CHAPTER 3 REVIEW FOR GAINING INSIGHTS

“Besides providing a foundation for the problem to be investigated, the literature review can demonstrate how the present study advances, refines, or revises what is already known”.

-Merriam, 1988

3.1 Objectives of the Review of Related Literature

This chapter is concerned with the review of related literature, which is an essential and significant aspect of a research process. A systematic review of the related literature can help the researcher in the following ways.

It can:

i. show how another researcher handled a similar problem.

ii. suggest a method or technique of dealing with similar problem.

iii. reveal new sources of data which the researcher may not have known.

iv. introduce to the researcher eminent personalities whose work may not have been known before.

v. help the researcher to see the study in a historical perspective and in relation to other efforts to solve the same or similar problems.

vi. provide new ideas and approaches which may not have occurred to the researcher before and

vii. help the researcher to evaluate the research effort by comparing it with the efforts made by others.

3.2 Sources and types of Research Literature

Books, journals, reports, popular media, computer-based materials, memos, minutes, internal reports, letters, diaries, published and unpublished papers, contemporary and classic works, introductory and overview texts, edited
collections and literature reviews, methodological and confessional writing, primary sources, secondary sources and tertiary sources form the different sources and types of research literature.

**Figure 3.F.1 Possible Scope of Questions offered by the Review**

*(Amutha, S, 2010)*

- What are the key theories, concepts and ideas?
- How are key components of the research design identified?
- What are the origins and definitions of the topic?
- What are the major issues and debates about the topic?
- What are the Epistemological and Ontological grounds for discipline?
- What are the main questions and problems that have been addressed to date?
- What are the International views on the topic of the research?
- What are the pedagogical standpoints?
- What are the insights gained from the reviews?
- How is knowledge on the topic structured and organised?
- What are the pedagogical standpoints?

Most science teacher in-service courses typically do not expose teachers to science in a real, creative setting (Raphael *et al.* 1999). Without experience and training in alternative strategies, high school teachers are likely to teach science the same way that they were taught; most will rely on memorization and lecture (Darling-Hammond 1996; NRC 1996).
The effectiveness of teaching methods plays an important role in imparting the desired messages to the students. The teaching methods or the instructional strategies are dynamic and varying from time to time and target to target. To cope up with the changes, the competence of the teachers has to be enhanced and enriched in not only on the methods but also on the content knowledge. Towards this end several aspects such as Development of e-content, inclusion of Metacognition and Instructional design were utilized in the present study.

3.3 Conceptual Symbiotic Validation

The American Association for the Advancement of Science (AAAS, 1993) advocates science education standards require systemic changes involving the development of teachers’ perceptions of science teaching. The Australian National Science Standard Committee (2002) also recommends professional knowledge, professional practice, and professional attributes as standards for recognising accomplished teachers of science. “Education reform can succeed only if it is broad and comprehensive, attacking many problems simultaneously. But it cannot succeed at all unless the conditions of teaching and teacher development change” (National Commission, 1996).

Novak (1963) in his article entitled “A preliminary statement on research in science education” describes science education as a poor cousin of the sciences, because it lacked theoretical models that could be tested in educational settings and it was intellectually isolated from disciplines such as psychology and behaviour.

The project study on the status and quality of teaching and learning of science in Australian schools done by Goodrum, Hackling and Rennie (2001) recommended Department of Education, Australian government to address raising community awareness of science and science education issues such as teacher supply and demand, initial teacher education, professional development and
professional standards. It has also recommended reviewing the quality of science teaching and learning. The national action plan 2008 -2012 prepared by Australian government addresses teacher education for science and professional learning. It has identified few areas such as curriculum assessment, teacher education, professional learning, teacher supply and demand and resources of learning.

The primary objective of science education research and scholarship is to improve teaching and learning practices so as to improve science learning. The field of science education as developed into a diverse aggregation of interest areas as witnessed in the pages of research in science education and other journals in this field (Research in Science Education, 2006, 36:1-6)

A major component of the current reforms in science education worldwide is the shift from the dominant traditional teaching for algorithmic lower-order cognitive skills to higher order cognitive thinking skills (Leou,Abder,Riordan and Zoller ,2006).

It has been observed by Windschitl (2003) and Barak and Dori (2005) that although the guiding ideas of science education reforms and the corresponding supporting teaching strategies have been, and are incorporated into teachers’ pre-service courses and in-service professional development progrmmemes, a substantial portion of the strategies are not implemented in the teachers’ class rooms. Indeed, the design and implementation of teaching strategies that enhance higher order thinking among student are not a simple endeavour; they challenge even the most expert teachers (Tobin,Kahle and Fraser ,1990)

It is imperative to go through the observations of James Bower (1994) a scientist in California institute of technology on science education reform. The following are his observations on science education in the globe:
♦ The problem with public science education is that large percentages of teachers are incompetent.
♦ Teachers are under motivated to teach science because they do not understand how exciting it is.
♦ The primary reason teachers do not teach science well is lack of science content knowledge.
♦ Supplemental teacher training is necessary because too few teachers especially in early grades have been required to take science classes in school.
♦ The key to scientist involvement in teacher training to provide complex information in as digestible a form as possible.
♦ The problem with science education is lack of good curriculum.
♦ Training a few highly motivated teachers will produce ‘trickle down’ reform when they return to their schools.
♦ If teachers are motivated enough during training, they will find a way to obtain the material necessary to teach science in class rooms.
♦ Reform can be accomplished with existing resources if they are simply allotted more efficiently.

Ronald Anderson (2002) indicated that the key elements of research about reforming science teaching to yield the desired inquiry orientation must include attention to both means and ends. This form of inquiry is treated as being grounded in certain abilities and understandings. Inquiry was used in a variety of ways with respect to teaching. Since “inquiry is central to science learning”, it is expected to be prominent in science teaching. This definition of inquiry reflects an understanding of how science proceeds and is independent of educational processes. Teachers seeking an inquiry orientation should focus on the nature of student work, the students’ role and their own role. Research indicates that teachers focus on what works in terms of student involvement or classroom management, rather than on melding theory and practice. Teachers’ understanding
takes “the form of practical, not theoretical or propositional, knowledge”. They anchor their understanding in classroom events and base it on stories and narratives more than on theories and propositional knowledge. Their view of teaching was “dominated by tasks and activities rather than conceptual structures and scientific reasoning”. Teachers and others in positions of leadership focused on creating a climate of collaboration among teachers and providing a context within which they can reflect on their values and beliefs. The facets of the needed systemic process are many and must stay in place over a long period of time.

The findings of the study entitled “a model for science education reforms in rural schools” done by Preston Prather et.al (1989) reveal that science instruction in Tennessee classrooms of rural schools has not made a satisfactory start due to the lack of methods of instruction. It is also observed from the justification given in the study that several studies reviewed indicated that lack of understanding of science and the resources needed for effective science instruction have played the key role.

The Iowa scope, sequence and coordination (SS&C) project was one of five SS&C original status (Iowa, North Carolina, California, Puertorico and Alsk) committed to science teacher enhancements and toward teaching fewer concepts in greater detail. The Iowa SS&C was a funded teacher enhancement project active from 1990-1997 through two distinct funding phases. In both the phases, the participating teachers came from sites ranging from relatively large metropolitan districts to very small rural districts. The Iowa SS&C project was guided by a commitment to the following aspects:

♦ Improvement of science education through professional development activities and continuous collaborations. The teachers planned and designed constructivist learning experiences and curricular frame works using a science – technology-society context emphasizing the concept of reflection in action.
♦ Development of a network continuing teacher enhancement.
♦ Communication between lead teachers and teacher participants was a high priority.

Adrienne Kozan Naumescu (2008) analyzed the competencies of Science teachers by using the questionnaire. Phenomena by their nature involve various disciplines and hence teacher should be able to search for explanations involving the single discipline and at same time frame it in a multidisciplinary scenario. Therefore, it is recommended that a science teacher training programme must offer trainees the knowledge and awareness of the relationships between disciplines. This competency cannot be accomplished in the framework of a strict disciplinary-separate training programme. Furthermore, prospective teachers must be provided with instruction that facilitates the identification and development of concepts that unify the traditional science disciplines. In such training, specific learning opportunities and instruction that would help prospective teachers to develop such interrelationships should be included. Science education programmes should pay more attention into the learning of science in social and technological context, such as field trips, arranged visits to museums or to industries and institutions. Such training programmes must allow teachers to develop a deep understanding of scientific ideas and the manner in which they were formulated.

There is one critic who raises cautions about the over rules of technology is Oppenheimer (1997; 2003) who states that technology is not the only answer to fostering students success. He has uncovered many examples to illustrate that technology use in classrooms has not significantly improved student learning. He notes that many school districts in California have invested millions of dollars in technology, hardware and software and the schools have not realised the desired learning goals as anticipated. The author does not share is broadly negative view of technology in the classroom, but he wants to remain the reader that one possible
misuse of technology is to reinforce one particular instructional modality instead of differentiating learning to meet the needs and learning styles of diverse students. Using a variety of instructional strategies provides a richer set of experiences for all students of rethinking how technology can be applied and constantly striving to use it to build a deeper understanding; educators will have a wider range of tools for planning and delivering instruction to reach the largest number of diverse learners. For Tomlinson and Mctighe (2006) technology is one way to help educators to “work smart”. The use of technology can bring together instructional design and strategies in creative ways that work to promote the development of student’s science knowledge, understanding and skills.

Thanu Padmanaban, professor at the inter university centre for Astronomy and Astrophysics has shared his observation for the Hindu (6.10.2010 ) on quality of science teachers. He asserts the science not taught as hands – on experience. The curiosity of the students is not developed, nurtured and satisfied. Students rely on memory and assimilation of facts rather than on the pleasure of learning and application of knowledge. He also wanted to improve the quality of science instruction and research using technological advancements. Linn (1992) also recommended that computers be incorporate as a learning partner in science education reform of computers are used wisely they can lead to effective learning on the other hand, the use of computer for presenting electronic texts could reinforce students as memorizers of science facts. Only if students are challenged to interpret or reflect on the information that is displayed can be productive partnership emerge (Linn, 1992).

Yasemin Godek Altuk, Ahi Evran Universitesi (2010) explored the perceptions of secondary science student teachers, newly qualified teachers and PGCE tutors about the role of the PGCE courses in knowledge base (Subject Matter Knowledge- SMK and Pedagogical Content Knowledge- PCK)
Participants’ perceptions were revealed through in-depth interviews and a short questionnaire. The results revealed that there was a difference between the philosophies of the universities and the schools in terms of the support provided, participants’ conceptions concerning the process of learning to teach and the role of ‘experience’, the difficulty in the implementation of the reflective practitioner model in schools, and the difficulty in relating the theory to the practice. Unless students’ perceptions are challenged through informing them about the nature of the reflective practitioner model and students’ own role in this model, it will be difficult for the teacher education courses to have a strong effect on students’ professional development.

