto-Sterling, 1985, cited in Oxford, 2002) oppose the idea that brain hemispheres are more integrated in females than in males or that brain hemispheric differences can make a significant difference. The prevailing opinion seems to be that there are indeed gender differences in brain hemisphericity that deserve consideration and further exploration. And our understanding of language Learning Style--for both ESL and foreign languages--would benefit if these differences were explored (Oxford, 2002).

Russo, Persegani, Papeschi, Nicolini and Trimarchi (2000) examined gender differences in Hemisphere Preference (HP) assessed by the Preference Test (PT). Factor analysis on the total sample revealed a clear two-factor structure (i.e., left-HP and right-HP), although separate analyses for men and women suggest that this structure is more straightforward in men than in women. The main differences
between men and women have to do with PT items relevant to language abilities, where women tend to be more symmetrically distributed across the two factors. However, the frequency of right- and left-HP is similar in men and women and does not change for men when PT scores are recalculated after removal of unspecific items. Furthermore, once the items that assess verbal abilities were excluded, the corrected PT value for women showed higher right-HP. Results provide some indications of a less pronounced lateralization of hemisphere-linked cognitive abilities in women.

**Conclusion**

When Venugopal and Mridula (2006) examined the hemispheric preferences for information processing and styles of learning and thinking in children, results revealed that there was significant difference in the right and left (brain) hemisphere preference for information processing among children and boys were more right hemispheric oriented and girls were more left hemispheric oriented in information processing. Oxford (2002) postulated that males might usually process language learning information more readily through the left-hemispheric, analytic mode, but females might more often process language learning data through an integration of left-and right-hemispheric modes. When Russo, Persegani, Papeschi, Nicolini and Trimarchi (2000) examined sex differences in Hemisphere Preference (HP) assessed by the Preference Test (PT) found that the frequency of right- and left-HP is similar in men and women and does not change for men when PT scores are recalculated after removal of unspecific items. Furthermore, once the items that assess verbal abilities were excluded, the corrected PT value for women showed higher right-HP. Results provide some indications of a less pronounced lateralization of hemisphere-linked cognitive abilities in women.

**3.3.2 Studies Related to Hemispheric Preferences and selection of Academic Majors**

Lavach (1991) examined the brain hemisphericity of students with different majors. He reported that humanities students showed preference for the right-hemispheric dominance. Natural science students demonstrated a left-hemispheric mode, while social science majors showed preference for left-hemispheric dominance.

Studies have suggested that brain hemisphericity is associated with different occupations and academic majors (Kolb, 1979; McCarthy, 1996). Kolb believed people choose majors/fields based on congruence between their learning styles and the norms of those majors/fields (1979). People choose their academic majors based
on the compatibility between the norms of these disciplinary fields and the individual's hemispheric dominance (Kolb, 1979; Gordon and Coscarelli, 1986; Rowe, Waters, Thompson, and Hanson, 1992). Academic subjects such as arts, the humanities, and architecture are believed by several researchers to require a more global, synthetic, and spatial orientation which make them more suitable for right-brain dominant students, whereas other subjects such as science, engineering, and language emphasize logic and verbal analysis, which make them a better fit for left-brain dominant students (Coulson and Strickland, 1986; Herrman, 1982; Katz, 1983).

Conclusion

When Lavach (1991) examined the brain hemisphericity of students with different majors, reported that humanities students showed preference for the right-hemispheric dominance. Natural science students demonstrated a left-hemispheric mode, while social science majors showed preference for left-hemispheric dominance. Studies by Kolb (1979) and McCarthy (1996) have suggested that brain hemisphericity is associated with different occupations and academic majors. According to Coulson and Strickland (1986), Herrman (1982) and Katz (1983) academic subjects such as arts, the humanities, and architecture require a more global, synthetic, and spatial orientation which make them more suitable for right-brain dominant students, whereas other subjects such as science, engineering, and language emphasize logic and verbal analysis, which make them a better fit for left-brain dominant students.

Thus the studies in section 3.3 reveal that students have major preference for either left or right hemisphere. Studies revealed that left hemispheric dominants are analytic, verbal, linear and logical learners, whereas right-hemispheric dominants are global, visual, relational, and intuitive learners. Whole brain dominants are those who process information through both hemispheres equally and exhibit characteristics of both hemispheres. Selection of major subjects for study is dependent on Hemispheric Preference of students.

