CHAPTER – II

REVIEW OF RELATED LITERATURE

This chapter encompasses review of literature related to the present study. It is divided into sub sections such as studies related to online learning, blended learning, critical thinking, problem solving and learning science. The researches related to learning styles are also included in the respective subsections.

The review of related literature helped the researcher to identify existing research gaps, to define key terms operationally, to identify methodology and techniques of the analysis and to arrive at hypotheses. The exercise of reviewing related literature also helped in identifying tools to assess the variables and it was useful in the stage of discussing the findings. The following paragraphs describe various studies related to the present study in detail.

2.1 STUDIES RELATED TO ONLINE LEARNING

The review of related literature indicated that several researches were conducted on online learning during the last two decades. The studies were undertaken mainly to find out participants’ perceptions on various aspects of online learning, to identify factors contributing to the effectiveness of online learning and to analyze interactions occurring in online learning environment. In addition to this, studies were undertaken to find the effect of online learning in terms of problem solving, self regulated learning and achievement.

McLaughlin and Hollingworth (2000) conducted a research on developing first year science students’ problem solving skills through online learning and found that students’ problem solving skills can be developed significantly by taking a proactive online approach and by designing an environment specifically for problem solving. He asserts that this requires creating real life anchors and enabling students to explore, test and review their own strategies. Added to the above study, Cain (2005) revealed that computer mediated conferencing enhances student learning outcomes irrespective of student background variables. The findings suggest that computer mediated conferencing should be used in combination with traditional classroom instruction to have the best effects.
Researches were also undertaken to study the effect of internet technologies in specific disciplinary areas such as science and history (Kubasko, 2003; & Li, 2004). Kubasko (2003) compared the impact of real time internet experiments versus interactive asynchronous replays of experiments on high school students’ science concepts and attitude. The result of the study revealed that the students’ investigations using the internet and stored replay experiences can assist science educators in providing students with more inquiry based experiences. Li (2004) conducted a research on the impact of online project and indicated a positive impact on students’ learning in history. However, the data did not show significant difference in students’ attitudes towards computer technology and history learning. Most of the students “enjoyed working on the project” and believed “computer technology was useful” and they “learned not only the local history, but also computer technology” and they “learned much more from researching on the internet than from the text book”.

Some of the studies attempted to find the effect of different formats of online learning on variables such as achievement, self regulated learning and learner satisfaction (Brewer & Klein, 2004; & Chapman, 2004). Brewer and Klein (2004) studied a small group learning in an online asynchronous environment and the results indicated no significant differences in achievements by type of interdependence, or by affiliation motive. Correlation analysis revealed a significant positive correlation, indicating that participants with higher number of interactions attained higher posttest scores. Participants in reward groups had significantly higher agreement with several attitude statements that reflected benefit from working with others and being able to generate better ideas in groups. Chapman (2005) found a statistically significant positive effect of online collaborative learning on academic achievement and college students’ perceptions regarding the instructional design process. Kaur (2004) conducted a study on social construction of knowledge and its relationship to academic achievement using asynchronous conferencing tool. The study analysed the online transcripts of participation, interaction and knowledge construction in undergraduate courses. Course syllabi and policies set up by the instructors were used to examine the structure of these web based courses and found a relationship between grades assigned and knowledge construction categories for two of the three online courses.

There were studies which assured the improvement in higher order thinking through web based tools such as Dabbagh and Kitsantas (2005), who conducted a
study on web-based pedagogical tools as scaffolds for self-regulated learning and found that Web-Based Pedagogical Tools (WBPT) (e.g., collaborative and communication tools, content creation and delivery tools) supported different Self Regulated Learning (SRL) processes (e.g., goal setting, self-monitoring). In addition, analyses of qualitative data collected revealed that WBPT were highly effective in activating the use of SRL processes. Prilluck (2004) compared the effect of two technologically different methods – traditional teaching and web-assisted method of instruction on student responses and found that students in the traditional course were more satisfied with their learning experiences and these students felt that the course helped them develop their skills in critical thinking. But this result was contrary to the findings of Pstein (2003) who studied the effects of web-based versus web-enhanced learning on school students’ learning outcomes and self regulatory skills. His findings indicated that the type of instruction did not account a significant amount of variance in predicting students’ achieved learning outcomes and their self regulatory skills.

Whitesel (2002) investigated the impact of instruction on the use of online help on computer novices’ ability to complete unfamiliar computer tasks and the result showed that performance of treatment group on unfamiliar tasks did not significantly improve over the control group whereas, Sukhai (2005) studied the effects of web based animated demonstration and guided simulation in business software applications training and found that web based training had the highest training efficiency followed by courses with guided simulation compared to courses with combined animated demonstrations and guided simulations.

A few researches were conducted to study the factors which determine the effectiveness of online learning environment. The case study conducted by Bucy (2003) described the experience of students enrolled in an online course and identified cognitive load as the negative factor. This suggested that it is possible to increase student motivation to participate and persist in online courses by adjusting the course design to enhance positive factors identified by participants and minimize negative factors. Similarly, Yukawa (2005) conducted a case study on a narrative analysis of learning through co-reflection in an online action research course and found that online learning action research is effectively supported by 1) field based inquiry learning 2) instructor understanding of the learner’s background 3) learning philosophy that values constructivist learning 4) online facilitation and mentoring skills and 5) social software.
Williams (2003) conducted a comparative study on transforming an educational graduate degree program from traditional classroom instruction to online based instruction and found that time was a major factor in developing and teaching an online course and student learning centred more on required participation rather than traditional faculty lectures. The study revealed that students enjoyed online learning but had to be more self motivated due to the increased demands of online learning. Overall, the online experience was as enjoyable as traditional classes for most participants but more demanding. Faculty members were satisfied with the quality of online work and students liked the flexibility of online courses.

Another set of studies analyzed interaction in online learning environment whereas a few studies tried to study the influence of online interaction on different variables. Ho (2005) evaluated online interaction in asynchronous learning environments through a conversation analysis approach and examined the actual participation and dynamics that occur in an online conference discussion. Results indicated that students whose participation characterized high quality maxim received higher final course grade compared to their counterparts. In the larger class, a significant correlation was found between the number of instructor contributions and the number of student responses, suggesting that instructor participation can generate a higher level of active student participation.

Wingard (2004) assessed the impact of web-based enhancements on teaching and learning. Higher levels of interaction and comfort among participants were reported. Teaching faculty reported increased efficiency and convenience of making updated material available on the web. The studies conducted by Fite (2003), Whisler (2005) and Summers (2005) attempted to study the factors which influence interaction among participants enrolled in online courses. Fite (2003) studied influence of learner-learner interaction in online classes and found that there is no correlation between cognitive style and quality of learner-learner interaction. Interaction elements during online discussions do not indicate the content of discussion, but do indicate how the discussion is taking place and students have opinions on how their experiences in online courses should impact online course design, particularly in terms of knowing the learner and communication. Whisler (2005) conducted an intrinsic case study with a survey to explore learner self-efficacy and interaction during the implementation of accelerated online college courses. As a participant observer, the researcher concluded that self-efficacy is a valid and reliable predictor
of learning outcomes in an online course, interaction is a critical component of learner satisfaction and making better use of instructional time is more important than the actual amount of time allocated to courses. Added to the above study, Qureshi (2004) conducted a study to investigate various factors that might affect students’ satisfaction with online course components of an undergraduate programme and the investigator singled out five quasi models of descriptive characteristics (demographic, experiential, motivational, learning styles, instructional designs) as potentially having an impact on students’ satisfaction with the online course components (email, hypertext, online threaded discussions, web links, chat, video, audio, simulations, and graphics).