Ugo Besson, Lidia Borghi, Anna De Ambrosis & Paolo Mascheretti (2010) have elaborated and tested a model of teacher preparation aimed at favouring the diffusion in schools of innovative teaching practice. The model focused on analysis and discussion of research-based teaching learning sequences developed by the group and involves three steps. In the first one, a research based teaching learning sequence was proposed to teachers: they follow the same path designed for secondary school students, but they were guided to reflect both on the content and on the didactical aspects. Then each teacher prepares a teaching plan for a specific teaching situation and implements it in class. Finally she/he produces a report on his/her work in classroom and discusses it with the whole working group. The investigator experimented modules concerning different physics topics. As an example, they summarize the module on hydrostatics and the results obtained. Results revealed that the module leads teachers to reconsider the science content, jointly with the teaching approach, and that their personal reconstruction of the topic in a didactical perspective produces a motivation to introduce innovation in their teaching.
Maor (1999) describes a professional development programme using an interactive multimedia programme to develop teachers' understanding of a constructivist epistemology in science education. The aim of this study was to describe teachers' reflections on and perceptions of a series of professional development workshops and how teachers changed their classroom practices after having participated in the workshops. The software, developed with the cooperation of teachers and students, is based on the Birds of Antarctica database (Maor & Phillips, 1996). This database was designed as an interactive programme which requires teachers to use a constructivist-oriented approach to teaching and learning, in order to promote the development of inquiry skills particularly higher-order thinking skills. A series of workshops for teachers were conducted to empower them to become comfortable with using computers in science classrooms and to enable them to enhance their understanding of, and ability to use, personal and social constructivist approaches. Teachers' perceptions of the process of learning with the multimedia programme and their reactions to their experiences were assessed using a new instrument, the Constructivist Multimedia Learning Environment Survey (CMLES). It has been suggested that teachers who participated as learners in the professional development programme became familiar with a constructivist-oriented multimedia learning environment; understood the context, problems, and issues faced by students in the classroom; and were better able to facilitate students' needs and understanding in this learning environment.

Markus Wilhelm, Dorothee Brovelli, Markus Rehm, Alexander Kauertz (2010) explored the interdependence of professional identity and students’ views on teaching competence. Questionnaire data were obtained for 311 students from different teacher training programmes at 6 universities in Germany and Switzerland. Three aspects of professional identity considered were: subject matter expert, pedagogical expert and didactical expert. Views on teaching competence
were also investigated in three categories: viz. competencies with respect to subject matter content (science competence), teacher (self-competence), and learner (tutorial competence). Students were asked to self-evaluate their teaching competencies and to rate the relative importance they attribute to these competencies. The questionnaires were shown to have reasonable reliability and validity. Results show that perceived stronger science competence correlates with a professional identity as a subject matter expert, while perceived stronger self-competence could lead to any type of professional identity. Furthermore, a given professional identity seems to influence how much students’ value competence in the matching category, e.g. pedagogical experts considers tutorial competence especially important. Results vary significantly for different teacher training institutions. In particular, students from the sole teacher training institution with combined science disciplines showed significantly higher values for a professional identity as “subject matter expert” than students from institutions teaching science in separate disciplines. This suggests serious implications for the design of programmes in teacher education.

Mason (2002) outlines a wide spectrum of interests and understandings attached to the term e-learning, and concludes that many continue to see it as a convenient medium for content delivery and testing students. He summarized five principles that integrate the affective and cognitive domains of learning. They are maintaining a buffer between the learner and the potentially damaging effects of instructional practices; provide a context for learning that supports both autonomy and relatedness. Embed the reasons for learning into the learning activity itself support self-regulated learning; professional development programmes should be based on student learning needs and should help science educators address difficulties students have with subject-matter knowledge and skills. The following are the observations of the author on professional development programmes:
♦ Professional development programmes should be based on the needs of science educators of both individuals and members of collaborative groups who are involved in the programme. Ongoing professional development initiatives should be assessed and refined to meet teachers’ changing needs.

♦ Professional development should be integrated and coordinated with other initiatives in schools and embedded in curriculum, instruction, and assessment practices.

♦ Professional development programmes should maintain a sustained focus over time, providing opportunity for continuous improvement.

♦ Professional development should actively involve teachers in observing, analyzing, and applying feedback to teaching practices.

♦ Professional development should concentrate on specific issues of science content and pedagogy that are derived from research and exemplary practice. Programmes should connect issues of instruction and student learning of knowledge and skills to the actual context of classrooms. Structuring process strengthen the learner's tendency to engage in intentional learning processes, especially by encouraging the strategic exploration of errors.

♦ Professional development should promote collaboration among teachers in the same school, grade, or subject.

It is apparent in current literature (Gray and Bryce, 2006; Hewson, 2007) that there is a lack of adequate teacher professional development opportunities in science education which consider the multi dimension aspect of professional practice, strengthen teachers foundation in the knowledge, practical skills, pedagogical and socio-scientific dimensions of science education and inspire them as practitioners to deepen their commitment to contemporary science education and debate. To date, teacher have relied in most part on professional development.
sessions that have been regarded as ‘ad-hoc’, ‘top – down’, ‘just-in-time’, ‘hit and run’, ‘show and tell’, ‘piecemeal’ (Senate employment education and training references committee (1988) which according to Adey, Hewitt and Landan (2004) are universally condemned in the research literature as being in effective ways for teachers to learn. These are generally the types of professional development sessions provided by tertiary institutions, government departments, industry outreach programmes and individuals from within the education community (Loucks-Horsley,Love,Stiles,Mundry & Hewson,2003). Whilst these professional development attempts have been well meaning and have simultaneously addressed several of the key aspects of effective professional development, Anecdotal evidence indicates that they have lacked the ability to present a sustainable and totally relevant professional development programme that takes into account the syllabus, financial constraints in schools, the needs of adult learners and effective pedagogical practices to ensure positive students learning outcomes (Stephen Thomas Garrett,2009).

Yager 1993 has suggested that science teacher education programmes should be based upon objectives expressed in performance terms that delineate a variety of instructional skills and competence. Taylor, Middleton and Napier (1990) have also advocated that the major thrust of teacher education programmes is to maximize the professional competence of teachers.

The concept of metacognition, unlike the teaching thinking programmes, was one construct from the field of cognitive psychology that education theorists and practitioners alike saw great promise and that has persisted in the minds and souls of many educators, if not always the day-to-day practices. Interested readers will find informative, short histories of the evolution of the concept of metacognition in Hacker, Dunlosky, and Graesser (1998) and Schwartz and Perfect (2002).
White (1988) explained that the promise associated with metacognition was to be found in its usefulness as a construct for conceptualizing and designing classroom interventions that aimed to improve educational outcomes and students’ learning abilities. This was highly preferable to what many see as the alternative of acceding to deficit models of cognition and intelligence that view ability as a relatively fixed learner characteristic. Several science educators embraced the concept of metacognition. Prominent among them were the antipodan trio of John Baird, Dick White and Dick Gunstone who contributed substantially in moving metacognition into mainstream science education research and who sought to engage science teachers and their graduate students, many of whom were practicing science teachers, in considering how they might develop students’ metacognition. As some science educators embraced the concept of metacognition it became quickly apparent that metacognition research faced several challenges. Garner and Alexander (1987) in the psychology field and White (1988) in science education Gibbons (2008) on research based strategies for teaching English learners found that the use of advance organizers helped those learners make visual connections between science concepts. This strategy also set the framework for the lesson by connecting learners’ prior knowledge with new content to be learned. Concept maps can be tools for determining hierarchical relationships among information and making those relationships clear (Novak & Canas, 2006). Our science students come to science class with ideas about how the world works—ideas that are often different from accepted scientific ideas. Teachers work hard to help students rethink their ideas through a process of conceptual change, but the students themselves also have an important role to play. Students regulate their own learning. Self-regulated learners are able to set learning goals, find strategies that help them achieve those goals, and monitor their progress (Schraw, Crippen, and Hartley 2006). An important part of self-regulation is thinking about thinking, or metacognition. According to cognitive scientists (Donovan and Bransford 2005), metacognition involves self-monitoring and
reflection on learning. Researchers have shown that metacognition can support student learning with understanding in many subjects.

Meaningful learning (Ausubel, 1963, 1968; Bodner, 1986) involves among other things taking responsibility for one’s own learning processes. Metacognition is often described as active monitoring, conscious control, and regulation of learning processes (Baird, 1986; Baird & White, 1996; Flavel, 1987; Gunstone, 1994; Larkin, 2006; Mintzes & Wandersee, 1998; Thomas, 1999; Thomas &McRobbie, 2001; White, 1993, 1998). While other frameworks exist (Veenman, Van Hout-Wolters,&Afflerback, 2006), it provides a useful view for understanding students’ learning. Moreover, this view has the capacity to reveal underlying mechanisms related to student knowledge construction.

Learning to teach science is conceived as a cognitive activity involving the future teacher who should learn what to do, what knowledge he/she would have to use and how to choose the suitable strategy in order to make decisions about science teaching. In other words, it means teaching would be teacher to regulate their own learning. For our purposes, there is no need to distinguish between terms as self-regulation and metacognition, because both terms refer to processes that are learnable and its possession and use determine students' abilities to learn (White, 1998). In this sense, we consider when would be science teacher is self-regulated, he/she displays metacognitive features as knowledge of processes of thinking; awareness of one's own processes; ability to control them (Flavell, 1976) and willingness to exercise that control (White, 1998).

Hollingworth and McLoughlin, (2001) while exploring the different dimensions of online quality found that social constructivist theory concerning reflective thinking is very important. Fostering reflective thinking need multiple sources of feedback on their understanding gained through social interventions. It is suggested that reflective thinking will most likely occur in situations where
problems are complex and meaningful to the students to organize, monitor and evaluate their thinking and learning to come to a deeper understanding of their own process of learning; students’ Metacognitive skills can be developed significantly by taking proactive approach and by designing an environment specifically for problem solving and Metacognition.

Anne Graham and Renata Phelps (2003) discussed about teacher education initiative that attempts to integrate both the skills and identity agendas through a Metacognitive and reflective practice approach. They made it a point that a continued commitment to the approach in teacher education will require ongoing investigation and documented evidence as to its efficacy, particularly over time. They ensure that the approach has significant implications for teacher educators. It stressed that strong partnership between universities, schools and professional bodies to continue to effectively challenge and re-shape possibilities for ‘being a teacher’ in the future.

The work of Gertrude Hennessey (2003) in teaching and researching elementary science has shown that children’s metacognitive abilities are essential to conceptual change in science. In a series of studies with first through sixth graders, Hennessey developed strategies for helping students be metacognitive, implemented them in her teaching, and listened closely to students as they learned science. Hennessey found that children of all ages could become aware of and regulate their own thinking processes. Furthermore, through self-interrogation and introspection, students came to understand the scientific ideas more deeply. For example, in a fifth-grade unit on the particulate nature of matter, students used their metacognitive skills to help reason about states of matter using water as a case example (Beeth 1998). One of the students recognized that the various explanations the class had developed for differences in solid and liquid water were inconsistent, which helped the class come to a deeper understanding of states of
matter. Hennessey’s work as a science teacher and a researcher demonstrates that teachers can help students become more metacognitive and that thinking about thinking improves conceptual understanding in science.