3.4 Studies related to Achievement in Physics

In this age of Science and Technology, the role Physics plays in the actualization of the needed technological advancement cannot be overemphasized. Physics as a science subject at the secondary school level is an important subject that is required for the scientific and technological development of any nation. Physics is a vehicle for achieving the long-term goals of science because it is instrumental to
technological and socio-economic growth across the globe (Okoronka, 2004). According to Oludipe (2003), the role of Physics in the education of scientists, engineers, chemists and practitioners of other physical and biological sciences are enormous. Moreover, the applications of Physics can be seen in all spheres of life. Some of the studies related to Achievement in Physics of students associated with different instructional strategies are presented below.

Muriithi, Odundo, Origa and Gatumu (2013) determined the impact of Project method on learner achievement in Physics in Kenyan public secondary schools. Quasi-Experimental design was applied. It was realized that use of project method produced better results when compared to traditional methods like discussion and lecture method. The study recommended the use of project method to supplement other methods of teaching Physics.

Uside, Barchok and Abura (2013) determined the effects of Discovery Experimental Method (DEM) on secondary School Students’ achievement in Physics in Kenya. The Solomon four group experimental design was used in the study. Students in Experimental group were taught using the DEM while those in control group were taught using the Teacher Demonstration method. The study revealed that the DEM had significant effect on the achievement of students by enhancing knowledge retention and instilling confidence.

Kumar and Mathur (2013) brought out the relative effectiveness of concept attainment model of teaching and conventional method of teaching on the achievement of students for the acquisition of Physics concepts in class IX. The results of the study indicated that there is significant difference between concept attainment model and traditional method on the achievement of students in understanding Physics concepts. Of these methods, concept attainment model was more effective than traditional method.

Rajasree (2013) studied the effectiveness of McCormack and Yager Taxonomy in teaching Physics at Secondary level. The findings of the study revealed that the teaching of Physics using McCormack and Yager Taxonomy helped to enhance Achievement in Physics of Secondary school students.

Khan, Muhammad, Ahmad, Saeed and Khan (2012) investigated the impact of activity based teaching on the students’ achievement in Physics at secondary level. Pre-test Post-test control group design of experimental research was selected for the study. Experimental group was taught with the help of activities whereas control
group was taught the same lessons through traditional method of teaching for a period of six weeks. The results showed that the activity-based teaching was more effective for achievement and development of higher order skills in the students.

Bello (2011) investigated the outcomes of using group instructional strategy on learning of Physics in senior secondary schools in Nigeria and also determined whether group instructional strategy will improve the performance of below average ability students. The study design was pre test-post test control experimental. The study revealed that those exposed to group instructional strategy performed better than those exposed to individual learning treatment; the below-average students exposed to group instruction have gain score over what they scored when not exposed to this method, which shows that there was improvement in their performance hence, more understanding of the Physics concepts.

Ogunleye and Babajide (2011) implemented generative instructional strategy for teaching selected Physics concept using the pre-test, post-test control group quasi-experimental design. Findings showed that students exposed to the generative instructional strategy performed better than their peers in the conventional teaching group to a significant extent.

Selcuk, Caliskan and Erol (2008) investigated the effects of problem solving instruction on Physics achievement, problem-solving performance and strategy use in an introductory Physics course at University level. In this study, pretest-post test and quasi-experimental design with nonequivalent control group was used. Two groups of student teachers (N = 74) participated in the study. During the 8-week study, one group received the strategy instruction while the other group acted as control. Findings of the study indicated that strategy instruction was effective on Physics achievement, problem-solving performance, and strategy use.

Gonen, Kocakaya and Inan (2006) compared the effect of the computer Assisted teaching and 7E Model of the Constructivist Learning methods on the Achievements and Attitudes of high school students in Physics classes. Two groups were selected for the study of which one received computer assisted, and the other was given instructions based on 7E model of the constructive learning method. A statistical Analysis of achievement test showed a significant difference between the students achievements at the knowledge and comprehension levels of cognitive domain (p<.05). No difference was noted between their achievements at the
application level of cognitive domain. The results also showed that the students’ attitude towards Physics learning was not affected by different instruction method.

Wambugu and Changeiywo (2006) found the effects of Mastery Learning Approach (MLA) on students’ Achievement in Physics. The study was Quasi-Experimental and Solomon Four Non-equivalent control group Design. The target population comprised of secondary school students in Kieni East Division of Nyeri District. The experimental groups were exposed to MLA for a period of three weeks, while the Regular Teaching Method was used in the control groups. The results of the study revealed that MLA teaching method resulted in higher achievement. The researchers concluded that MLA is an effective teaching method, which Physics teachers should be encouraged to use and should be implemented in all teachers’ education programmes.

