This research work deals with two focused areas viz., 1) learner characteristics that rely more on pedagogy which in turn involve social aspects, 2) s/w agents which is more technical in nature. Hence both deductive and inductive research techniques are involved for the above. The literature survey presented in this chapter is thus broadly grouped under two categories (sections) namely issues that are related to e-learning aspects and issues that are concerned with s/w agents and their resources for e-learning. Accordingly, Section 2.1 sums up the issues concerned with s/w agents for e-learning and Section 2.2 presents the literature review on e-learning aspects. Section 2.3 presents the summary of the essential base papers that helped in identifying the research problems, which in turn derived the major research questions. Citations are mentioned in all chapters as and when they are needed. Material resources of the cited papers are listed in the ‘References’ section that is kept at the end of the thesis, in the Appendix-I.

2.1 On Issues Related to E-Learning Resources and S/W Agents

Mobile agent can be advantageous when used as an e-Learning resource [Quah et al 2002]. Mobile agents in reality move computation procedures or codes to data in contrast to data being moved to computation procedures. Therefore the requirement for handshaking between systems is eliminated. Besides, the intermediate processing apart from bandwidth computations are reduced. In addition to these advantages agents do not need a continuous connection between machines, as they can perform processes off-line. Even unreliable network connections need not be a hurdle, as there is no need to monitor the agent’s movements. Therefore the communication cost also is reduced. In e-learning, even the students’ learning time is also not wasted as agents themselves monitor learner progress without centralise system to execute such processes. Agents are certainly documented to be advantageous in e-learning environment. However, issues persist, both in e-learning systems as well as in agent’s processing.
One of the frequently complained facts about e-learning environment is the unexpected elimination of learning materials or objects. In addition to these, changing (without notice) important resources when anyone is using with those resources [Baeza Yates et al 2005], was also pointed out. This may be due to the fact that most of the e-contents are designed for computers to process and manipulate and not for humans to read. To deal with this problem, one suggestion could be the use of semantic web and classify the instructional resources according to their service requirements, so as to compose them in a virtual learning environment. But at the same time such resources are also needed to be made scalable. Most of the existing e-learning system architectures deal with plain client-server or peer-to-peer architecture and therefore suffer from scalability and inter changeability issues [Pankratius et al 2004]. A clear picture of the e-learning system is presented by these authors. The solution to distributed computation in such e-learning systems using s/w agents has thus been demonstrated. A user (learner) authentication service using a user-profile database has been suggested. An authoring service gives the authorised content authors an environment to create, modify and to publish e-learning content. Maintaining content registry is thus suggested. An important additional feature is the creation of ontology for semantic search for and retrieval of content. It is stated that ‘web services are used as wrappers around SCOs or granules of instructional contents’. In fact web services come along with SCOs that can extract and manipulate the SCOs. Besides, for maintaining consistent interface between extraction, modification and storing of SCOs, the services are recommended to be wrapped up with the contents. But for querying metadata in a distributed environment, agents would play an important role and provide several advantages for personalised searches. Various perspectives of learning processes (particularly in e-learning environments and in automated learning processes), when adopted in multiple s/w agents, would play a vital role in solving complex and user related problems [Leman et al 1995]; [Gouarderes et al1998]; [Okonkwo et al 2001].

Learner centered agents have been tried out for effective utilization of various resources by assembling them together as whole as possible, so as to make interaction of learners better [Gregg & Dawn G 2007].

Feedbacks on the
effectiveness of the course are collected online by the agents for continuously monitoring learning outcomes. In addition, personalization agents continuously monitor progress of learners, analyze and rate the usefulness of the materials. Contextualization is one of the important characteristics of e-Learning [Capuano et al 2008]. In fact any educational model that is adopted in e-learning systems must be complemented with semantics so that data or information can be virtualized. In addition, standards could be incorporated in e-learning system, so that s/w agents could be applied. But for such applications pedagogical and instructional viewpoints may be required.