Instructional design is instrumental for the development of professional competence of science teachers in particular. It is a widely acknowledged system of planning, implementing and evaluating instructions (Gagne, Wager, Golas and Keller, 2005; Reiser and Dick 1996; Shelly, Cashman, Gunder and Gunter, 2006). Historically, instructional design was recognised for its use in the military and now gradually has become more a mainstream in teacher education programmes. The premise of instructional design is to make learning more efficient. Reiser and Deck (1996), Morgan (1989) and Bowsher (1989) note that employing this organised approach in such diverse settings as schools, developing countries and business has lead to valuable methods of instruction. Snell Becker (1947) and Morrison, Ross and Kemp (2007) proposed that this structured systematic process establishes the link between educational research and practical applications.

A study done by Gregory Schraw, Kent J. Crippen and Kendall Hartley (2006) is to review recent research on self-regulated learning and discuss the implications of the research for science education. Examples of self-regulated learning from the science education literature are to summarise and illustrate effective instructional methods and the development of metacognitive understanding (Gunstone; 1999a; Rickey & Stacy, 2000; White & Mitchell, 1994). The focus is also on the crucial role that metacognition plays in self-regulation (Baird & White, 1996; Nichols, Tippins, & Wieseman, 1997; White, 1998). The discussion is divided into two main parts. The first focuses on three components of self-regulated learning, including cognition, metacognition, and motivation. Authors relate these aspects of self-regulation to current practices in science
education. The second section focuses on six general instructional strategies for improving self-regulation in the science classroom. Main focus was on the use of inquiry based learning, the role of collaborative support, strategy and problem solving instruction, the construction of mental models, the use of technology to support learning, and the role of personal beliefs such as self-efficacy and epistemological world views. These instructional strategies are selected because they reflect extensive research agendas over the last decade within the science education literature and are essential to metacognition and self-regulation (Butler & Winne, 1995; Gunstone, 1999b). In addition to instructional strategies, technology can be used to promote metacognitive activities such as planning and monitoring (Puntambekar, 1995). The author has reviewed the study on Puntambekar and duBoulay (1997) and developed a computer assisted instructional system called Metacognition in Studying from Texts (MIST) to train students to reflect upon what they were reading and to monitor their understanding.

Dachao Li & Ping Li (2003) are of view that scientific cognition as Model-Based Reasoning (MBR) has increasingly occupied the recent literature, and the accounts of mental modelling have provided an elementary understanding of the cognitive basis of scientific reasoning. He used a cognitive-historical approach to the case of Maxwell’s electromagnetic theory and pointed out that MBR is a central characteristic of scientific reasoning during scientific revolution. There are three important aspects in the analysis of the concept of paradigm as constraints of modelling: a disciplinary matrix as explicit constraints; exemplars as implicit/tacit constraints; and puzzle-solving as MBR according to one fixed set of constraints. Thus, it is possible to account for scientific practices of normal science in the light of the key characteristics of the use of mental models in reasoning. First, a mental model captures what is common to all the possibilities even though it represents only one possibility satisfying constraints of modelling. In the practices of normal
science, the central function of exemplars is to represent the modelling constraints involved in a paradigm in a cognitively manageable way, so that scientists develop other models through processes of inference by similarities. Second, mental models represent what is true relative to modelling constraints, and thus may lead to systematic errors. The similar situations would happen in reasoning practices of normal science – for example, the historical cases of the particle theory when it was used to explain phenomena of light such as reflection, refraction, and Newton ring. Of course, it should be noted that, due to the function of generic abstraction, new constraints can emerge in the processes of model-based reasoning, even those that suggest us to reject the old entrenched constraints. Third, procedures of model-based reasoning in ordinary inferential tasks rely entirely on alternative models to refute invalid inferences.

John Gilbert (2005) reviewed the range of terminology used in the field of ‘visualization’ and, in the light of evidence that it plays a central role in the conduct of science, it was argued that it should play a correspondingly important role in science education. The paper conceptualized that visualization is central to learning, especially in the sciences, for students have to learn to navigate within and between the modes of representation and therefore argued that students – science students’ especially - must become metacognitive in respect of visualization, that they must show what I term ‘metavisual capability’. Without a metavisual capability, students find great difficulty in being able to undertake these demanding tasks. The development of metavisual capability is discussed in both theory and practice. It was concluded that much more research and development is needed in respect of visualization in science education if its importance is to be recognized and its potential realized.

Qiyun Wang (2008) wrote a paper to examine the effective integration of Information and Communication Technology (ICT) into teaching and learning.
This paper proposes a generic model, which consists of three fundamental elements: pedagogy, social interaction and technology. Sound design of these components should help teachers to integrate ICT into their curricula in effective ways. Constructivist learning theories, the design of interactivity and the notion of usefulness provide the theoretical foundations for the construction of this model. Some examples of applying this model to the design of Web-based learning environments, facilitation of online discussions and comparison of ICT tools are presented.

A study done by Sadiah Baharom (2009) describes the development of e-Portfolios by pre-service science teachers and its impact on their self-regulation. e-Portfolios provide the opportunity for students to collect, organize, interpret and reflect on their learning and practice. e-Portfolio also serves as a tool for encouraging individuals to take responsibility and demonstrate the results of their own learning, and increases students’ skills and competencies in ICT. Through e-Portfolios, self-regulation is increasingly supported by interactive learning environments, and enhanced development of content via the Web 2.0 technologies. The sample in this study consists of 39 postgraduate students attending a course in ICT in Science Education at Masters Level. The Revised Self Regulated Learning Questionnaire (MSLQ) was used to explore the effects of e-Portfolio development on students’ self-regulation of their motivational strategies. This questionnaire was administered prior and post to the e-Portfolio development, necessary for the course requirement. Thirty-nine postgraduate teachers responded to a questionnaire of the RMSLQ before and after completing their e-portfolio. The quantitative and qualitative analysis of the data revealed that there is a significant increase in the motivated learning strategies employed by these teachers especially in the expectancy and value components. The postgraduate teachers’ responses indicated that developing their e-portfolios resulted in a higher degree of participation in the task even if challenged by the lack of skill in the
technology involved. These students also exhibited the urge to perform better to be able to demonstrate their ability i.e. displaying and sharing their e-portfolio with others. Another significant impact of e-portfolio development was in the increase in students’ perception of the task at hand. All respondents agreed that developing the e-portfolio has many benefits amongst which documenting evidence of their learning and performance, and sharing of information top the list. Respondents also found that the acquisition of the ICT skills and competencies was a very rewarding experience during e-portfolio development. The readiness and comfort of seeking help from peers and instructors or getting aids from web-based resources exemplified the notion of lifelong learning being developed in these students.

Balakrishnan Muniandy, Tan Poay Phing and Rasslene Rass Rasalingam (2009) examined and mapped out the ICT training curriculum used for training pre-service teachers in Malaysian public universities. Consequently, the curriculum was viewed in terms of its alignment and expectation to the international standards of ISTE NETST and UNESCO ICT-CST, national ICT in education policy, and to the current development of the field of ICT itself. A content analysis procedure using qualitative research methodology was used to collect and analyze data from documents of such university ICT course contents, ISTE NETST, UNESCO ICT-CST. A literature review on the development of the field of ICT in education was also carried out. The findings showed that there was a gap between the ICT curriculum used to train pre service teachers in the universities with what is expected from the international standards, national ICT in education policy and the development of the field of ICT itself.

The study on infusing technology in pre service teacher education programmes done by Emily Hixon and Hyo-Jeong (2009) is to provide a comprehensive review of how technology has been used to enhance or replace
field experiences in pre-service teacher preparation programmes, and discuss the benefits and limitations of traditional and technology-enhanced/virtual field experience approaches. In this paper, three types of technology-enhanced field experiences are discussed: Type I - concrete, direct experience in reality; Type II – vicarious, indirect experience with reality; and Type III – abstract, experience with model of reality. Five specific benefits of technology use in field experiences are identified, namely a) exposure to various teaching/learning environments, b) creation of shared experiences, c) promoting reflectivity, d) preparing students cognitively, and e) learning about technology integration. Several limitations of technology-integrated field experiences are also discussed, including (a) lack of interaction with teachers and students, (b) limited reality and complexity, (c) availability of relevant cases, and (d) technical problems. In conclusion, it is suggested that the overall goals and objectives for a specific field experience must be the focus when field experience options are being explored.

Charalambos Vrasidas & Marina S McIsaac (2001), in their conceptual paper discussed integration of technology in teaching and teacher education. Emphasis was placed on policy and curriculum reform as they relate to the use of information technologies for teacher education. Particular reference was made to the situation in Cyprus public schools. It was argued that for successful technology integration, there needs to be a shift in pedagogical approaches and reform of teacher education programmes.

William Anthony Sadera (1997) in the field of instructional technology described several models for computer use in the classroom. These models illustrate how widely accepted instructional theories, epistemologies and the computer can be used in unison to enhance student learning experiences. These models are based upon both behaviorist and constructivist teaching styles. Many teachers believe that students learn best through knowledge transfer. As a result,
many instructors teach in a behaviorist manner, which effects how the computer is used in the classroom. For example, a teacher using behaviorist teaching methods is likely to use the computer solely to reinforce previously learned knowledge (i.e., drill and practice).

An article by Johannes Cronje (2006) proposes a model that integrates the traditionally conflicting objectivist and constructivist approaches to instructional design. According to the author these two approaches are complementary rather than oppositional. The aim is to analyze two learning programmes in order to show how learning events can contain both objectivist and constructivist elements. By plotting the two approaches at right angles to one another, four quadrants were produced which were discussed and explained, followed after that is a discussion of comments that were received from members of a prominent instructional technology mailing list about the feasibility of the model. Finally two case studies were presented. The first describes a two-day workshop that was designed to be high on both axes, while the second shows how the model could be used as a decision-making tool. Initial findings suggest that it is both feasible and useful to plot objectivism and constructivism at right angles to one another rather than at opposite ends of a continuum.

Miyoung Lee and Amy Baylor (2006) discussed about the Instructional tool which can be used to overcome learning disorientation and enhance their web based learning experience. It stressed the importance of four key metacognitive skills namely Planning, Monitoring, Evaluation and Revision. It lays importance on the adoption of these metacognitive skills in teaching process for enhancing the effectiveness of teaching and overcoming the learning disorientation. A study also suggested metacognitive map as a metacognitive support tool which has to support learners’ metacognitive activities to facilitate their orientation within web based learning environment. With this metacognitive map the study believes that
learners are expected to perform both cognitive and metacognitive activities effectively and efficiently.

The National Research Council (Duschl, Schweingruber, and Shouse 2007) recommends that K–8 teacher’s use metacognitively guided learning in their science teaching. They suggest that teachers help students become aware of their initial science ideas, make predictions and provide reasons for their predictions, and discuss and compare their ideas with others. Keogh and Naylor (1999) offer a strategy to help students compare scientific ideas, i.e the concept cartoon. A concept cartoon presents several viewpoints on a concept in a captivating way. Students think about how their ideas compare to those of the individuals in the cartoon. In their research, Keogh and Naylor found that elementary teachers thought the cartoons were useful in making students’ ideas accessible to them during instruction. Metacognitive strategies can be integrated throughout instruction. Blank (2000) recommends a metacognitive learning cycle that includes explicit conceptual status checks to accompany each learning cycle phase (Brown and Abell 2007). Schraw and his colleagues (2006), describe a set of instructional strategies to improve self-regulation in the science classroom, including inquiry, collaboration, and mental models.