The research reviews revealed that several studies were conducted on perception of learners and faculties about online learning and its various aspects (Conrad, 2002; Dill, 2003; Shih, 2004; Krebs, 2004; & Spampinato, 2005). Conrad (2002) explored how learners perceived themselves as participants in online learning activities. The results indicate that online learners worked hard and continuously negotiated to build community feeling while engaged in online learning. Dill (2003) investigated undergraduate business students’ perception of their critical thinking skills development in an online business information management course. Participants identified the factors which enhance and kinder critical thinking skills development through an online course.

Shih (2004) examined role of social presence in relation to students’ perception of online asynchronous learning. The study not only found measures of perceived presence significantly related to satisfaction with online class discussions but also that perceived social presence was a predictor of perceived interaction, perceived learning and satisfaction with instructors. The study found that students’ perceived social presence also coincided with the social presence behavior they projected in online class discussions, indicating that students who perceived higher degrees of social presence were more able to present themselves effectively and socially in the online environment.

Spampinato (2005) found that a higher percentage of students in the online course perceived the personal attributes such as study habits, reading ability, independent learning, self motivation and time management as more important to course success than did the students in the classroom format. The survey also showed that student-student interaction was perceived as important course attribute.
A phenomenological case study was conducted by Krebs (2004) on implementing an online web design course at a suburban high school in Apple Valley, Minnesota. The purposes of the study were to examine the possibility of utilizing student centered learning in an online multimedia class and to receive student input with regard to the online course on how to improve the online learning process. This study revealed that students believed the online environment encouraged them to work at their own speed, to be active participants, to be intrinsically motivated and to individualize learning more than in a traditional class. Additionally, the students believed that they were more challenged and more prepared for life after high school through online learning. However, some students also believed that they were less able to build relationships online. The students suggested better communication software, more images and audio-visual instructions and more interactions online as methods to improve the course. Strachota (2004) conducted a study on student satisfaction in online courses and found that students in courses that had either a voluntary or required discussion group were significantly more satisfied than those students who were in courses with no discussion group. The study further showed that students in science courses were significantly more satisfied with their online courses compared to students from the business and graphic arts courses. Females were significantly more satisfied with learner-instructor interaction than males. Students identified learner-content interaction as the most important criteria for a satisfying online experience and learner-instructor interaction as the second most important criteria.

Lai (2003) analyzed the sense of community in computer mediated learning environments from the perspectives of learners. Analysis of the data showed that learners felt connected and supported, felt valuable, comfortable and relaxed, felt close to each other, felt they shared intellectually, felt happy, excited and invested in the process and had a strong sense of honesty and trust. All participants claimed that these experiences increased their learning quality and most of them had a very high level of satisfaction with those courses in which they had this experience.

The results of the study conducted by Otto (2004) revealed that a homepage can be very beneficial to the students of a seventh grade social studies class. Students enjoy using the homepage in their classes because it is more fun when they can utilize computer technology, it is easier to find the required information, it keeps them organized, and it allows them to work on their assignments outside of the classroom.
Hao (2004) explored students’ attitude towards four types of interactions in online learning: instructional, affective, collaborative, and vicarious. Data were collected through online questionnaires and interviews from a sample of 182 students enrolled in online courses at a community college in US. The research indicated that students had significant differences in their attitudes towards the four types of interactions. Learning style was not a significant predictor of students’ attitude towards interactions. Learner’s attitudes towards the four types of interactions were related to course satisfaction and the four attitudes significantly predicted course satisfaction. Song (2004) studied perception of college students regarding the instructional quality of online courses delivered via WebCT (Web Course Tool). The results of the study showed overall positive perception regarding the instructional quality of online courses delivered via WebCT. The visually appealing website material received the highest rating. The result was closely correlated to student responses regarding the important aspects of instructional quality of online courses.

Roh (2004) conducted a study on designing accessible Web Based Instruction (WBI) for all learners and found that many students feel that some common web based instruction features make content inaccessible because designers do not consider accessibility at the beginning of the course design. If the issues of accessibility are not appropriately addressed, the potential of WBI cannot easily transfer into direct educational benefit for all learners especially students with disabilities. Ho (2005) went beyond students’ perception, satisfaction and attitudes and examined the actual participation and dynamics that occur in conference discussions through a conversational analysis approach and found that instructor participation can generate a higher level of active student participation.

Researchers such as Wang (2004) and Allert (2005) studied the influence of learning style on variables like achievement among online students. Wang (2004) analyzed learning style preferences and their relation to achievement among online and traditional higher education students. The findings from the study indicated that there were no significant differences in academic achievements among the four KOLB learning styles and between two instructional modes. Adding to the above studies, Myers and Dyer (2002) found that student learning styles, patterns of learning, and characteristics did not have an effect on achievement measured by class grade in the web-based courses. Additionally, field-independent students did not differ significantly from field-dependent students in their use of learning strategies and patterns of learning.
and he concluded that students with different learning styles and backgrounds learned equally well in the web-based courses. No significant interactions were found in post-test scores between the learning styles and the instructional modes. But the result is contrary to the results obtained in a study conducted by Ross (2002) who investigated the effects of learning styles on the achievement of 7th grade African-American students when instructed through co-operative learning. The results indicated that African-American students are social in their learning habits and are field dependent learners and therefore it creates a conflict when using co-operative learning as an instructional method with low socio-economic class African students.

On similar lines, LaPrise (2003) examined the patterns among computer-mediated instruction, student learning styles and student achievement. The results showed that no patterns were found in the data which indicated a relationship between perceptual modality preferences and achievement when students are exposed to computer-mediated instruction. However, Buket and Meryem (2009) investigated the effects of learning styles on students’ achievement in different learning environments – text based, narration based and computer mediated (narration + music + text + static picture) and found that learning styles do not have any significant effect on students’ achievement in different learning environments. Yahr (2005) conducted an investigation of the relationship between expertise and learning style and the results showed no statistically significant relationship between learning style and domain expertise. Allert (2005) conducted a research on learning style as a correlate of success in introductory computer science education. As a part of this study, learning style profiles of students in each class were constructed; the visual, verbal scale was skewed to the right in each instance. The study identified that active reflective scale is significantly related to performance in computer programming classes. On similar lines, McCann (2005) investigated the relationship between extension employees’ learning styles and their performance in a minimally interactive online environment, a multimedia-rich, highly interactive online environment, and a traditional face-to-face environment. Results indicated that participants belonging to traditional and multimedia rich, highly interactive online environment had statistically higher posttest scores than those participants in a minimally interactive online environment. Further, it was observed that participants’ learning style had no statistically significant effect on their final posttest scores in any of the three instructional methods and no significant interaction was found between the learning style and instructional method.
Adding to the above study, Scribner (2004) explored the influence of instructional methods and learning style and found no statistically significant difference between spatial ability score and basic drafting instructional methods. However, statistical significance was found in the relationship between spatial ability and learning style. Statistical significance was found in the change between the pretest and posttest of subjects’ perceptual modality learning style.