For the purposes of selecting most relevant self-assessing quizzes for e-learners it has been reported that generic topic-based knowledge model could be used [Brusilovsky et al 2005] in adaptive e-learning environment. Distributed component based architecture is arguably suited to adaptive e-learning environment, which will allow the developers of e-contents and also allowing the users in parallel. A centralized approach, with three component architecture of i) Learning portal, ii) Activity servers and iii) Value-added services, has been proposed.

To locate appropriate e-learning resources for customization, intelligent agents have been suggested [Gregg& Dawn G 2007]. An E-Learning environment has been proposed to foster collaboration. Intelligent agents were used to personalize instructions based on cognitive requirements (learning needs) of individual learner. Learner’s social characteristics were used by the agents that monitored the e-learning environment for improving the learning process. The agents need to find out new objects more easily to increase efficiency. An important and useful suggestion provided was that learning objects could be clustered (assembled in different configurations) depending on the requirements of an individual learner of an educational situation. E-learning resource models on adaptive learning could incorporate ontology for learner characteristics and instructional roles, in addition to ontology for domain. Even ontology on instructional structure and goal can also be adopted [Hammami et al 2012]. It is a well known fact that any domain content, which is based on a model, would
represent only the domain specific subject content. For increasing the accuracy of finding learning characteristics, local social study was recommended [Zhao et al 2008]. The main objectives for performing such studies could be: Processes of learning; Finding societal relationships in education; and establishing the best one for the purpose for which the study is undertaken.

Mobile agent based search engines have found to be helpful to e-learners with searching tools between users and systems [Quah et al 2002]. The tools could be used to select preferred e-courses and agents can track the user’s progress status. Agents could be used to record frequently used objects along with frequently consulted objects that are either used prior or after the frequently used objects [Woolf et al 2005]. This process could be used for proposing an appropriate course structure. Such course structure might be used to dynamically generate instructional resources apart from instructional schedules for the purpose of customization. Agents could also generate progress reports on learning against predefined objectives while they could also document learning efficiency and efforts [Huang et al 2006]. Separate agent platform is recommended for e-learning environment so that one agent could better cooperate with other agents, as s/w agents function in a particular environment [Sandel&Korczak2003]. Intelligent s/w agents can cooperate, mobile and have the ability to interact with other agents exhibiting social and adaptative behaviour. An innovative dedicated intelligent agent platform for legacy e-learning environment was designed that was scalable for virtual assessment (agents) which has been documented [Christos et al 2008]. The assessment method included computational intelligent techniques such as Genetic Algorithm, Naive Baye’s probability etc. The overall system performance was enhanced in terms of interoperability, flexibility and efficiency. Another intelligent agent based e-learning system that is based on multi-agent based architecture has been developed that uses artificial intelligence [Silveira et al 2002]. This system supports interactivity and adaptability. It was pointed out that mere adaptation of technology resources already available will not be sufficient in e-learning environment; rather the technological platform should be transformed into a pedagogical platform. Collaboration agents that encourage collaboration between agents and e-learning participants have been suggested for improving the
efficiency [Besser et al 1996]. In addition, the collaboration can also be improved as per the authors.

Construction of wrappers (or tagging of information) around e-content objects have been recommended [Pankratius et al 2003]. These wrappers’ information could be of those that are required for services of web for interoperability and reusability. Such information could encapsulate the content inside the objects.

2.2 On Issues Related to Adaptive E-Learning

Education theories may be used for designing metadata [Yahya et al 2009]. Though they may not be useful much for technical issues, learning theories along with basic parameters may be used for describing and designing instructional objects. The ranges catering to the ways with which the learners receive and process information (instructional materials) will vary from learner to learner [Felder et al 1988]. That depends upon the style of learning pertaining to the style of presenting the instructional materials. Out of several aspects the authors have elaborated, which aspects of learning style would be significant? What learning styles would be preferred by the students of higher learning? How much the students of present day of information era would differ from traditionally followed instructional style? The differences between active and passive styles are clearly demonstrated. It was concluded that the active learning styles could be incompatible with the passive teaching by the professors. Many of the active (engineering) students preferred visual and were found to be inductive and active and some of the most creative students were found to be global. Most of the teachers adopted passive styles which were auditory, abstract and sequential.