Renata Phelps and Anne Graham (2008) have done action research and surveyed the teachers about the influence of metacognition in ICT learning. The findings reveal that teachers metacognitive approach has brought in several desirable changes in them and the important observations are listed below:

♦ changed the teachers’ understandings of ICT integration;
♦ promoted a positive attitude towards ICT;
♦ motivated teachers to experiment and try new things;
♦ increased teachers’ confidence on use of ICT;
♦ created a ‘can do’ attitude;
changed teachers’ attitude to professional learning;
• enhanced the relationships of school leaders with teachers;
• lead to positive outcomes for students
• helped to build a learning community;
• changed teachers’ relationships with their students;

These important observations initiated the inclusion of ICT in the present study.

Kasinath.(2008) in his paper explained that the sources of knowledge like one’s feelings, self concept, beliefs, truths of the external world and existing knowledge actually influence the acquisition of new knowledge. The general principles of information processing are

1. Assumption of a limited capacity of the mental system
2. Control mechanism is required to oversee the encoding transformation, processing, storage, retrieval and utilization of information
3. Two way flow of information as anyone try to make sense of the world around us and
4. Genetically prepared to process and organize information in specific ways. Information processing is governed by Metacognition. As Metacognitive knowledge and skills improve, learners develop the capacity for self regulation.

Findings show that the Cognitive theories emphasize that human mind is an active and individual processor of information. Active thinking is influenced by one’s feelings, self-concept or identity, beliefs and existing knowledge and in turn is bound to influence the structure of new thoughts. Knowledge is acquired by constructing a representation of the outside world. The realities and truths of the external world direct the knowledge construction. Individuals reconstruct outside reality by building accurate mental representations such as proportional networks, concepts, cause and effect relationships and condition the action production rules
that reflect “the way things really are”. Information processing holds this view of knowledge.

Gregory Schraw (2008) described five indices of metacognitive monitoring which are referred to as absolute accuracy, relative accuracy, bias, scatter, and discrimination. These five measures have different interpretations that provide information about different facets of metacognitive monitoring. Absolute accuracy provides a measure of the discrepancy between a confidence judgment and performance on a task. It was interpreted as the absolute accuracy of one’s confidence judgment given that performance outcome; relative accuracy provides a measure of the relationship between a set of confidence judgments and a corresponding set of performance scores; the bias index assesses over- and under-confidence and can be interpreted as a measure of the direction of judgment error. The scatter index measures differences in variability for confidence judgments about correct and incorrect responses; the discrimination index provides information regarding whether an individual can distinguish between confidence judgments for correct versus incorrect responses.

3.4 Empirical Symbiotic Validation

Dennis Rose and John Church (1998) conducted a study on teacher education programmes attempting to develop two general kinds of changes in pre-service trainees: changes in trainee knowledge of what and how to teach, and changes in trainee performance in the classroom. The development of appropriate classroom teaching behavior is widely recognized to require observation and practice in actual classrooms. This practice is typically provided by means of classroom placements during the course of the training programme. Evaluations of a variety of different kinds of practical skills, training procedures have been reported in the teacher training literature, and these evaluations have been reviewed by a number of authors. Few of the studies examined the effects of the
various components of the training packages which were used. Nevertheless, some consistent findings were identified. First, the microteaching, Mini course, and protocol training packages did not generally produce consistent improvements in trainee performance. Compared to other training procedures, these procedures appear to provide practice in situations which are too far removed from the actual classroom situation, and too little practice, to produce measurable improvements in teaching performance.

Second, there is no evidence to suggest that didactic instruction alone will produce changes in teacher performance. This clearly has important implications for teacher training given that most teacher training programmes involve large amounts of didactic instruction relative to the time spent on skills practice.

Third, modeling and cueing strategies on their own appear insufficient to produce changes in teacher behavior. However, they may have an important role to play when combined with supervised practice. More work needs to be done to identify the situations in which prompting strategies such as these are likely to be necessary.

Fourthly, application of contingent access to further training and contingent reinforcement for achievement appeared to work well when they were applied to improvements in teaching skill. These procedures should not be disregarded simply because of their behavioral origins.

Fifth, the research suggests that supervised practice, that is, practice with feedback regarding performance of the target teaching skill, may well be a necessary component of any training programme which aims to change teacher behavior in the classroom. It is certainly the training component which has the strongest training effect. It should be noted, however, that the feedback provided in the present experiments tended to be much more specific than that typically
provided during the classroom placements of pre service trainees. In these experiments, supervised practice typically involved the practice of specific teaching skills and the provision of clear and specific feedback regarding the extent to which targeted changes in performance had been achieved by the trainee. This clearly has implications for the practice of supervising teachers during student placement in the classroom. However, these studies leave unanswered the question of how much supervised practice will be required to achieve particular level of competence with respect to particular teaching skills.

Thomas Dormody and Robert Torres (2001) studied the teaching competencies of agricultural education programme graduates using questionnaire survey methodologies. The study aimed to determine perceived teacher competency abilities at graduation from the pre-service agricultural education programme. Results revealed that all selected professional development activities were perceived to have an influence on participants’ general teaching competency improvement. On-the-job experience was considered to have the highest influence on participants’ general teacher competency improvement. Other professional development activities perceived to influence participants’ current teacher abilities were

i. having a student intern,
ii. assistance from the FFA Executive Secretary, and
iii. information from other agricultural education teachers. Overall, there is a strong comprehensive professional development system in place for agricultural education teachers in New Mexico.

An exploratory study was done by Maricar Prudente and Socorro Aguja (2002) in order to do in-depth analysis of effective teaching and learning processes and strategies in the pre-service teacher education programme in science at De La Salle University, Manila. Three groups of respondents were involved in
the study: college faculty, cooperating teachers and student practicumers. Interviews and classroom observations were done to describe the level of competence on skills/values of the respondents and their views on science teaching and learning. Questionnaires were utilized to determine the extent to which the respondents have demonstrated the necessary skills, processes and strategies in teaching and learning science. Results indicated that the teaching processes employed by the college faculty and cooperating teachers have influenced the learning process of practicumers. Such influence was manifested through the observed teaching competence of the practicumers. Congruences between teaching skills, thinking skills, laboratory skills, scientific and teaching values, and concepts taught and learned were observed. A prevalent science teaching philosophy that involves guiding and facilitating students through integrating concepts, skills and values to actual life situations was likewise revealed. Consolidated survey ratings of teaching processes and strategies and classroom observations confirmed that this prevalent teaching philosophy is actually being practiced.

The US National Research Council (2003) was organized by the National Academy of Science in 1916 for the purposes of advancing knowledge and advising the federal government. It completed a 2-year study on how people learn, and explored how to link the findings to actual classroom practice. One of the essential findings regarding active learning, where students take control of their learning is recognizing when they understand and when they need more information. It was observed that this ability to monitor their mastery of skills, make self assessments and reflect on understanding, often referred to as metacognition, which demands new approaches to creating classroom environments. The key concepts of the National Research Council studies include: students come to a classroom with preconceived notions about how the world works; the failure of a teacher to recognize these preconceptions results in a failure
for students to grasp new concepts; students develop competencies by understanding facts and ideas, and organizing knowledge in ways that can be easily retrieved and applied; students must embrace a metacognitive approach to learning, where they identify learning goals and monitor their progress in achieving those goals. These findings have a direct impact on the way teachers might construct a learning environment. First, they have to draw out and work with the preconceptions of their students. Next, they have to provide a foundation for factual knowledge that includes real world examples. Finally, they have to incorporate metacognitive skills into their curriculum which not only engage, but also empower the students.

A case study done in New Zealand by Lindsey Conner (2004) raised issues for teachers in supporting students to develop the skills of self-questioning and independent enquiry. Teaching and learning about the social and ethical implications of a contemporary issue have been part of the national biology curriculum in New Zealand for over a decade. The relevant achievement objective states that students will ‘investigate contemporary biological issues and make informed judgements on any social, ethical, or environmental implications’ (Ministry of Education, 1994: 28). The reason for including bioethical issues in the curriculum is that students have the opportunity to develop critical thinking skills and become more informed decision makers. It was found that some students in the class studied, were not self-starting in terms of evaluating their own and others’ ideas, even though they were in the final year of high school.

Rosemary Reilly and Gillian Bramwell (2007) adopted a qualitative methodology using an instrumental case study approach to find out how individuals in groups can co-develop expertise in practice teaching. An important concept to emerge from the analysis of cognitive activity in naturalistic settings is the notion of socially shared or distributed cognition, in that cognition is not just a
product of one head, but a product of several heads in interaction with one another. Social cognition, then, is an effort to give meaning to the persons and to make sense of the processes with which people are engaged. The patterns evident within this inquiry point to the likelihood that shared metacognitive expertise is a product of social cognition. Each individual used her conversational “turn” as an arena to practice her metacognitive capacity, and in turn, examined and shaped the metacognitive musings of the other novices in an effort to clarify ideas (an intrapersonal process) or create common understandings and meanings (an interpersonal process). Public reflection allowed increased access to how experts and novices think, decide, and translate into action their conceptions of group development and intervention. Organized multivocality, vicarious participation engineered by listening to each other’s narrative constructions, and comprehension as a private achievement were realized, but through collective interaction. The individual’s private comprehension was then shared. This introduced it back into the collective space, thus allowing information proposed and skill demonstrated by one to be observed and assimilated by all. This then created the collective comprehension indicative of social cognition.

A longitudinal case-study carried out by Barak Miri, Ben-Chaim David & Zoller Uri (2007) aimed at examining whether purposely teaching for the promotion of higher order thinking skills within the framework of science education. Within a pre-, post-, and post–post experimental design, high school students, were divided into three research groups. The Experimental group consisted of 57 science students who were exposed to teaching strategies designed for enhancing higher order thinking skills. Two other groups: science 41 and non-science majors 79, were taught traditionally, and acted as control. Findings of the study reveal that the Experimental group showed a statistically significant improvement on critical thinking skills components and disposition towards critical thinking subscales, such as truth-seeking, open-mindedness, self-
confidence, and maturity, compared with the Control group. Also the study suggested that if teachers purposely and persistently practice higher order thinking strategies for example, dealing in class with real-world problems, encouraging open-ended class discussions, and fostering inquiry-oriented experiments, there is a good chance for a consequent development of critical thinking capabilities.

Umadevi (2008) in her experimental study developed a Biological Science Inquiry Model (BSIM) on the topic Photosynthesis in biology for eighth standard students to find out the effectiveness of biological science inquiry model on achievement in biology. Findings reveal that biological science inquiry model is useful in teaching students the skill of inquiry in order to process information; inquiry training allows students to think independently and organize data in a systematic way. The study suggests that ample freedom should be provided to students in learning; biological science inquiry model encourages discovery learning which is more effective and meaningful in learning scientific concepts. Teachers and students should be trained in the use of BSIM in order to develop scientific temper and attitude.