Du (2003) conducted an evaluation of the effect of learning styles and computer competency on students’ satisfaction in web based distance learning environments and found that there is a significant difference among the students belonging to different learning styles with respect to their satisfaction level when the subjects differ with regard to computer competency. A significant correlation was found between computer competency and students’ satisfaction levels within web based courses for accommodating styles and no significant results were found in other learning styles. Murray (2004) conducted a research on exploration of kinesthetic learning modality and virtual reality in a web environment and used both qualitative and quantitative methods to explore the kinesthetic learning style preferences of online Brazilian English language learners and to obtain their reactions to specific virtual reality formats on the web. The study revealed that the kinesthetic learning style was strongly preferred by the online participants and the other perceptual modalities were also preferred, but to a somewhat lesser degree. Cox (2004) examined learning styles and student attitudes toward the use of technology in higher and adult education courses. With regard to attitude towards the use of technology, data showed that the subjects viewed one-to-one communication (email), multimedia (PowerPoint), course website and internet when used by the Professor in class as more positively facilitating course objectives. The use of DVDs and music CDs were seen as a distraction from achieving course objectives. The finding also showed that the participants who were classified as ‘converging’ in learning style had the highest mean attitude score and those who were ‘diverging’ had the lowest mean attitude score. The findings demonstrate that no relationship exists between attitude toward the use of technology and learning style.
2.2 STUDIES RELATED TO BLENDED LEARNING

The review of related literature revealed that blended learning started gaining significance and popularity in the early years of 21st century. It is very much evident from reviews that most of the studies on blended learning were focused in the areas of higher education (Dziuban, Hartman, & Moskal, 2004; Dowling, Godfry, & Gyles, 2003; Clark & Patrick, 2005; O’Toole & Absalom, 2003; Vanicharoenchai & Tosulkaew, 2010; King, 2002; Bekele & Menchaca, 2009; Akyuz & Samsa, 2009; McClure, 2007; Oliver, 2005; Yen & Lee, 2011; Chen & Jones, 2007; Lynch & Dembo, 2004; Dettori & Persico, 2007; Meyer, 2003; Prilluck, 2004; & Kish, 2004). A few researches were conducted on effectiveness of blended learning courses/programmes and the effectiveness was assessed in terms of students’ pass rate, learning outcome, critical thinking and other allied variables. Some of the studies were evaluative in nature wherein attempts were made to study experiences of faculties, students’ satisfaction and perceptions of blended learning courses/programmes whereas some other studies gave emphasis on modes/ways of integrating web based instruction, computer based visualizations and online learning with regular teaching. It is observed that ‘hybrid learning’ and ‘blended learning’ were used synonymously by researchers.

Dziuban, Hartman and Moskal (2004) found that blended learning results in more success compared to face-to-face modality for all ethnicity and asserted that blended learning increases student learning outcomes. Adding to the above study, Dowling, Godfry and Gyles (2003) found that the hybrid flexible delivery model is more positively associated with accounting students’ final marks and improved learning outcomes whereas, Clark and Patrick (2005) conducted a study using blended learning approach to deliver science courses and he found that the overall impact on student learning through blended learning was neutral. But this evaluation shows that it is possible to use online resources to deliver introductory science courses and make the courses more flexible without reducing the learning benefits.

The study conducted by O’Toole and Absalom (2003) also reported that blended learning has positive impact on student outcomes. The purpose of the study was to learn whether the provision of course materials on the internet had a positive effect on student achievement. They found that those students who attended lecture and read web materials performed better than those students who only attended lecture or only used the web. Similar results were obtained in a study conducted by
Ozgen and Ufuk (2009) who worked on the impact of blended learning model on student attitudes towards geography course and their critical thinking dispositions and levels. An experimental pattern with pretest posttest control group was used in the study. The study group consisted of a total of 57 students – 28 in the experimental group and 29 in the control group – at Kirşehir High School. The experimental group was subjected to hybrid learning through the Geography web page, while the traditional learning model was used for the control group. The results of the study indicated that blended learning model contributed more to student attitudes toward geography course, student critical dispositions and levels when compared to the traditional learning model. There was a positive correlation between student attitudes toward geography course and their critical thinking dispositions and levels.

Tuckman (2002) evaluated effectiveness of a hybrid instructional model, namely, ADAPT, combining web based and classroom components and found that those students who were taught study skills through the ADAPT method achieved the highest GPA relative to past performance; those not taught study skills at all achieved the lowest and those taught through traditional methods fell in between. Whereas, King and Hildreth (2001) investigated the effectiveness of an internet based biology course and found no significant differences between students’ test scores in the internet based courses compared to the traditional courses. In connection to the above study, Vanicharaoenchai and Tosulkaew (2010) compared academic achievements of students who studied through blended learning based on action learning, and students who studied through traditional learning. It was a quasi-experimental research wherein the subjects were 128 second year undergraduate nursing students at Mahidol University. The subjects were selected by purposive sampling and separated into two groups – 64 students in a control group, which studied through traditional learning; and 64 students in an experimental group, which studied through blended learning based on action learning. The results showed that the experimental group had higher achievement scores than the control group. The subjects were highly satisfied with the blended learning based on action learning methods. Whereas Utts, Sommer, Acredolo, Mahar and Matthews (2003) found that student performances in the hybrid format equaled that of the traditional format, but students in the hybrid format were slightly less positive in their subjective evaluation of the course and felt that the course was more work, with some students feeling that the workload was excessive. Added to the above study, Schweizer, Paechter and Weidenmann (2003) examined how groups of
learners work together in blended learning and e-learning environments. Result of the study indicated that achievement in a particular group does not solely depend on the mode of communication used in the course.

The results obtained by Boyle, Bradley, Chalk, Jones and Pickard (2003) revealed that student success rates in blended learning program are improved and also demonstrated marked improvements in pass rates. But the results obtained in a study conducted by Carroll (2003) about a professor’s initiative to supplement face-to-face courses with online instruction evidenced equal learning outcomes compared to those students who have finished the program without the online components.

Hong and Miao (2009) aimed at investigating how blended learning has influenced sixth grade students with different ability levels in an elementary school in Taiwan in terms of their achievements in environmental education. The outcomes of the experiment are: 1) no conspicuous interaction between teaching approaches and learning capability is found in the posttest on environmental education; 2) subjects who accept blended learning demonstrate better achievements than the other group; 3) students with higher learning capability have higher achievements than the lower ones; 4) with different teaching approaches, students with lower learning capabilities show a remarkable difference in the posttest on environmental education.

Some researchers conducted studies to find effectiveness of integrating online learning with classroom learning in terms of acquisition of higher order thinking (McCary, 2000; King, 2002; Bekele & Menchaca, 2009; Akyuz & Samsa, 2009; McClure, 2007; Oliver, 2005; Yen & Lee, 2011; Chen & Jones, 2007; Lynch & Dembo, 2004; Dettori & Persico, 2007; Meyer, 2003; Prilluck, 2004; Pstein, 2003; Ferdinand, 2004; & Kish, 2004). These researches revealed mixed results. McCary (2000) reported utility of online learning environment in traditional classes both as an efficient means for executing activities previously tethered to the classroom setting and as a means to allow the pursuit of higher levels of learning. This result is asserted by King (2002) who conducted a case study and found that hybrid online class discussions had the potential of prompting critical thinking. The depth of insight found in participants’ responses was higher than is often possible in face-to-face classroom due to time constraints. But the result obtained in a study conducted by Bekele and Menchaca (2009) who examined the effect of blended learning on critical thinking is not completely in agreement with the result obtained in the study conducted by King (2002). Out of 157 psychology majors, 72 were randomly chosen
and assigned to either an experimental (EG) or a control group (CG). The former attended to blended learning while the latter experienced the course traditionally for one semester. The result indicated that both the groups performed equally on critical thinking and problem solving tasks. Similar result was obtained by Akyuz and Samsa (2009) who did a single group pretest - posttest study on effects of blended learning environment on the critical thinking skills of students wherein the duration of the intervention was of 5 weeks. The result indicated that critical thinking doesn’t improve in blended learning environment whereas, a study conducted by McClure (2007) on Graduate Teaching Assistant (GTA) students found that blended learning environment encouraged self reflection and self evaluation, supported collaborative learning and problem solving skills, and facilitated tasks requiring analyses and evaluation of ‘real life’ teaching situations.

Added to the above studies, Oliver (2005) used a blended learning approach to support problem-based learning with first year students in large undergraduate classes. The findings appeared to provide evidences for the premise that a problem-based teaching approach delivered using blended learning involving web-based tools and direct instruction could provide strong support for students in large class settings. Most students demonstrated positive levels of satisfaction with the approach to learning and indicated that the approach supported their learning.