Eryilmaz (2004) explored the effectiveness of one of the interactive engagement methods, which is peer instruction enriched by concept test on students’ achievement and attitudes towards Physics. The study was conducted with three teachers, six classes and total of 192 tenth grade students in the public high schools at Yenimahalle district of Ankara in the fall semester of academic year 2002-2003. Students from three classes participated in traditional instruction group and referred as control group, whereas the other three classes instructed by Peer instruction referred as Experimental group. The statistical results indicated that Peer instruction was more effective than traditional instruction whereas the statistical analysis failed to show a significant difference between the experimental and control groups’ attitude towards Physics.

According to Major and Palmer (2001) Problem-based learning is an educational approach in which complex problems serve as the context and the stimulus for learning. In PBL classes, students work in teams to solve one or more complex and compelling ‘real world’ problems.

Enyeneokpon, U.E. (n.d.) determined the effect of Problem-Based learning on NCE pre-service teachers’ achievement in Physics and acquisition of science process skills. The study adopted a quasi-experimental research design with 98 females and 94 males from six colleges of education in South Western Nigeria constituted the sample. A treatment group was exposed to the problem based learning instructional strategy and a control group exposed to the conventional lecture method. The treatment was found to have significant effect on pre-service teachers’
achievement in Physics $F_{(2,185)} = 43.44, P<.05$ and science process skills $F_{(2,175)} = 1983.80, P<.05$. It is concluded that problem-based learning strategy improves students’ achievement in Physics and acquisition of science process skills and is therefore recommended for the use by lecturers in colleges of education.

**Conclusion**

Muriithi, Odundo, Origa and Gatumu (2013) found that the use of project method produced better learner achievement in Physics when compared to traditional methods like discussion and lecture method. The study by Usido, Barchok and Abura (2013) revealed that the Discovery Experimental Method had significant effect on the achievement in Physics of students by enhancing knowledge retention and instilling confidence. When Kumar and Mathur (2013) brought out the relative effectiveness of concept attainment model of teaching and conventional method of teaching on the achievement of students for the acquisition of Physics concepts in class IX found that concept attainment model was more effective than traditional method. The findings of the study by Rajasree (2013) revealed that the teaching of Physics using McCormack and Yager Taxonomy helped to enhance Achievement in Physics of Secondary school students.

Activity-based teaching was more effective for achievement and development of higher order skills in the students according to the study by Khan, Muhammad, Ahmad, Saeed and Khan (2012). Bello (2011) investigated the outcomes of using group instructional strategy on learning of Physics in senior secondary schools in Nigeria and the study revealed that those exposed to group instructional strategy performed better than those exposed to individual learning treatment. After implementing generative instructional strategy for teaching selected Physics concepts, Ogunleye and Babajide (2011) showed that students exposed to the generative instructional strategy performed better than their peers in the conventional teaching group to a significant extent. Findings of the study conducted by Selcuk, Caliskan and Erol (2008) indicated that problem solving instruction was effective on Physics achievement, problem-solving performance, and strategy use.

When Gonen, Kocakaya and Inan (2006) compared the effect of the computer assisted teaching and 7E Model of the Constructivist Learning methods on the Achievements of high school students in Physics classes found significant difference between the students achievements at the knowledge and comprehension levels of cognitive domain. The results of the study conducted by Wambugu and Changeiywo
(2006) revealed that Mastery Learning Approach resulted in higher achievement in Physics of secondary school students in Kieni East Division of Nyeri District.

Eryilmaz (2004) explored the effectiveness of peer instruction enriched by concept test on students’ achievement in Physics and showed that Peer instruction was more effective than traditional instruction. According to Major and Palmer (2001), in Problem-based learning classes, students work in teams to solve one or more complex and compelling ‘real world’ problems. When Enyeneokpon, U.E. (.) determined the effect of Problem-Based Learning on NCE pre-service teachers’ achievement in Physics and acquisition of science process skills; it was found that the treatment had significant effect on pre-service teachers’ achievement in Physics and science process skills. It is concluded that problem-based learning strategy improves students’ achievement in Physics and acquisition of science process skills and is therefore recommended for the use by lecturers in colleges of education.

The studies reviewed in section 3.4 indicate that better Physics Achievement can be attained using different innovative instructional strategies. The achievement in Physics is important for the progress of a society and thereby nation.

CONCLUSION

The review of related literature enabled the researcher to have extensive information on various Learning Styles and Hemispheric Preferences of students undergoing various courses, how Learning Styles are related to other variables like students’ achievement and Hemispheric Preferences and how Hemispheric Preferences are related to other variables like gender and selection of courses for study. It also helped the researcher to know the effect of 4MAT System of Instructional Design on students’ achievement, their attitude towards learning, creativity and retention of achievement. It capacitated the investigator to frame the objectives for the study.