Ling Liang, Greer Richardson (2009) studied the impact of a recently revised science course that engaged pre service teachers in a scaffolded, student-directed inquiry unit on local streams of prospective elementary teachers in four sections of an interdisciplinary science course. Quasi-experimental design with a qualitative component of Pre test & Post test were employed as tools along with Metacognitive Questionnaire & STEBI-B, an instrument consisting of 23 five-point Likert scale statements. The result revealed that, while engaging the pre service elementary teachers in scientific inquiry projects related to the real world in science content courses, the teacher candidates would have multiple opportunities to develop their understanding of science and scientific inquiry and, therefore, would be more likely to develop more positive attitudes toward science.
and become more confident and effective in teaching inquiry-oriented science to their future students.

A Training Module for Improving Knowledge Competencies for Resource Room Teachers in Jordan was developed by Hairul Nizam Ismail, Suhail Mahmoud Al-Zoubi, Majdoleen Bani Abdel Rahman and Ahmad Mohammad Al-Shabatat (2009). The objective of the study was to measure the effect of a training module in improving knowledge competencies for resource room teachers in Jordan. The training module consisted of 10 training sessions, covered three domains, namely, planning, instruction and classroom management, and evaluation competencies. The sample of the study consisted of 50 teachers. The participants of the sample were distributed into two equal groups, with 25 teachers in each group. The teachers in the Experimental group were attached with the training module for five weeks whereas the teachers in the Control group were exposed for the same period to the conventional training adopted by the Ministry of Education in Jordan. The results of ANCOVA revealed that there were statistically significant differences between the means of the two groups on the post-achievement test, favoring to the experimental group. Furthermore, results of the Experimental group on the achievement test revealed no statistically significant difference across the demographic variables, namely, gender, specialization, qualification, and experience.

Arzu Tasdelen Karçkayseyda Sanlıa (2009) examined the effect of micro-teaching application on teacher competency level of early childhood pre-service teachers who are included in the activity. Students’ teacher competency levels were measured by “Prospective Teacher Competency Sub-Scale” which was developed by Erisen and Çelikoz (2003). For the study the pretest-post-test design of experimental research model has been used without Control group. The data is analyzed by the Paired Samples t test and ANOVA test for repeated measures.
After the experiment of micro teaching, significant differences have been found between participants’ pre-test and post-test scores. The results showed that the micro-teaching activity may affect students’ teacher competency levels positively. Researches supported that the effective video tape recording in micro-teaching worked for teacher education (Kpanja, 2001). The video not only reflected their performance but also provided to evaluate them in classroom. This technology supported the strategy of doing, reviewing and doing again that seemed effective in improving teacher performance (Jurich, 2008).

In 2009 a study on pre-Service teachers’ views about their competencies in Biology applications was made by Esin, Bahattin Deniz which examined the perceptions of pre-service biology teachers about their competencies in biology applications. The study was conducted on pre-service biology teachers who have taken all application courses since the first year of the university. One hundred and fifty pre-service biology teachers participated in the study. The data were collected between the periods of 2003-2007, each year with a different group consisting of 30 pre-service biology teachers. The pre-service teachers were asked how competent they perceived themselves in effectively using the instruments in the biology laboratory, in teaching the subjects covering laboratory techniques and methods, ensuring maintenance of the instruments in the biology laboratory and establishment of a biology laboratory in a secondary education institution. The responses were on a 5-point Likert type scale, ranging from 5 (quite competent) to 1 (quite incompetent). In addition, by means of two open-ended questions, the students were asked if they considered themselves inadequate, and if they felt themselves inadequate, whether or not they had suggestions to overcome their inadequacy. The responses were analyzed by using content analysis procedures. The results showed that pre-service teachers found themselves “partially competent” in “using effectively the instruments in the biology laboratory” and “teaching the subjects covering laboratory techniques and methods”. Moreover, a
significant, positive relationship was found between pre-service teachers’ scores on “using effectively the instruments in the biology laboratory” and “teaching the subjects covering laboratory techniques and methods” (r=0.73, p=0.01).

A qualitative study by Judy Somers (2009) examined seven pre-service teachers' perceptions of their science content knowledge, teaching practices, and reflective processes through the use of the metacognitive strategy of concept maps. Some of the review of teachers' perceptions of teaching, concept development, concept mapping, science content understanding, and reflective process as a part of metacognition. The key questions addressed include the use of concept maps to indicate organization and understanding of science content, mapping strategies to indicate perceptions of teaching practice, and the influence of concept maps on reflective process. There is also a comparison of pre-service teachers' perceptions of concept map usage with the purposes and practices of maps as described by experienced teachers. Data were collected primarily through interviews, observations, a pre and post concept mapping activity, and an analysis of those concept maps using a rubric developed for this study. Findings showed that concept map usage clarified students' understanding of the organization and relationships within content area and that the process of creating the concept maps increased participants' understanding of the selected content. These participants saw benefit in using concept maps as planning tools and as instructional tools. They did not recognize the use of concept maps as assessment tools. When the participants were able to find personal relevance in and through their concept maps they were better able to be reflective about the process.

Chi Hyun Jung (2010) examined a new conceptual model of Science Teacher Identity (STI). The construct dimensions of science teacher identity were conceptualized; a newly developed instrument to measure the level of science teacher identity was tested for validity and reliability and preliminary evidence in
support of the STI model was gathered. For this study, a 48-item questionnaire was developed in Likert format to measure the nine postulated dimensions of the proposed STI model viz. science teachers' personal learning experience, knowledge and skills, community practice, science teaching practice, degree of success, social respect, belief and value in science teaching, intrinsic satisfaction, and representation. To validate the construct validity of nine dimensions, the model of STI was quantitatively and qualitatively examined using a sample of 17 pre-service science teachers who were completing a graduate level science teacher preparation programme. Techniques used included administration of a questionnaire, interviews, and document analysis. To examine the underlying structural formation of the STI model, subscale score reliabilities and correlations of each dimension of the STI model to a variety of variables were analyzed using survey data from an instrument administered to 414 experienced science teachers. Results provided empirical evidence that the construct of science teacher identity can be explicitly modeled and reliably measured. Also, preliminary findings supported the construct validity of the STI model, with several hypothesized correlations implied by the model being documented, and the change in level of STI expected to be associated with professional development experiences being observed. Competent teachers apply broad, deep, and integrated sets of knowledge and skills as they plan for, implement, and revise instruction. In this study, prospective elementary school science teachers’ self-regulation skills intended for motivational beliefs, cognitive and meta-cognitive strategies and resource managing strategies are examined within “Laboratory Practices in Science Teaching” course. The purpose of the study is to determine that if “Laboratory Practices in Science Teaching” course is effective on the development of prospective elementary science teachers’ self-regulation skills development. Correspondingly to the importance of “Laboratory Practices in Science Teaching” course’s effect on development of self-regulation skills during
elementary Science teaching, the requirement of elementary science teachers’ enough proficiency on using self-regulation strategies makes the study important.

The major goals of the research done by Abdul Rahim Hamdan, Mohd Najib Ghafar and Lily Ting Hwa Li (2010) were to study the teaching competence and dominant characteristics of 309 teachers from different secondary / primary schools in Johor Bahru. Their competencies are determined through teaching skills, concern for school, concern for students and concern for self. The result showed that all teachers were competent, and there were significant relationships between teaching competency and gender, specializations, and academic achievement. The study suggested that teachers have to enhance their competence in other elements such as subject knowledge, teaching process, classroom management, instructional planning, collegiality, concern on schools, concern on students and concern on self to build the image and ability as a competent teacher.

Sara Wolf, Thomas Brush and John Saye (2003) in a case study to find out the effectiveness of Big 6 model of Metacognitive Scaffold with eighth grade students indicated that the Big6 model might act as a metacognitive scaffold for students who are asked to complete unfamiliar tasks involving complex content. Scaffolding, when implemented according to the principles is gradually withdrawn from the learner as performance approaches an expert level. Students indicated their understanding of the process as being beneficial outside the realm of the social studies class in which it was presented. Additionally, the researcher utilized the scaffolded format of Big6 to support the interaction with the students. Big6 and other models that provide a systematic guide for information problem solving seem to provide the elements for mental modelling so necessary in helping the novice construct a method to meet the information use tasks placed before him or her. These models appear to help students visualize the series of tasks that at first are not understood or seemingly connected.
Anne Graham, Renata Phelps, Berenice Kerr and Andrew Burgess (2003) surveyed the secondary teachers to explore the relevance of the Metacognitive and reflective approach with practicing teachers. Their approach within a professional development framework, included issues of remote delivery supplemented with face-to-face workshops, support materials and online interaction. They identified issues impacting on the successful implementation of the approach for teachers’ professional development and relevant areas for refining the model and process. There is a strong evidence to suggest that the initiativeness was basic factor for the success of a significant number of participants. Those who have fully embraced the approach underwent considerable transformation in their ICT confidence, use and integration in their teaching. Those who were less accepting of the approach were only partially successful and they might have had quite different expectations of the professional development initiative.

David Huffaker and Sandra Calvert (2003) investigated K2 students using production features to motivate children to learn (active learning), facilitating children to construct their own learning paths with information (Active learning and Metacognition), encouraging online collaborations that facilitate both cognitive and social aspects of learning (active learning and Metacognition). Since e-Learning is a learner centered it creates interesting learning environments for children. It provides exemplars of the new science of learning. They empower children to take active control of their own learning. They also allow children to plan and to monitor their own learning process. They encourage an environment where learning can be applied to new situations and they foster collaborative learning activities.

A conceptual paper by Charlene D'Avanzo (2003) discussed about comprehension of complex science topics which occur from the creation of new understanding of the information by the learner. However, learners are not very
successful in generating their own meaning, especially in computer-based learning environments in which learners are required to make decisions about their learning process, since they rarely regulate their own learning process cognitively or metacognitively. This study examined the instructional effects of generative learning strategy and metacognitive feedback on learners’ comprehension and self-regulation while learning a complex science topic in a computer-based learning environment. The 36 participants were assigned to either static visualized instructional material dealing with the human heart system or the same material with generative strategy and metacognitive feedback. The results of this study revealed that the generative strategy with metacognitive feedback group scored significantly higher on comprehension and self-regulation measures. The results also found a significant positive relationship between self-regulation and comprehension.

Georghiades (2004) conducted a study to determine the potential for situated metacognition to improve students’ acquisition and long-term retention of concepts. The researcher used a quasi-experimental design in which 30 students in six groups were based on the pre-test score were selected as a sample. The Experimental group received several metacognitive activities over the course of each 80-minute lesson. Journaling, annotated drawing, and concept mapping were also used. Results indicated that students who had participated in situated metacognitive activities consistently outperformed students in the comparison group.