Yen and Lee (2011) tried to explore problem solving patterns and their impact on learning achievements in a blended learning environment. Through quasi-experimental instruction, data was collected from 34 students in a blended learning environment using classroom instruction, mobile and web scenarios. By combining cluster analysis and content analysis, three groups were identified with distinct characteristics: the hybrid-oriented group, the technology-oriented group, and the efficiency-oriented group. Learners in the hybrid-oriented group used the classroom, mobile and web scenario almost equally. They displayed a regular manner in following the instructor’s teaching procedure, and tended to passively accept whatever the teacher said. Students in the technology-oriented group spent most of their time using mobile and web technologies but they revealed only superficial problem solving abilities. The efficiency-oriented group was characterized by the efficient monitoring of learning processes. It was more task-oriented and problem solving performance was better than the other two groups.
Similar finding was obtained in a study conducted by Chen and Jones (2007) on Master of Business Administration (MBA) students. Compared to students in the traditional settings, blended learning environment students indicated stronger analytical skills as a result of the course. Lynch and Dembo (2004) conducted a study on relationships between self-regulation and online learning in a blended learning context. The study identified learner self-regulation skills as predictor of academic success in a blended education context. It also revealed that verbal ability and self-efficacy are related significantly to performance. Dettori and Persico (2007) conducted study on supporting Self-Regulated Learning (SRL) in a blended learning course. The study investigated the practice and development of SRL abilities in a blended learning course for trainee teachers. They found that the online component of the course was especially valuable with regard to the social aspects of SRL whereas, the face-to-face sessions seemed to contribute in particular to the development of the cognitive sphere. The study suggests that a balanced blend of in-person and online activities may result synergistic from the point of view of SRL. Meyer (2003) found that learnings that occur in both face-to-face settings and through online mode have value and some students seem to prefer one over the other based on their learning preferences. He coded online discussions using the Garrison Cognitive Processing Categories and found evidence of higher order thinking in the online discussions.

Ferdinand (2004) as part of a project, implemented blended learning for imparting science lessons at six schools and found that self directed learning was successfully stimulated by blended learning. Kish (2004) investigated the use of vignettes as a teaching strategy and as a learning activity to develop higher order thinking and academic achievement in adult learners in a hybrid online course. The research indicated that the use of teacher generated vignettes can increase academic achievement, and that learner generated vignettes can help students achieve higher order thinking. The result also indicated that vignettes were preferred both as a learning activity and teaching strategy when compared to lectures, demonstrations, projects, online slide presentations and online discussions.

Some studies found that accessibility to content and connectivity among students increased in a blended learning programme, but with no difference in terms of effectiveness of instruction. Johnson (2002) found that accessibility to course content and connectivity with students increased in a hybrid course, while no differences were found in terms of effectiveness of instruction. Fong (2007) found
that web based logging of classroom teaching activities for blended learning provides more flexibility in learning with more facilities of e-learning and classroom learning. Cox, Carr and Hall (2004) evaluated the effectiveness of synchronous communication considering the roles of course design, group dynamics, and facilitation style in two blended courses and found that these three factors strongly influenced the successful use of this medium and student participation.

Researchers such as Graff (2003) studied gender differences and difference in cognitive style in blended learning environment with respect to students’ sense of community. Results indicated that students with intuitive cognitive styles reported a lower sense of community than students with an intermediate or analytic style. Few differences were found with respect to gender and sense of community in a blended learning environment. Similar attempts were made by researchers (Rovai & Jordan, 2004; Mathur & Oliver, 2007) to study the sense of community in a blended learning environment including interaction between students and teachers and interaction among students from different countries. Rovai and Jordan (2004) conducted a comparative analysis of blended learning courses with traditional and fully online graduate courses. Results indicated that blended learning courses produce a greater sense of community than either traditional or fully online courses. Mathur and Oliver (2007) discussed a model for global learning that utilizes a blended learning approach and its implementation in an international technology master’s program. They reported that through an international distance education program that utilizes a blended learning approach, knowledge can be shared, and all countries and individuals participating can learn and expand on their knowledge. Added to this result, Gulsecen, Ugurlu, Ersoy and Nutku (2005) found that blended learning provides students with equal opportunities, regardless of the fact that they either study at a private or state university. Benson (2005) conducted a research on comparison of learning style and other characteristics of site based, hybrid and online students. Research showed that participants in the three learning environments were significantly different in terms of their general information course selection, internet experience, location of internet use, work schedule, learning style preferences and attitude towards online learning. The participants were not significantly different in terms of final course grade and course satisfaction.

There were several studies on perceptions and reactions of students and teachers about blended learning courses/programmes (Humbert & Vignare, 2005;
Buket & Meryem, 2006; Leh, 2002; Riffell & Sibley, 2003; Delialioglu & Yilderum, 2007; Reid, 2004; Cottrell & Robinson, 2003; Balarabe, 2006; Chew, Jones, & Turner, 2007; Clark & Patrick, 2005; Olson, 2003; & Girelli, 2004).

Humbert and Vignare (2005) conducted a research case study and found that students like blended learning and believe faculty are offering more instructional strategies and resources using blended learning. Buket and Meryem (2006) examined students’ views on blended learning environment and found that students enjoyed taking part in the blended learning environment and students’ achievement levels and the frequency of their participation in forum affected their views about blended learning environment. The dimension of face-to-face interaction had the highest score and the results demonstrated the importance of interaction and communication for the success of online learning. The results of the action research conducted by Leh (2002) based on hybrid courses conducted from 1999 to 2001 also revealed that those students who studied in a hybrid course, learned as much as or more than the other students who studied in traditional courses. They were more motivated and preferred hybrid courses over traditional ones. He also found that students felt a greater sense of belonging in those courses that used synchronous communication although they enjoyed the flexibility of asynchronous communication.

Riffell and Sibley (2003) studied student perception of a hybrid learning format and the result indicated that students experienced more student-instructor interaction in the hybrid environment in a Biology course. Delialioglu and Yilderum (2007) conducted research on students’ perceptions on effective dimensions of interactive learning in a blended environment in a hybrid course of computer networks and communication. The findings showed the need for meta cognitive support, authentic learning activities, collaboration and individualized learning. The study also revealed that access to internet played important role in students learning in the hybrid course. Robinson (2004) conducted a study to understand faculty experience in designing and teaching blended learning course at Brigham Young University and identified faculty perceptions of three major benefits from the blended learning experiences such as more effective use of classroom time, increased flexibility in meeting time constraints of both students and professors and greater ability to meet the needs of individual learners. The quantitative phase revealed that there is a positive correlation between effectiveness of blended learning and support from the University administrators. Cottrell and Robinson (2003) reported that
accounting students prefer blended learning approach. Balarabe (2006) studied the influence of blended e-learning on students' attitude towards mathematics and computers. A random sample of 70 students of the preparatory year program of King Fahd University of Petroleum and Minerals (KFUPM), Dhahran served as the sample of this study. The result indicates that the subjects have positive attitude towards mathematics and computers. However, analysis of variance shows no statistically significant change in students’ attitudes towards mathematics and computers except for computer confidence and anxiety subscale.

Chew, Jones and Turner (2007) found that blended learning helped in holistic learning by bridging closer relationships between educators and learners with autonomous communication. Clark and Patrick (2005) conducted a project to determine whether students perceived as beneficial the online learning resources that had been incorporated into the teaching. The ease of getting readings from the online course page was praised by the participants and they found the questions accompanied by readings were useful and helpful. Responses about the online discussions varied and were about evenly balanced between those who found the discussion page to be excellent to those who either did not use it or used it very infrequently. Quite a number of students indicated that they acted as lurkers on the discussion page and that they checked into it, but did not submit any specific questions. Olson (2003) studied the perceptions of hybrid classes at a notebook university and found that the majority of students preferred hybrid classes to traditional face-to-face classes. The most prominent reasons were the students’ ability to complete coursework at their own convenience, the increased time for other activities, not having to physically meet all the time, increased interaction with others, and the freedom that goes along with hybrid classes. Students’ responses were favorable toward hybrid courses and their learning experiences. The hybrid course model enhanced the students’ learning experiences through the increase in the amount and promptness of feedback between students and the instructor. Girelli (2004) conducted a qualitative study on teachers’ perceptions of a hybrid in-service delivery model and reported that teachers entered the program preferring informal onsite workshop instruction to all other technology training options and that this preference proved durable. Teachers perceived video-based instruction as valuable but felt synchronous video was not valuable and found web-based learning challenging and frustrating but believed educational resources on
the web are bountiful. Overall cohort members expressed satisfaction with the course attributing their satisfaction primarily to participation in project work.