In any design of web based learning environment, integration of user interface under any instructional approach is needed to be considered, so that the overall quality may be improved. This is needed apart from an evaluation framework [Nam et al 2007]. But the instructional approach should not be a traditional one, but several aspects of learning styles should be considered in detail. Large gaps between design model and implementation model of web based
education are seen and that is one of the reasons why some web based courses are not acceptable [Hadjerrouit & Said 2005]. The design model should be strong on pedagogy. The design should be based on continuous cycles of design – experimentation – evaluation in addition to research.

Web based learning issues could be better understood through exploring the potentialities of constructivism. In fact pedagogical patterns may be used and reused for analysis and refine the design and modify the model to be more effective.

The characteristics of the users (e-learners) that a collaborative agent could understand, were in the form of texts, graphs, icons, animation, multimedia and virtual reality that were documented in files as databases. Advances in technology have facilitated the development of such educational agents: A significant advance in developing active pedagogical agents [Johnson et al 2000]. Agents could be analogous to instructor’s assistants that provided the instructor with the learning portfolio or profiles of the students, which included learning performances, understandings and misunderstandings, levels of efforts, and motivations of the students. But the term ‘instructor’ and ‘students’ referred to in this paper, operationally meant the adaptive e-learning system and the e-learner profiles and the portfolios were delimited to active/reflective and group/solo learning. These portfolios, if documented as learner profiles, would then help the e-learning system to understand the learners’ behaviour better and respond appropriately back to them. The e-learning user, were actually hid by the agents. One of the drawbacks of such agent based systems is that the work is rarely sharable and reusable [Hayashi et al 2009], because they have to deal with many learner characteristic factors, which are subjective and not logically definable. Core thinking skills of learners may vary depending upon certain strategies of learning [Marzano R et al 1988]. These strategies of learning are: meta-cognitive strategies, processes of cognition, domain knowledge, and special modes of investigating the domain knowledge. These strategies of learning cannot be separated from the domain knowledge. These strategies of knowledge can be represented through instructional models.
One of the major objectives in designing learning objects for adaptive e-learning environment should be ‘reusability’ of objects. Reusability could be achieved through designing the objects for scaling and editing [Brusilovsky& Peter 2003]. The main issue in dealing with reusability would be the design of metadata [Noor et al 2011]. The usefulness of automating metadata generation based on contextual analysis has been indicated [Bauer et al 2010]. It is observed that current technology could manage effectively the delivery of e-contents through the web, but cannot support reusability of learning objects [Harris J2005], because, the current learning objects are not grouped according to domain specific areas and non-adaptive and hence could not support object reuse.

One of the major issues in web of e-learning is the vastness of available e-contents and the problem in accessing desired learning objects that hindered interoperability [Lehman& Rosemary 2007]. This problem could be dealt with by providing a learning object repository which could be generated by allowing appropriate learning object accessibility for user needs. Such characteristics of the learning objects could be documented in a metadata. However the design of the learning objects should include the data on granularity, interoperability and accessibility of such objects. Yet another important documented literature is on self describing learning object designed purposely for linking objects for specific learning context [Lagoze et al 2006]. In addition, a complex digital object management s/w could be developed which would allow storage and dissemination of such objects along with their relationships for constructing the modules. [Hao Ma et al 2009] have provided the required steps involved in designing outcome based educational approach. They are: Subject content, which may deal with the simplest concept prior to going for more complex concepts; Context levels, which may introduce a real world task which is applicable by the subject; Competencies or abilities which are actually social skills that could be integrated with the subject content. Critical thinking abilities are possible to be integrated with applicable or replicable techniques that uses cognitive learning strategies for web based e-learning [Jonassen & David 1999]. For every input of condition of learning, there seems to be a learning process which leads to a learning outcome [Gagne R. M 1985]. Learners have mental conditions for learning. Different types of subject
knowledge are linked to different skill sets according to different learning conditions [Merrill 2002]. This condition of learning theory was further extended into theory that will lead to forming models of learning such as the ‘Component Display Theory’ [Merrill et al 1994].