A Case Study initiated by Sperandeo-Mineo, Fazio and Tarantino (2005) addressed the question of how to develop prospective teachers’ pedagogical content knowledge (PCK) in science teacher education. The main focus was on the knowledge transformation process and on the cognitive strategies used to shift prospective teachers’ explanations within the domain of modelling thermal physical phenomena. This study investigated the development of PCK
within a group of 28 pre-service physics teachers during the first semester of their
two-year post-graduate teacher education programme. It focused on the central
issue of the relationships between observable phenomena, like macroscopic
thermal properties of matter and their interpretation and/or explanation in terms of
corpuscular characteristics and/or thermodynamics theory. The strategy was based
on the consideration that knowledge transformation is not a one-way process from
subject matter knowledge to Pedagogical Content Knowledge (PCK), as literature
suggests, but a bidirectional process involving deepening of subject matter
knowledge and increasing awareness of pedagogical issues. This study
significantly adds to the value of the concept of PCK within the domain of
research on science teaching and that other teachers may benefit from this type of
topic-related PCK as it can be used as input in pre-service or in-service teacher
education.

Savia Coutinho (2006) while deducing the relationship between the need
for cognition, metacognition and intellectual task performance in a survey of
undergraduate psychology students found that only the need for cognition was a
significant predictor of performance. Students who had a strong desire to
understand and solve complex problems tended to respond accurately to these
problems. Metacognition did not appear to benefit students in performance terms
as students with good metacognition did not score significantly better than
students with poor metacognition. This finding was unexpected as students with
metacognition were expected to use their metacognitive strategies to solve the
problems. However, it could be the case that problems were too difficult for
students’ to solve and students with good metacognition might have realized this
and not invested effort in solving the problems.

Susan Sunny Cooper and Penne Stewart (2006) studied the Metacognitive
Development of Professional Educators. This study examined the metacognitive
skills of adults as they develop naturally with age. The Metacognitive awareness
Inventory was completed by 214 pre-service and experienced teachers. Results indicated that metacognition improves significantly with age and with years of teaching experience. Male and female respondents showed no significant difference in metacognition and teachers of grades from preschool to post-secondary showed no significant difference in metacognition.

Shoop (2006) explored the effect of student self-reflection combined with teacher feedback on science achievement in high school biology students. Three groups were taken for the study. First group consisted of one class that practiced both self-reflection and received teacher feedback. The second group consisted of two classes that practiced self-reflection without feedback and the final group consisted of three classes that did not practice self-reflection or receive feedback. These activities represented the only difference in the teaching sequence between the two groups. The result indicated that students who received the feedback in combination with their self reflection outperformed their counterparts.

Saravanakumar and Mohan (2007) attempted to develop appropriate strategies to enhance the level of Metacognitive orientation and attention activation technique for enhancing students’ achievement in science. The main challenge of teaching is to help students develop skills which will not become obsolete. Meta-cognitive strategies are one set of such skills. They facilitate ‘learning to learn’ identified as essential for the twenty first century. It was found that there was significant difference between the pre and post mean scores of Metacognitive orientation and attention activation. The data indicated that achievement in any subject could be improved through meta-cognitive orientation and attention activation. The study suggests that teachers should be trained for imparting meta-cognitive orientation and attention activation in students; they will enable students to successfully cope with new situations. Teachers and school library/media specialists and the wealth of resources available offer an
environment which facilitates the development of good thinkers who will be successful problem-solvers and life-long learners. Metacognitive orientation is indispensable for identifying and selecting the elements most relevant for a given problem on hand from the vast wealth of information that is readily available today.

Ramganesh (2003) developed a Metacognitive strategy for teaching Mathematics for school students. In the experiment, Metacognitive orientation was given to the B.Ed trainees in their Problem solving in mathematics. The study found the influence of Metacognitive strategy on teaching competency in mathematics among the prospective teachers. The study suggests that metacognitive orientation may be given to trainees to enhance their teaching competency in mathematics. Teacher guide books for using Metacognitive strategies in teaching mathematics may have to be prepared. In order to excel in their teaching, student-teachers must be trained to identify which study strategies are effective and which are not. Thus as a teacher, he/she should be able to teach students how to study material in addition to presenting subject matter.

Esen Uzuntiryaki, Yezdan Boz, Demet Kirbulut and Oktay Bektas (2009) studied the Pre-service Chemistry Teachers’ Reflect on constructivism in their Teaching Practices. Eight pre-service chemistry teachers taking a practice teaching class in the Department of Secondary Science and Mathematics Education at an university in Turkey were the participants of this study. Semi-structured interviews, observation notes, and lesson plans were used for data collection. Pre-service teachers’ beliefs about constructivism were classified into three categories which are weak, moderate, and strong conceptions of constructivism. For detailed exploration, three cases of pre-service teachers representing these three categories were selected. The findings of this study showed that most of these pre-service teachers in this study did not have a strong conception of constructivism and no relationship between the pre-service teachers’ beliefs and their practice.
Sevgi turani et.al (2009) investigated the acquisition of Metacognitive awareness and self regulated learning skills in medical schools using different curricular models. The study was carried out in four medical schools implementing different curricular models. 862 medical students took part in the study and two scales (Self Regulated Learning Perception Scale-SRLPS and Metacognitive awareness Inventory –MAI) were used. There were significant differences in MAI scores according to gender, curricular language and previous exposure. With regard to SRLPS score, no difference was found according to gender but significant differences were found according to phase, curricular language and curricular model. MAI and SRLPS scores of students from the medical school using a learner centered curriculum where higher than the other school students. This study suggested that students who experience a learner-centered curriculum, such as PBL(Problem Based Learning) during their medical education demonstrate improved Metacognitive awareness and self regulated learning skills.

The research done by Helen Ngozi ibe(2009) explore the metacognitive strategies for strengthening the classroom participation of senior secondary students of science. The design of the study was quasi experimental involving three intact groups namely two treatment groups : Think Pair Share (TPS) Strategy and the metacognitive questions (MQ) and a Control group . The study lasted for 11 weeks. The sample comprised of 24,22 and 21 subjects for Control group , TPS and MQ respectively. Density was used to measure achievement in the three groups. The research question was answered using descriptive statistics as in mean and standard deviation while the hypothesis was tested using analysis of covariance (ANCOVA). Results revealed that the metacognitive strategies were most effective in enhancing academic achievement followed by the TPS.
Anne Morris (2006) in her study investigated the learning from practice skills that pre-service teachers possess when they enter teacher preparation programmes in the United States. Two sub skills were hypothesized to represent, at least in part, what is required to learn from practice: (1) the ability to collect evidence about students learning in order to analyse the effects of instruction, and (2) the ability to use the analysis to revise the instruction. Because it seems likely that different teaching situations and contexts reveal these learning-from-practice skills in different ways and to different degrees, this study examined the skills that pre-service teachers exhibited under two experimental conditions. 30 pre-service teachers were asked to analyze the effects of a videotaped mathematics lesson on student learning, to support their analysis with evidence, and to use their analysis to revise the lesson. Based on the results, it appears that many entry level pre-service teachers can carry out a cause-effect type of analysis of the relationships between specific instructional strategies and students’ learning, and can use this analysis to make productive revisions to the instruction. However, prospective teachers’ ability to collect evidence that supports their analysis appears to be less developed. In addition, the type of analysis that prospective teachers carried out about the effects of instruction on students’ learning differed dramatically across the two experimental task conditions.

Moshe Barak and Larisa Shakhman (2007) qualitatively analysed science teachers’ instructional practices. This study aimed at exploring the practices and beliefs physics teachers have about introducing reform-based instruction into the physics class. Data were collected from semi-structured interviews held with 11 experienced physics teachers. The results revealed that the teachers occasionally introduced a small number of enhanced instructional strategies explicitly required by the formal curriculum into their class, such as presenting, analyzing and generalizing experimental results in different forms. However, the teachers used much fewer other strategies aimed at enhancing higher-order thinking, such as
asking students to formulate their own questions or introducing them to problem-solving strategies used in class. Although physics is considered a relatively well-established subject in Israeli schools, extensive differences have been identified among teachers in issues such as using rich instructional strategies in class, their self-confidence in utilizing progressive instruction, and their beliefs about students’ abilities to develop higher-order thinking. It is learnt from this study that teachers often regard reform-based instruction as an idealistic view rather than a clear schooling practice. Further work is required in teachers’ pre-service and in-service training to make the fostering of higher-order thinking which a common ingredient in science teaching is.

Amutha and Ramganesh (2010) made a study on application of metacognition in the instructional design and e-content development. The aim of the present study was to ascertain the level of metacognitive thinking integrated with the components of Instructional Design and their e-content development of prospective teacher educators while they design instruction to deliver for their targeted audience. In this study M.Phil and M.Ed students were taken as sample for e-content development as partial fulfilment of their programme. Results reveal that only 20 percent of M.Phil scholars use metacognitive thinking in their design of instruction with reference to its components such as Task analysis, Learning objectives, Instructional materials, Instructional strategies and Evaluation and 27 percent of M.Ed students use metacognitive thinking for their e-content development.

The history of science demonstrates that visualization and imagery have played a key role in the development of scientific thinking (Miller, 1986) and recent sociology of science has further emphasized the importance of visual displays (Latour 1986; Lynch, 1985) to the everyday work of scientists. In education, simulations and animations that display conceptual object have proven
particularly valuable in advancing Children’s thinking (Horwitz & Barowy, 1994; Snizr, Smith, & Grosslight, 1993). On the other hand, artificial animations have proven exceptionally effective in provoking genuine inquiry involving difficult concepts (Di sezza, 1986; White, 1993, White, Shimoda & Frederiksen, 1999). On the other hand, MBLs (Thornton, 1987; Nemisrousky, kaput, Roschelle, 1998) and physical output devices (Monk & Nemirovsky, in preparation) complement simulations by connecting to real phenomena.

An investigation by Handal et al. (1999) described the first phase and results of a programme whose main objective was to produce animated educational material to stimulate the students’ interest and learning process of the sciences and measure the impact. The programme material was designed to support middle school educators with an effective, accessible and novel didactic tool produced specially to enhance and encourage the learning of chemistry. The study introduced the periodic table of the elements, specifically developed for middle school students in two distinct formats in English and Spanish. 320 students have participated in this study. They used the 10 minutes video tape and responded to questionnaire. Results revealed that participants from who viewed the video tape scored significantly higher on the questionnaire than those who read the printed version of the material.

A study on using computers to support a beginning teacher’s professional development made by Huann-shyang Lin and Houn-Lin Chiu (2000) explored the efficacy of promoting a beginning chemistry teachers’ curriculum development and teaching practices through the use of computers. Using pictorial analogies, historical cases of science, and discrepant events in a web site designed by the researchers as curricular samples, the beginning teacher was asked to develop similar curriculum for his own teaching. After taking the researchers’ advice into account and making adjustments, the beginning teacher implemented the
curriculum in his classroom teaching and shared his experience with the researchers by e-mail communications. The teacher’s teaching practices both before and after the website treatment were observed and analyzed. It was found that before the treatment the teacher used the textbook as the only resource of his teaching. Extra curriculum was rarely seen; there were not many student-teacher interactions and analogies or examples used in the explanation of abstract concepts. On the other hand, after the treatment, the teacher was able to develop suitable curricula by himself for the purpose of increasing student involvement. It was also explained that the applications of chemical concepts in daily lives and his analogies and demonstrations were well organized. Although the beginning teacher was able to develop curricula after the treatment, many aspects of his teaching can be improved, especially in the areas of student-teacher interaction and the implementation of students’ activities in science teaching. The student teacher in this study has made significant progress on developing curricula; There is enormous space for him to improve his teaching practices. For example, from the classroom observations, it was found that the questioning skills recommended by Trowbridge and Bybee (1986) and Carin and Sund (1989) were not properly used to promote student-teacher or student-student interactions. In addition, the wait time proposed by Rowe (1987) to promote meaningful answers was not implemented.