Chen (2003) attempted to study how the selected faculty and teaching staff members of University of South Carolina integrate Web-Based Instruction (WBI) in regular teaching and found that 72% of the faculty integrates WBI in regular teaching. The study showed no significant relationship of faculty’s gender, academic rank, tenure status with their level of integration of web-based instruction. But the study did find that the faculty’s attitudes and belief of WBI, their technology expertise, their accessibility of technology, support, and training affected their integration of WBI. The top five benefits listed by faculties were: improving communication, improving teaching, increasing student access to information, enhancing learning and reaching more students. Time and workload issues, technology availability and reliability, student factors, technical support, and technology expertise were top five top barriers.

Some researchers worked on the design of blended learning, dimensions of blended learning, and ingredients of blended learning (Singh, 2003; Huang & Zhou, 2005; Chan & Law, 2007). Various models/designs of blended learning emerged as a result of the researches. Singh (2003) provided a comprehensive view of blended learning and discussed possible dimensions and ingredients of blended learning. The dimensions are of blending ‘offline and online learning’, blending ‘self paced, live and collaborative learning’, blending ‘structured and unstructured learning’, blending ‘custom content with off-the-shelf content’ and finally, blending ‘learning, practice and performance support’. The researcher provided a model to create the appropriate blend by ensuring that each ingredient, individually and collectively, adds to a meaningful learning experience. Five key ingredients of blended learning as proposed by Carman (2005) are: Live events, Self-paced learning, Collaboration, Assessment and Performance Support. Huang and Zhou (2005) presented that design procedure for blended learning consists of pre analysis, activity and resource design and instructional assessment. Sreekala (2009) proposed a paradigm shift adopting blended learning approach and discussed ways and strategies of blending online learning with face-to-face instruction in higher education institutions. Valiathan (2002) argued for three models of blended learning: Skill driven learning, Attitude driven learning and Competency driven learning and discussed the blended learning techniques which can be adopted to enhance them. On similar line, Padmanabhan (2008) discussed two
approaches to blended learning—intending to train employees, namely the core and
speak approach and program flow approach. He presented various case studies of
learning programs conducted successfully using blended learning approaches and
discussed various learning channels employed to effectively provide learning
solutions to the employees. Chan and Law (2007) proposed a structured blended
learning implementation for an open learning environment and opined that by
introducing structured blended learning with the concept of learning cycle, the
problem of being lost in hypermedia environment can then be solved.

2.3 STUDIES RELATED TO CRITICAL THINKING

Review of related literature revealed that researches in the area of critical
thinking vary from analyzing critical thinking among learners, teachers and principals
to the implementation of various strategies in developing critical thinking. In addition
to this, the review revealed a few studies on correlation of critical thinking with
various variables such as students’ characteristics like motivation, self efficacy and
academic performance. A very few studies tried to find the role of critical thinking in
problem solving such as Barile (2003) who conducted research on the role critical
thinking dispositions play in problem solving and decision making of urban
elementary school principals and the findings connect the influence of critical
thinking dispositions to principal’s problem solving and decision making activities.
These findings endorse the existence of a relationship between a principal’s
disposition to think about a task and his or her skill to perform such a task.

Some comparative studies were also conducted to find the differences in
critical thinking of students with respect to their subject of study or between students
critical thinking dispositions between master’s level counseling students and business
students. Analysis of the results revealed that students belonging to both the groups
showed a positive disposition towards critical thinking except in the sub scale ‘truth
seeking’. But the result did not support the hypothesized direction that master’s level
counseling students would score higher than master’s level business students. In a
comparative study, Roether (2003) analyzed the level of critical thinking skills of
Korean English as a Second Language (ESL) students compared to US college
students and found that Korean ESL students scored lower than U.S. college students
on the California Critical Thinking Skills test.
A number of researchers have recommended using specific instructional strategies to encourage the development of critical thinking skills. Several researchers attempted to enhance critical thinking by adopting different methods or strategies of teaching or learning such as collaboration or co-operative learning, constructivist techniques and strategies which make use of technology. A method recommended by several critical thinking researchers is a collaborative or cooperative approach to instruction (Abrami et al., 2008; Heyman & Legare, 2008; Bonk & Smith, 1998; Sullivan, 2004; & Smitha, 2009).

Abrami et al. (2008) found a small but positive and significant effect of collaborative learning approaches on critical thinking. Heyman and Legare (2008) indicate that social experiences can shape children’s reasoning about the credibility of claims. Bonk and Smith (1998) identified a number of classroom activities that build on the potential for collaboration to enhance learning. These activities include think-pair-share, round-robin discussions, student interviews, roundtables, gallery walks, and jigsawing.

An effort by Sullivan (2004) who analyzed dialogue and group interaction during collaborative examinations also tried to find the benefits of group work in the development of critical thinking. He found that critical thinking skills were exhibited during group dialogue and collaborative examinations offered opportunity for students to realize the benefits of group work while receiving immediate feedback on performance and participating in their own formative assessment.

Similar studies were conducted in the development of critical thinking with the aid of technologies by providing collaborative environment. Yang (2002) investigated on the effects of using structured Web Based Bulletin (WBB) board discussion with Socratic questioning to enhance students’ critical thinking in University level correspondence style distance learning courses and found that the facilitation of structured WBBs significantly improved students’ critical thinking skills. It also indicated that the teaching and modeling of Socratic questioning helped students demonstrate critical thinking skills at a higher level in the process of making judgments and decisions and after exposure to and modeling of Socratic questioning, students maintained their critical thinking skills without the instructor’s further facilitation. These findings suggest that using structured WBB discussions with Socratic questioning could be an effective pedagogy to enhance students’ critical thinking skills. Myers and Dyer (2003) attempted to determine the influence of
student learning styles on critical thinking skills. The target population for this ex post facto study was 135 students enrolled in a college of agriculture and life sciences leadership development course. Results showed that no critical thinking skill differences existed between male and female students in this study. Students with deeply embedded Abstract Sequential learning style preferences exhibited significantly higher critical thinking skill scores. No differences in critical thinking ability existed between students of other learning styles. However, there are some studies which contradict to the above findings (Massey, 2003; & Lee, 2004). A study conducted by Massey (2003) on the effects of cooperative learning versus traditional classroom instruction on cognitive achievement and critical thinking revealed no statistically significant difference in cognitive achievement and critical thinking scores between the cooperative learning section and the lecture section. To corroborate the above studies, Lee (2004) examined effects of individual v/s online collaborative case study learning on the development of critical thinking skills in undergraduate students. Facione and Facione’s holistic critical thinking lubric was used to measure the change in participants’ critical thinking over the completion of the case study learning analysis. A non-equivalent pretest posttest control group design was used to obtain statistical quantitative results from a sample of 80 undergraduate students, and a process satisfaction questionnaire was used to survey students’ satisfaction with various aspects of the case study learning analysis. The study showed that there are no significant mean differences in critical thinking between the online collaborative discussion group and the traditional individual assignment group.

Hall (2005) conducted a research to investigate the extent of higher-level critical thinking exhibited by two groups of graduate students enrolled in an online course. The researcher used a process of qualitative content analysis to study the posted discourse of the participants to determine their exhibited level of higher-order critical thinking in the domain of cognitive presence. Study findings indicated that students tend to operate at the lower levels of critical thinking and only progress through higher levels when challenged to do so by the instructor. In this study, participants were impacted by the planned intervention to the point that the frequency of their higher order thinking comments improved.

The dissertation done by Buffington (2004) presented a critical content meta-analysis of published literature related to using internet to develop critical thinking
skills in students and to build online communities of teachers. The literature largely endorses the view that thinking critically about the internet involved accepting information because it is represented in multiple sites on the internet and rejecting information that is not congruent with dominant cultural beliefs. The use of the websites enables students to access multiple perspectives relating to the objects, thus allowing them to learn about divergent interpretations and understandings through online interactions. Teachers may be able to overcome the often-cited feelings of separation from peers and find ways to improve their teaching practice. To build an online community, it is not enough to pronounce a group of students in a class as a community but the members must perceive a common interest and benefit from their interaction. The researcher argued that insufficient research has been conducted on using the internet to develop critical thinking in K-12 classrooms with students.

In addition to explicit instruction and collaboration, several other strategies have been identified as helpful in promoting critical thinking. For example, critical thinking can be enhanced by using constructivist learning methods, characterized as more student-centered than teacher-centered (Bonk & Smith, 1998; Smitha, 2009). Bonk and Smith (1998) suggested specific classroom learning activities which are believed to promote critical thinking include the creation of graphic organizers, such as concept maps and argument diagrams. Added to the above study, Friedel et al. (2008) compared the effectiveness of overtly teaching critical thinking and inquiry-based learning in an undergraduate biotechnology course. They found that overtly teaching for critical thinking improves students’ critical thinking skills as compared to using the inquiry-based teaching method whereas Smitha (2009) found that inquiry training model and guided discovery learning are more effective in enhancing critical thinking among secondary school students when compared to conventional method of teaching.

Several studies were conducted to promote critical thinking among learners by using various strategies of teaching/learning, even though technological aids were not used for this purpose. Boghossian (2004), through an exploratory study examined the hypothesis that Socratic pedagogy is a useful tool for imparting critical thinking and moral reasoning skills to inmates. Results of this study suggested that ‘Introducing Socrates’ has the potential to help inmates by providing them with better options, by changing ways they approach problems and by ultimately giving them tools that will enable them to make better decisions. i.e. this ancient educational and pedagogic
approach when combined with existing corrections in educational objectives may prove to be a uniquely powerful tool to help inmates generate better solutions to problems and make better choices. A study by Ernst (2004) examined the relationship between environment-based education and high school students’ critical thinking skills and disposition towards critical thinking and the result of the study supported the use of environment-based education in achieving broad goals of education reform, specifically for improving critical thinking skills and their dispositions toward critical thinking.

Several correlation studies were conducted to find the relationships between critical thinking and various other variables. Burris and Garton (2006) examined the relationship between student characteristics and critical thinking ability of agriculture students. Additionally, this study sought to determine the unique variance in critical thinking explained by achievement levels. The study found that male and female are similar in their ability to think critically whereas upper classmen outperformed lower classmen on critical thinking. It is also found that students having higher academic achievement levels exhibit higher critical thinking skills than those who are having lower achievement levels. Added to the above study, Torres and Cano (1995) found that a moderate bivariate relationship exists between learning style and critical thinking of students. Friedel, Irani, Rhoades, Fuhrman and Gallo (2008) studied the relationship between critical thinking and problem solving and found that though correlation between critical thinking and problem solving were significant, they were low and indicating critical thinking and problem solving may be more independent. Added to the above studies, Harish (2011) found that package of integrated critical thinking skills has helped students of ninth grade to enhance their achievement in mathematics.

Roberts (2003) determined the influence of learning style, self-efficacy, motivation and critical thinking dispositions on student achievement and attitudes when an illustrated web lecture is used as the learning activity in an online learning environment. A causal comparative research designed was used and a purposive sample of students enrolled in the online section of an introductory food science course at University of Florida was selected as the sample. Multivariate analyses were conducted to determine the influence of each independent variable on achievement and attitudes. Motivation was the only independent variable that influenced the attitudes and achievement. Participants in the study were mainly concrete in their
learning styles, had high critical thinking dispositions, had high self-efficacy and were highly motivated. Perry (2004) explored critical thinking in web-based courses offered at Maryland Community College. The content analysis of selected web pages revealed that six of the seven dimensions of critical thinking (interpretation, analysis, evaluation, inference, presentation of argument and reflection) were included and assessed in the web pages but the seventh (dispositions to use these skills) was not. Most of the assignments on the web pages were individual activities, curriculum designed was found to be very traditional and the information in the WWW was not being utilized to its fullest. Moreover, McCarthy (2004) examined the relationship between critical thinking dispositions and academic performances and found that a relationship exists among critical thinking dispositions and academic performance whereas Seidman (2004) studied the relationship between instructor’s beliefs and teaching practices for critical thinking in higher education and beliefs about critical thinking and related topics appeared to be compatible with their actual teaching practices. Across disciplines, findings suggested that there were both similarities and differences in beliefs and practices. Specifically, instructors conceptualized critical thinking in different ways and focused on various critical thinking skills required for their respective disciplines. In practice, courses included active learning strategies and ongoing writing assignments. The instructor teaching critical thinking explicitly held the narrowest perspective on critical thinking and represented the largest departure in teaching methods. Valdes (2005) conducted a study on the effect of the Watson Glaser Critical Thinking Appraisal test preparation on the critical thinking of teacher education program application and found that although the WGCTA pass rate was slightly higher for applicants who participated in the test preparation programme, critical thinking of the first group was not statistically significantly higher compared to the second group.

2.4 STUDIES RELATED TO PROBLEM SOLVING

Review of literature in the area of problem solving extends from analysis of problem solving patterns of learners to finding the effect of various methods to enhance problem solving among learners. A research conducted by Hou and Sung (2008) attempted to explore the process of asynchronous problem solving-based discussion activities and observed learners’ online problem solving discussions without intervention or guidance from the teachers. From the sequential pattern
derived, the researchers had not only induced a pattern of students’ discussion behavior but also discovered that, compared to discussion activity based on a single topic appointed by the teacher, the problem solving online discussion activity is more helpful for students’ knowledge construction.

There were efforts to find the effects of different teaching learning strategies on problem solving of students. Case (2004) studied the effect of collaborative grouping on student problem solving in first year Chemistry and supported the use of IMMEX software system as a problem delivery system and analysis tool and found that it is possible to improve the problem solving strategies that students employ through the use of online collaborative learning activities. Although Bucalos (2003) found that video based anchored instruction resulted in acquisition of content knowledge, it did not show an overall significant difference between anchored instruction and traditional instruction in problem solving as measured by debates and essays. Visser (2003) compared the effect of lecture based instruction to that of problem based instruction on learner performance, problem solving processes and attitude in a genetics course. In terms of problem solving performance, results revealed that the lecture based group performed significantly better on near-transfer posttest problems whereas the problem–based group performed better on far-transfer posttest problems. In addition, the results indicated the learners in the lecture based instructional treatment were significantly more likely to employ data driven reasoning in solving problems whereas the other group employs hypothesis driven reasoning in problems. Further, a significant positive correlation between prior academic achievement and problem solving performance scores was detected in both treatment groups. A significant positive correlation was found between self-regulatory skill scores and problem solving performance scores in the problem based group, but not in the lecture based groups.