Eunjoo Oh and Russell French (2002) discussed the importance of the technology standards for the teacher preparation programmes and the students’ perceptions of the adequate use of technology for their teaching practices. The survey was conducted with 80 students who enrolled in the Introductory Instructional Technology Course at a research university in the Southeast in fall 2002. A survey instrument was composed of 29 questions with three-point Likert scale. Findings suggest that the standard-based curriculum and the use of project-based assessment enable students to achieve all the necessary skills and
knowledge through cross-curricular hands-on practice during the course. The data also indicate that the students enrolled in the course feel that they can comfortably use computers in their future classrooms. The students expressed more confidence in planning and designing learning environments and experiences, such as developing lesson plans, teaching strategies, utilizing online resources and technology-based materials than confidence in their ability in other standards. Many students were uncertain about their skills, in installing content-based software or basic troubleshooting techniques. Generally, the students believed that the use of technology in classrooms enhances students' learning and helps to create meaningful learning environments. They also believed that the use of technology tools affects the quality of teaching practice and that computer literacy will increase their chances of finding employment.

Jane Howland, Judy Wedman (2004) studied the Individualizing Technology Learning. A total of 156 participants were involved in the teacher preparation programme at a large research university located in the mid-west. 21 members of the faculty participated in a two-year individualized professional development process to: (a) develop technology knowledge and skill efficacy and (b) integrate technology in teaching. The pre-service teachers were enrolled in the courses taught by the faculty participants. Evaluation of the professional development process included a pre/post questionnaire that yielded data for faculty's development of technology knowledge and skill efficacy, integration of technology into courses, and change in teacher practices. The pre-service teachers completed a survey that examined the frequency of technology use during the course in which they were enrolled. Analysis included computing frequencies, means, standard deviations, and significance levels. Results indicated change in faculty skill efficacy in the areas of communication (p<.05), inquiry-based learning (p<.01), feedback and metacognition (p<.01), and problem-solving (p<.05). Results related to technology integration indicated significant change in
inquiry-based learning (p<.01), feedback and *metacognition* (p<.05), problem solving (p<.01), and content knowledge (p<.05). Results related to changes in teaching practices indicated that the faculty significantly reduced the frequency of lecture (p<.05) and integrated problem based learning (p<.001) more frequently. Pre-service teachers reported using a variety of technology applications during the courses.

Dhindsa and Anderson (2004) explored a problem, based on constructivist learning theory, examined how effectively 43 Pre-service chemistry teachers could be educated to think flexibly and to reorganize their thinking in a way that might complement diverse ways students approached the subject domain. The teacher’s cognitive structure was assessed prior to and after a conceptual change intervention using flow-map narrative analyses. There was a significant change in the organization of the pre-service teacher’s narrative after the conceptual change intervention, including greater networking of ideas and more thematic development of the content.

Brenda, Capobianco and James Lehman (2004) investigated the practical and philosophical issues in attempting to integrate technology into the practice of prospective teachers and teacher educators. This study reported on a case study of a first-year science teacher educator, a novice with instructional technology, who integrated technology in an elementary science methods course.

Qualitative analysis of classroom observations, field notes, student feedback forms, and other documents revealed themes related to technology’s role in inquiry, factors affecting the faculty member’s development, and pre-service teachers’ development of expertise and willingness to use technology themselves. Pre-service teachers’ growth and development related to technology integration parallels that of teacher educators.
Eunjoo Oh and Russell French (2004) studied on the integration of technology into education suggest that, pre-service teachers have to experience effective applications of computer technology for teaching and learning, if they are going to use them in their own classrooms. This study discusses the importance of the technology standards for the teacher preparation programmes and the students’ perception of the adequate use of technology for their teaching practices. A survey was conducted with 80 students who enrolled in the Introductory Instructional Technology Course at a research university in the Southeast in fall 2002. Findings reveal that the standard-based curriculum and the use of project-based assessment enable students to achieve all the necessary skills and knowledge through cross-curricular hands-on practice during the course also implementation of technology standards may facilitate or act as a catalyst in the process of empowering learning. The study also recommended that pre-service teacher education programme should not only teach how to use hardware and software, but also emphasize the use of them in teaching strategies and activities.

Agiuseppe Chiazzese et.,al (2006) stated that one of the main challenges for those working in the field of ICT mediated learning is to develop innovative systems to support the knowledge e-learning practice for students and it has its own benefits and challenges. The perceived benefits of e-learning for students were:

Learn flexibly in time and place and at their own pace; similar to instructors in flexibility of teaching in time and place; Increase their ICT knowledge and skills to adapt to current ‘information age’ and learn to be life-long learners; Help them have different but more active and independent learning approach and attitude to improve their learning quality and outcomes; Provide more opportunities and different sorts of interactions to enhance their interactions with instructors and peers; Motivate their participation and cooperation in their
learning; and save cost and time for students to print out the course notes and sheets. In traditional educational contexts children’s learning problems are strongly influenced by their difficulty in managing their cognitive processes.

Sami Sahin (2006) while studying the implications of distance education with special reference to computer simulations in science teaching opined that although computer simulations cannot replace science classroom and laboratory activities completely, they offer various advantages both for classroom and distance education. This paper consists of four parts. The first part describes computer simulations; the second part reviews the benefits in science education; the third part looks for the relationship with science process skills; and the last part makes connections with the distance education. The findings from this study suggest that the success of computer simulations use in science education depends on how they are incorporated into curriculum and how teachers use it. The most appropriate use of computer simulations in science education is to use them as supplementary tools for classroom instruction and laboratory practical.

Kramarski and Gutman (2006) tested the effectiveness of self-metacognitive questioning in their study. Students supported with self-metacognitive questioning in e-learning environments significantly outperformed in achievement and in using self-monitoring strategies. Additionally, the extensive use of generative learning strategy, in turn, can enhance learners' self-regulation. A total of 156 Participants were involved in the teacher preparation programme at a large Research university located in the mid-west. Twenty one faculties participated in a two-year individualized professional development process to: (a) develop technology knowledge and skill efficacy and (b) integrate technology in teaching. A total of 135 pre-service teachers were enrolled in the courses taught by the faculty participants. Evaluation of the professional development process included a pre/post questionnaire that yielded data for faculty's development of
technology knowledge and skill efficacy, integration of technology into courses, and change in teacher practices. The pre-service teachers completed a survey that examined the frequency of technology use during the course in which they were enrolled. Analysis included computing frequencies, means, standard deviations, and significance levels. Results indicated change in faculty skill efficacy in the areas of communication (p<.05), inquiry-based learning (p<.01), feedback and metacognition (p<.01), and problem-solving (p<.05). Results related to technology integration indicated significant change in inquiry-based learning (p<.01), feedback and metacognition (p<.01), problem solving (p<.01), and content knowledge (p<.05). Results related to changes in teaching practices indicated that the faculty significantly reduced the frequency of lecture (p<.05) and integrated problem based learning (p<.001) more frequently. Pre-service teachers reported using a variety of technology applications during the courses.

Jonathan Singer and Michelle Maher (2007) made a case study on pre-service teachers and technology integration which explored the use of the student teaching experience as an avenue for both pre-service and in-service teachers’ professional development associated with Educational Technology. Two main questions are explored: First, to what extent can pre-service teachers enact a technology-rich curriculum unit during their field experience; second, to what extent and under what conditions can the pre-service teachers facilitate their cooperating mentor teachers’ acquisition of these same skills. Results indicate pre-service teachers could stimulate the integration of technology-rich innovations in their mentor teachers than that of their counterparts.

Bracha Kramarski and Tova Michalsky (2007) investigated the effects of two Computer Based Learning environments (CBL) with or without metacognitive instruction. Both environments were implemented: (a) to prepare pre-service teachers for self-regulated learning (SRL),
(b) to strengthen student-centered learning perceptions, and
(c) to develop skills for designing lessons.
Ninety-five pre-service university teachers participated in this study. Findings indicated that being exposed to metacognitive instruction by means of self-questioning improved pre-service teachers’ ability to reflect on the learning process. This in turn enhances their SRL skills (cognition, metacognition and motivation), shift perceptions toward student-centered learning (self-constructed knowledge) and develop skills for designing lessons (e.g., identifying goals, selecting relevant information, and creating effective learning experiences). Also the findings of the study are in line with research conclusions that metacognitive support for school junior students in CBL is a vehicle for being mindfully engaged in learning (e.g., Kramarski & Mizrach, 2006; Michalsky et al., 2007). The study described here makes an important contribution to SRL research, moving it into a new direction, into teacher education, with the goal of enhancing SRL in both teachers and students. Moreover, the research contributes to knowledge about the relationships between teacher perceptions, metacognitive instructional practice with CBL, and students’ outcomes.

A study was done by David Devraj Kumar, and Robert Sherwood (2007) on science teaching with a multimedia simulation on water quality, the “River of Life,” on the science conceptual understanding of 83 students in an undergraduate science education (K-9) course. Teaching reality-based meaningful science is strongly recommended by the National Science Education Standards (National Research Council, 1996). The topics addressed were classes of organisms that form river ecosystem, dissolved oxygen, macro invertebrates, composition of air, and graph reading skills. Paired t-test of pre- and post-tests, and pre- and delayed post-tests showed significant (p<0.05) gains. The simulation had a significant effect on the conceptual understanding of students enrolled in a K-9 science education course for prospective teachers in the following areas: composition of
air, macro invertebrates, dissolved oxygen, classes of organisms that form a river ecosystem, and graph reading skills. The gain was more in the former four areas than the latter one. A paired t-test of pre- and delayed post-tests showed significant (p<0.05) gains in the water quality and near transfer subsets than the dissolved oxygen subset. Additionally students were able to transfer knowledge acquired from the multimedia simulation on more than one concept into teachable stand-alone lesson plans.

Coutinho and Clara (2007) explored on weblogs, and experience of internet integration in pre service teacher education programmes in Portugal. 26 student teachers, 14 from Natural Sciences (S) and 12 from Foreign Language classes (L) participated in the study. Future teachers were encouraged to set up and maintain a weblog for their future students over a period of ten weeks during the 2nd semester of 2005/2006 in Educational Technology course (ET). The post-course survey and informal observations confirmed that, though not having prior experience of web design, student teachers enjoyed the experience and that the learning of a new-based technology such as blogging was something they felt complemented and enriched their pre service education. Results also point out differences between S and L students that can serve as interesting cues for the design of teacher education curricula in Portugal according to the Bologne Reform.

Balakrishnan Muniandy and Fong Soon Fook (2007) studied about authoring multimedia at University Sains Malaysia. Multimedia Authoring is a compulsory course for pre service teachers majoring in Interactive Multimedia. Besides acquiring theoretical knowledge on multimedia authoring, student teachers are required to produce a multimedia project during the course. This paper reported the findings of an experiment on a new approach to teaching multimedia authoring to pre service teachers. In the past, multimedia authoring
instructional methods such as using modules, text-books, templates, tutorials, demonstrations and lectures have been used. In the present method termed as the project-based learning approach to multimedia authoring, pre service teachers were provided with various learning resources required to author a multimedia project. They worked in groups of three to four students. As the students developed their project, they maintain a reflective journal of their experiences. The students indeed had a very rich learning experience and produced excellent multimedia projects.

Metacognitive Knowledge on the Pre-service Teachers’ Participation in the Asynchronous Online Forum was investigated by Abdullah Topcu and Behiye Ubuz (2008). This study aims to find out the effects of metacognitive knowledge on students’ participation in online forum discussions, which form part of a web-based asynchronous course based on a constructivist instructional approach. The study was carried out with 32 third-grade pre-service teachers. Each message in the forum discussions was analyzed in terms of interaction types identified by McKinnon (2000) and also scored using a grading rubric developed by the researchers. The metacognitive knowledge of the pre-service teachers was measured by the component of the General Metacognition Questionnaire. Results reveal that 67% of the pre-service teachers were at the high or medium-to-high metacognitive knowledge level and mostly sent messages having “example to idea,” “clarification and elaboration,” or “idea to example” type interactions. Pre-service teachers who exhibited low metacognitive knowledge, however, mostly forwarded messages having “acknowledgments,” “unsubstantiated judgment,” or “thoughtful query” type interactions. Moreover, metacognitive knowledge of the pre-service teachers uniquely explained 21.4% of the variance in the online participation score. The study concluded by outlining some implications metacognitive knowledge has on forum discussions in relation to the constructivist approach.
Elizabeth Murphy (2008) showed the effectiveness of computer-based learning environments depends on learners’ deployment of metacognitive and self-regulatory processes. Analysis of transmitted messages in a context of Computer Mediated Communication can provide a source of information on metacognitive activity. However, existing models or frameworks (Henri, 1992) that support the identification and assessment of metacognition have been described as subjective, lacking in clear criteria, and unreliable in contexts of scoring. This paper developed a framework that might be used by researchers analysing transcripts of discussions for evidence of engagement in metacognition, by instructors assessing learners’ participation in online discussions or by designers setting up metacognitive experiences for learners.

Olagunju and Abiona (2008) investigated the production and utilization of material resources in biology education in South West Nigerian Secondary Schools. In this survey, 450 teachers from 150 randomly selected secondary schools in Oyo, Ogun, Osun, Lagos and Ondo States were used. Two instruments were developed, validated and used for collecting data. Chi-square, percentages and t-test statistics were used in data analysis. Three research questions and two hypotheses were addressed and tested. The findings revealed: (i) Less than average number of teachers produce material resources, (ii) Few teachers use microscope, magnifying glasses, preserved specimen, models, quadrat and aquarium, (iii) Male teachers’ perception of utilization of resources is significantly higher than their female counterparts. The study recommended that biology teacher must improvise, produce and use both materials and ideas to aid instruction at all times and some issues which could aid adequate training of teachers in production and utilization of available biology material resources should be highlighted in the teacher education curriculum and instructions.
Fei Yin Lo & Benny Hin Wai Yung (2010) reported on teachers’ learning as a result of their participation in a school-based teacher professional development (TPD) programme that utilized classroom videos as a mediating artifact. Research on teacher learning has emerged as an important area for research in education. Much research that focuses on the content of teacher learning considers what teachers need to know and be able to do in order to teach well, such as knowledge, skills and beliefs. But little attention is put on the emotional and motivational aspects of learning in teachers. Based on two case studies, this paper reports on teacher learning as development of confidence in teaching. It also discusses on the significant role of classroom videos in these teachers’ learning. This study contributes to the TPD literature by showing how the use of classroom videos can be best utilized to facilitate teacher affective learning.

The investigation carried out by Sheikh, Faisal (2010) observed that the meaningful use of technology requires, teachers to not only know how to use technology, but how the technology can be used to promote learning. Teachers often lack time and support to understand TI (Teacher Interaction) in the curriculum. Hence this study aimed to investigate the effectiveness of advance organizers as a design concept in a Performance Support System (PSS), known as Multidimensional Display Systems (MDDS), to promote the understanding of TI among teachers. The study was carried out as a case study with mixed methods. The participants of this study were pre-service teachers, in-service teachers, academic and industry professionals, who were registered in technology-related classes offered by the College of Education at a regional Midwestern university in the USA during spring 2009. A mixed-design ANOVA failed to show any statistically significant difference in TI knowledge between the Experimental group and Control group, who used the MDDS or PSS respectively. Additionally, an independent samples $t$-test showed that there was a statistically significant
difference on the TI intervention workshop scenario performance, with the Control group scoring higher than the experimental group. Three major themes emerged from the qualitative analysis. These themes were related to user interface design, decision making and advance organizers. Based on the qualitative analysis, the participants had positive feedback related to MDDS. The participants thought that MDDS was a good tool for decision making. The participants also thought that due to the logical organization of contents in MDDS, it would allow them to retrieve information quickly.

Savittree Rochanasmita Arnold, Michael J. Padilla and Bupphachart Tunhikorn (2008) in their paper discussed about Information and Communication technology including computer hardware/software, networking and other technologies such as audio, video and other multimedia tools became learning tools for students in 21st century. ICT changed the nature of the teachers’ work and the way they relate to other teachers in their professional lives. The researcher designed and implemented a course to enhance 18 pre-service science teachers’ professional knowledge. Technology was used as a tool for enhancing the development of professional knowledge. Data from questionnaires, classroom observation, journals, online discussion boards and pre-service science teachers’ artifacts were analyzed by the contrast comparative method. The results revealed that most of the pre-service science teachers who felt more comfortable using software and hardware were willing to learn, improve their creativity, participate in group collaboration and felt free asking questions and reflecting on their ideas on discussion boards. The results show that pre-service science teachers develop their professional knowledge when they are engaged in embedding ICT in subject teaching activities.

Sara McNeil (2009) described mental models in understanding cognitive change to support teaching and learning of multimedia design and development. It
is asserted by the author that designing and developing multimedia software is a complex and sometimes confusing learning process for students. Often, students learn to use multimedia authoring programmes and a collaborative instructional design model with little understanding of how the tools and the design process interrelate. In this study, teams of instructional technology graduate students in a two-semester, multimedia design and development course used an authoring programme to create multimedia software for authentic clients. This study examined the cognitive changes that occurred when these students were immersed in a project based, collaborative environment. The comparison of students’ visual representations of their mental models of multimedia design and development from the beginning to end of the course and in-depth interviews provided insight into these changes in their mental models. It is found that students demonstrated significant transformation in their mental models from linear, individualistic, and skills-based models at the beginning of the course to recursive, collaborative, and team-oriented models at the end. Visualization of mental models can help both instructors and students understand the knowledge building process (Yehezkel, Ben-Ari, & Dreyfus, 2005).

Omwenga, E.I., Waema, T.M., Eisendrath, G.P.C. and Libotton (2005) discussed a stratified objectives-driven e-content structuring and deployment framework which is an iterative and intuitive approach to content structuring and sequencing. The model has been developed from experiences and insights gained over four-stage content development training process involving university lecturers in liberal arts, sciences and engineering subjects. The model supports a hierarchical approach in knowledge presentation starting from the most abstract to the most specific. It is a layered structure of entities whose naming conforms to content abstractions. In this paper, it is argued that the concept of objectives is an effective tool that enables logical content breaking-up and sequencing. It is demonstrated that objectives help one to think critically on what to include under
specific topics. The findings indicate that objectives play a central role in providing an effective content validation mechanism. Further, collaborative efforts among homogenous groups result in the most efficient approach on training in content development.

3.5 Insights gained for research gap and the development of key components of research design


It is significant for the present study to note the observation of Hollingworth et.al (2001) and Renata Phelps and Anne Graham (2008) on the use of Metacognition and Technology by the factors. Hence the above mentioned concept reviews helped investigator gain insight on the use of Metacognition and Technology for the improvement of science education. These insights indeed threw some light to gain momentum to integrate Metacognition into the Instructional design for the development of e-content for the present study.
The empirical investigations done by the Handal et.al (1999) and Eunjoo Oh and Russell French (2002) found positively the significant effect of technology standards for the teacher preparation programmes. They found the positive impact of technology in teaching and learning process Brenda et.al (2004), Eunjoo Oh and Russell French (2004), Jonathan et.al (2007) found out the positive effect of integration of technology into the teacher education programme. Well (2007), Anne Graham et.al (2003), Georghiades (2004), Shoot (2006), Saravanakumar and Mohan (2007), Ramganesh (2008), Helen Ngozi (2009) explored the positive effect of Metacognitive strategies in teaching and learning. Susan sunny Cooper and Penee Stewart (2006) attempted the study on metacognitive development of professional educators. Sevgi Turani et.al (2009) investigated the acquisition of Metacognitive awareness and self regulated learning skills in medical schools. Both the studies used Metacognitive awareness Inventory (MAI) for their investigation. It is to be substantiated that these two studies guided the investigator develop and validate a tool on “Metacognitive awareness Inventory for student- teachers of science”. This is one of the research tools used in the present study.

Also the study done by Amutha and Ramganesh (2010) explored the application of Metacognition. It is significant for the investigator of the present study to note that Kramarski and Gutman (2006), David Devaraj Kumar et.al (2007), Abdullah Topcu and Behiye Ubuz (2008), Elizabeth Murphy (2008) empirically investigated and found out the positive impact of integrating Metacognition into technology on teacher education. In addition to this Olagunju and Abiona (2008) and Sheikh Faisal (2010) observed significance in the use of technology in science education.

research council (2003) referred the positive relation between metacognition and teaching competence. Rosemary Reilly and Gillian Bramwell (2007) emphasized the inclusion of metacognition in the instructional design and e-content development among the teacher educators. This study threw a light for the investigator to gain momentum to develop a tool on Metacognitive Instructional design.

Esin, Bhattin Deniz’s (2009) study on pre-service biology teachers about their competencies in biology applications. Judy Somers (2009) study on pre-service teachers’ perceptions on science content knowledge, teaching practices and reflective processes and Chittyun Jung’s (2010) study on conceptual model on science teacher identity paved the way and contributed a lot to the present investigation for the development of a model on “Science Teaching Competence” Hence the studies reviewed in the present study paved the way for the development of key components of research design. Although the studies reviewed are pertinent literature to the present investigation, none of them has attempted to develop e-content using Metacognitive Instructional design that even for student-teachers of science. The investigator being the teacher–educator of science made use of this research gap and attempted to develop an e-content in science using a unique instructional design so called Metacognitive Instructional design to empower the Science Teaching Competence of student-teachers of science in the rural areas. To fill this research gap, the investigator attempted this positivistic research entitled as “Empowerment of Science Teaching Competence of B.Ed trainees in the rural areas through e-content with a Metacognitive Instructional design”.

3.6 Conclusion

The objectives of the study, formulation of the hypotheses, research questions, variables, research design, experimentation, construction and validation of the tools are dealt in the next chapter.