Lugo (2004) explored how multimedia computer technology could be used for potential supplemental teaching and found the effect of this strategy on problem solving skills of ninth through twelfth grade students with learning disabilities. Swaruparani (2006) found that Polya’s heuristic method is successful in inculcating the problem solving skills of students. Added to the above studies, Praveen (2007) found that mastery learning strategy is effective in developing problem solving ability in Physics of secondary school students.
Lin (2003) examined the relationship between student perception of constructivist learning environment, self-directed learning readiness, problem solving skills, and teamwork skills. The results showed that a high correlation existed between students who observed a higher level of constructivist practices with higher scores on problem solving skills compared to their peers. Korsunsky (2003) explored the cognitive components of solving non-trivial physics problems and the result of the study supported the idea of rigid knowledge and bisociation being two distinct sets of skills essential to problem solving; the notion of bisociation as the main factor limiting one's problem solving success is also supported.

Maurice (2005) assessed the effect of reasoning and hemisphericity on problem solving ability of learners. Reasoning and gender are found to be the most significant predictor of problem solving ability in science. It is also found that significant relationships exist between problem solving ability and reasoning ability in science. No significant difference in problem solving ability is found between students with right and left brain hemisphericity. Behera (2009) found no difference between boys and girls in problem solving skills in mathematics learning.

Song (2004) examined goal oriented contexts and peer group composition on intrinsic motivation and problem solving. Two different versions of web based PBL treatments were developed in this study, providing either a learning oriented context or a performance oriented context. A significant positive correlation was found between the learning goal orientation and solution development for the students who participated in the learning oriented context in heterogeneous peer groups, while no significant correlation was found for students who participated in the performance oriented contexts in homogeneous peer groups. Durcikova (2004) studied the role of organizational climate in the use of Knowledge Management Systems (KMS) to support problem solving. The result revealed that the use of KMS positively affects both knowledge reuse and innovativeness. The result also showed that support for online action is more useful in environments with high time pressure than in environments with lower time pressure suggesting that building systems with good search features is especially important when users of KMS work under time pressure.

Kuo (2004) conducted a study on an explanatory model of Physics faculty conception about the problem solving process which consisted of two qualitatively different conceptions of the problem solving process. The result indicated that these two different conceptions differed in the underlying nature of what problem solving
entails, and also differed in their descriptions of the thinking processes that underlie successful problem solving. Jonassen (2002) argued that in order to support problem solving, problem and domain specific problem architectures must be implemented in online delivery packages.

2.5 STUDIES RELATED TO LEARNING SCIENCE

This section deals with researches conducted on learning science with emphasis on science achievement and science process skills.

Herring (2003) compared the effects of kinesthetic based and textbook based instruction on student achievement in science and found no significant difference between experimental group and control group. Interview with students and teachers revealed that kinesthetic teaching of science is more fun for students than the traditional way of teaching science whereas Plough (2004) analyzed students using visual thinking to learn science in a web based environment and found that making visual sensations helped students understand science knowledge and making web pages helped students construct science knowledge structures. Martini (1986) analyzed the effects of both matching and mismatching auditory, visual, and tactile instructional methods on the science achievement and attitudes of seventh graders who had been classified according to their perceptual preferences. Auditory students achieved significantly higher scores with the cassette tapes than visual or tactile students did. Visual students achieved significantly higher scores with the printed materials than either the auditory or tactile students. Tactual students achieved significantly higher scores with Computer Assisted instruction (CAI) than the auditory or visual students, but all youngsters achieved significantly higher with CAI than with either of the other two methods. It is also found that tactual students, who conventionally are the underachievers, evidenced higher test scores with CAI than either of the other two, normally higher achieving groups. But Chunshih and Gamon (2002) found that learning styles did not have effect on science achievement in the web based course whereas learning strategy is found to be a significant factor which influences the achievement of students.

Several studies were conducted to find science process skills of students as an outcome of various methods or strategies of teaching. For instance, Jager (2011) studied the factors influencing the implementation of the process approach in biology secondary education. The empirical research of the study found that various factors
hamper the effective implementation of the process approach. It is important that negative factors such as ‘large classes’, ‘lengthy syllabus’, ‘lack of equipment’ and ‘lack of resource material’ be duly considered when implementing this process approach. Ferreira (2004) studied role of a science story, activities and dialogue modeled philosophy in teaching basic science process skills of 5th graders. Some of the key findings were that the story, activities and dialogue facilitated the children’s learning in the performance of classification, observation and inference. The multi sensorial activities help children to develop skills of inference and dialogues help to self-correct and build upon each other’s ideas. Bayrak and Hale (2009) web based instruction with student centred collaborative learning environment enhances science process skills compared to traditional teaching. Added to the above studies, VonSecker (2002) found that an inquiry approach that included eliciting student engagement, using appropriate techniques, problem solving, conducting extended studies and scientific writing increased student achievement in science. The result is supported by the study conducted by Cuevas, Lee, Hart and Deaktor (2005) who found that inquiry based instruction enhanced the inquiry ability of students regardless of grade, achievement, gender, achievement, ethnicity, socio-economic status and home language. Proweller and Mitchener (2004) found that science content that failed to link with everyday experiences of students prevented them for becoming engaged in learning science.

Myers (2004) conducted a research on effects of investigative laboratory integration on student content knowledge and science process skill achievement across learning styles and reported that learning style, teaching method, content knowledge pretest scores and science process skill pretest scores accounted for 33% of the variance in content knowledge gain score. It was also reported that learning style, gender, teaching method, science process skill pretest scores and content knowledge pretest scores accounted for 36% of the variance in science process skill gain score. Added to the above study, Manoj and Devanathan (2011) found that problem based learning strategies significantly enhance science process skills. To corroborate the above studies, Aruna and Sumi (2011) found that process approach is effective in the development of science process skills. Sridevi (2008) found that constructivist approach enhances science process skills among students. Added to the above studies, Khan and Iqbal (2011) found that science process skills were improved as a result of inquiry lab teaching method.
Foulds and Rowe (1996) studied the enhancement of science process skills of primary teacher education students and the study establishes that significant skill development can be achieved as the effect of brief course in science education. Similarly Gautam (1991) found that inquiry training model was significantly superior to traditional method in enabling development of science process skills. A contrary result was obtained in a research conducted by Germann (1989) who developed directed inquiry approach to learning science process skills and scientific problem solving and found that the approach had no significant effect on the learning of science process skills or on cognitive development.

The review also revealed that in addition to studies which tried to find out the relative effectiveness of different models/approaches on science process skills, researchers of the past few decades also attempted to find the effect of computer based interventions on science process skills. For instance, Moodley (2004) studied the effects of computer-based dynamic visualization simulations on student learning in high school science and found that students’ understanding and performance were better in classes where teachers used computer-based dynamic visualizations to complement their traditional teaching. Analysis of classroom observations revealed a shift in classroom dynamics to more learner-centredness with greater engagement by students, especially in classes that tend to have little student participation without the simulations. Similar results were obtained by Aimée, Hairston, Thames, Lawrence, and Herron (2002) who conducted a research on using a computer simulation to teach science process skills to college Biology and elementary education majors and found that 40% of the Biology majors and 85% of the elementary education majors indicated that the simulation helped them to understand science process skills. Saat (2004) found that web based learning environment helps students to acquire science process skills.

Stephens (2004) conducted a research on the effects of web based inquiry on physical science teachers and students in an urban school district. The study showed that there were no significant differences in teacher’s perception of the learning environment before and after implementing web based inquiry activities. The findings also reported that there were no overall significant differences in students’ perceptions of the learning environments and achievements. The students confirmed that collaborating with others contributed to a deeper understanding of the science content. Similar studies were also conducted to explore the change in perception of teachers/
students on science process skills. Rambuda and Fraser (2004) studied the teachers’ perceptions of the application of science process skills in the teaching of geography in secondary schools in the Free State Province and found that the participants were able to distinguish cognitively between basic and integrated science process skills. In addition, the study reported that although the teachers did not apply science process skills to the teaching of geography on a regular basis, they were well acquainted with the fact that these skills remain an important facet in the teaching of geography in schools.

A few studies were conducted to assess the capacity of teachers to teach science process skills. For instance, Hamilton and Swortzel (2007) assessed teacher’s capacity for teaching science integrated process skills and found that AEST teachers exhibited a satisfactory level of ability to teach integrated process skills and they also had high self efficacy. There were also attempt to find out various modes of assessment of science process skills. For instance, Lanka (2007) constructed a framework for indentifying performance indicators of effective science process skills teaching in Botswana senior secondary physics whereas Marshall (1991) conducted a research on construct validity of multiple choice and performance based assessments of basic science process skills. The results indicated strong support for the convergent and discriminant validity for the test of basic science process skills for elementary and middle school students.

The research review revealed that there were studies to find out the relationship of science process skills, science achievement, problem solving and other allied variables. Chang and Weng (2000) explored interrelationships between problem solving activity and science process skills of tenth grade earth science students in Taiwan and found that a significant correlation existed between students’ problem solving ability and science process skills.

2.6 INSIGHTS FROM THE REVIEW

The review of studies related to online learning crystallized the understanding of issues associated with online learning and thus, justified the need for studies in the area of blended learning. The studies related to blended learning endorsed the relevance of blended learning as a pedagogical strategy and revealed some of the contradictory findings related to its effectiveness on various variables. Studies related to variables such as critical thinking, problem solving and learning science provided
innumerable cues for the present study. Researches related to the strategies employed for enhancement of these variables contributed significantly to the framing of present research problem and also helped in identifying the research methodology and analysis of data.

Studies on online learning vary with respect to the variables selected, methodology adopted and method of assessment. Mainly, researchers focused on different aspects of online learning and their effectiveness compared to the traditional method of instruction. The reviews revealed that several studies were conducted to find perceptions of learners as well as faculties on different aspects of online learning (Conrad, 2002; Dill, 2003; Shih, 2004; Krebs, 2004; & Spampinato, 2005). It was observed in many studies that there is an overall positive reaction towards online learning whereas some studies found that learners’ satisfaction levels were higher in traditional courses compared to online learning settings. Many studies revealed that students enjoyed online learning but had to be more self motivated due to its increased demands. Additionally, a few studies found that students believed they were more challenged through online learning though they liked the flexibility provided. However, some studies revealed that students believed they were less able to build relationships through online classes compared to traditional classes.

Attempts were made by researchers to find satisfaction levels of online learners as well as interaction among participants. Some researchers tried to find the factors which contribute to the effectiveness of online interaction; some researchers focused on the effectiveness of interaction on learning in an online learning context and some other studies attempted to study the factors which influence interaction among participants enrolled in online courses (Fite, 2003; Whisler, 2005; & Summers, 2005). Researchers even attempted to study the influence of learning style on variables like achievement among online students, out of which most of the researchers focused on Kolb’s learning styles. The studies presented contradictory results about the influence of learning style on achievement in online courses and some of the studies suggested no interaction effect between learning style and instruction mode.

Most of the studies were of case study type and phenomenological in nature. Very few researches were carried out in school settings whereas; most of the studies were focused on higher education. Very few studies were conducted on the designs of online learning and comparison of different formats of online learning. Though there
were countable domain specific studies, very few studies were done on the discipline of science with respect to different aspects of online learning. The research review revealed that there is a dearth of studies which explore effectiveness of online learning on science learning at school level even though there were attempts to introduce online learning in many of the schools.

Effectiveness of online learning was found out with respect to variables such as problem solving, self regulated learning, achievement and students’ participation. The results were contradictory; some of the studies showed certain positive effects of online learning whereas there were evidences of having neutral effects too. It could be noted that, even though most of the studies that compared online learning with traditional instruction reported positive effects, many of the studies endorsed the need for more participation from teachers, requirement of real life anchors and the need for combining online learning with face-to-face instruction. Some of the studies even suggested that a balanced blend of in-person and online activities may result in better learning outcome.

Even though the idea of integrating various learning resources for better learning persisted for decades, research on effect of blending online learning with face-to-face instruction is of recent origin. Review of literature related to blended learning reveals that even though some studies were undertaken on the effect of blended learning at secondary stage of schooling, majority of studies conducted swirl around higher education sector. Studies conducted were mainly on effect of blended learning on students’ pass rate, achievement and learning outcome. In addition to this, some studies attempted to find effect of blended learning on higher order thinking. Most of these studies revealed positive effects of blended learning on learning outcomes such as achievement and higher order thinking. However, some of the studies indicated neutral effect of blended learning. Supplementing to that, some researches found that learning outcomes do not significantly vary with respect to mode of instruction. Some researches revealed that learning outcomes in a blended learning environment excel that of other modes such as face-to-face instruction and online learning, even though the tools adopted or used to provide online learning varied in different studies. Different researches used different course management systems and online learning platforms for blending online learning with face-to-face instruction. Some of them developed online learning platform by themselves for catering to their needs whereas some others adopted available platforms and used it
along with face-face instruction. Some of the studies were undertaken to assess students’ achievement and attitude towards subjects in a blended learning course. But the review revealed that very few researches were undertaken intending to study learning outcomes in the discipline of science.

Researches were undertaken to find perceptions and reactions of students towards blended learning. Majority of studies indicated favorable reactions towards blended learning courses/programmes. However, studies to find difficulties faced by students while learning through blended learning strategy were not attempted. Attempts were made to study sense of community among participants of blended learning courses. Some researchers tried to explore differences in variables such as pass rate, satisfaction, critical thinking and sense of community among learners in a blended learning environment with respect to gender and learning style. Although few studies did attempt to find the differential effect of blended learning with respect to learning style, mixed results were obtained. In addition, in those studies, perceptual learning styles were not considered. Very few attempts were made to study experiences, perceptions and views of faculties on blended learning and most of the studies were focused on learners’ perceptions. The review of related literature endorses the fact that there is a dearth of studies on the effect of blended learning on science learning and higher order thinking in Indian context as research review could not find any such study.

Reviews on higher order thinking such as critical thinking and problem solving vary from analyzing the components of these variables to establishing some methodologies that intend to enhance these variables. Review of related literature revealed that there were many attempts to analyze critical thinking among learners, teachers and principals and to estimate the extent of critical thinking among them. In addition to this, the review revealed a few studies on correlation of critical thinking with various variables such as students’ motivation, self efficacy and academic performance. A number of researchers have recommended the use of specific instructional strategies to encourage the development of critical thinking skills. Several researchers attempted to enhance critical thinking by adopting different methods or strategies of teaching or learning such as collaborative learning or co-operative learning, constructivist techniques and strategies with or without the use of technology. Several correlation studies were conducted to find the relationships between critical thinking and various other variables. Out of these, very limited
numbers of researches were on the relationship between critical thinking and problem solving. The review found that empirical studies on problem solving are limited though there were attempts to analyze problem solving and to find the effect of various approaches/strategies on problem solving. The Indian studies which were reviewed, were mainly focused on problem solving ability in the discipline of Mathematics. A few studies were undertaken to find the effects of different teaching learning strategies on problem solving of students.

Researches in the area of science education focused on various methods, strategies, models, modes or approaches of teaching science. The studies were comparative in nature wherein traditional science teaching and other strategies of instruction were compared on the basis of differences in science achievement, science process skills or other related variables such as scientific attitude, attitude towards science etc. It included studies to find effect of different models of teaching, text book based instruction, computer based instruction, constructivist approach, co-operative learning and collaborative learning on learning science and attempts were also made to compare between or among these various approaches. The review revealed that there is a shift towards perception of science as a ‘process’. This has lead to emergence of various methods for enhancing science process skills. The research reviews revealed dearth of studies specifically attempting to enhance science process skills and science achievement by blending online learning with face-to-face instruction, especially in Indian context.

2.7 CONCLUSION

The present chapter dealt with the researches carried out in the area of online learning and blended learning. The studies related to critical thinking, problem solving and learning science were also presented and discussed in detail. In the next chapter, the methodological details of the study are presented.