The design of e-courses through chaining or sequencing of objects could be dealt with by defining relationships between the learning objects and the context of the course [de Marcos et al 2008]. By proposing particle swarm optimization technique and genetic algorithm, a revolutionary approach for curriculum sequencing automation with reusable learning objects has been demonstrated. With this, sequencing for individualized learning for specific learner characteristics has been demonstrated. Different course settings, such as user preferences, content details and the delivery depending on learner backgrounds etc., must be included for different learner characteristics, according to the authors. Learner behaviour could also be documented and referred for preferred options through profiling that could include navigational logs of users over a period of time [Chiu et al 2008]. Such an attempt has improved the learning processes. The documented dynamic learner profiles considered both the personalized behaviour of the users as well as the changes that happened during the learning process. The need for knowing users’ learning capabilities and their learning performances, and also knowledge level, has been stressed. It is thus evidenced from the author surveys that subjective learner characteristics [Watson et al 2010] are extremely important for effective learning, particularly in adaptive e-learning environments. Models of instructions need to be thoroughly studied in depth along with the context for comparing such instructional models [Lee & Jaekyung 1999]. In addition, researchers must have to develop their own terminologies and interpretation of these data, in addition to using different research tools. Comparative studies therefore need to include local and social issues.

Learning Management System that takes care of learner characteristics while satisfying SCORM standards has been reported [Kazanidis et al 2009]. The system recorded the learner’s learning progress and statistically analysed to improve the effectiveness of the course. Clustering of learning contents according
to learning complexity levels has been suggested [Premalatha et al 2011]. However, the difficulty in adapting individual learner’s learning preference and characteristics has been pointed out. To tackle this issue, the learner’s profiles could be modified every time depending upon the usage of the objects by the individual learner through navigation logs, time spent on objects etc. Genetic algorithm that used factors derived from multi-objective functions for personalized e-course has been presented [Chang et al 2010]. A personalized recommendation mechanism for learners in the cloud environment has been proposed. Similar work has been extended with optimal learning path along with personalized curriculum sequencing [Huang et al 2007]. Apart from optimum learning path, the course difficulty level, along with the continuity of consecutive courses have also been considered.

Behaviour of learners, like preference for over viewing of concepts instead of going through the detailed conceptual material; preference for mere facts or going through step by step procedures [Essaid El Bachari et al 2011] have been studied. In addition, preference for sequential reading or holistic manner using flow diagram has also been noted. Some learners preferred for textual contents while others preferred visual effects. Hence all these aspects must be considered in forming the learning objects. Many researchers have agreed on the importance of learning style or characteristics of learners ([Keefe & James 1987]; [Honey P & Mumford 1992]; [Tseng et al 2008], that are needed to be considered for effective instructions.

2.3 Summary of Survey and Problem Formulation

Through the support of a few essentially important but related papers (relevant papers) certain gaps in the issues raised by these papers have been brought out and the research problems have been formulated. These problems are tabulated in Table 2.1.
<table>
<thead>
<tr>
<th>Citation</th>
<th>Reference</th>
<th>Findings / Issues</th>
<th>Identification of Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Brusilovsky et. al. 2005, Outtagarts &amp; Abdelkader, 2009</td>
<td>Distributed adaptive e-learning system is generally based on centralized and decentralized approaches, while the decentralized approach has its root in agent based applications in distributed environment and the centralized approach provides a more reliable and practical solution.</td>
<td>To try out a centralized approach for generating agents and maintaining databases, while the user interface and services could be provided by a decentralized approach.</td>
</tr>
<tr>
<td>Several</td>
<td>Jon, T.S, Quah et. al. 2002, Outtagarts, A and Kadoch, M, 1999</td>
<td>Mobile agent paradigm when compared with client-server paradigm has outperformed in process oriented computational durations when plotted against number of nodes.</td>
<td>To validate efficiency through some technique, that complements with reliability.</td>
</tr>
<tr>
<td>Several</td>
<td>Premalatha, K.R and Geetha, T.V. 2011, Harris, J, 2005</td>
<td>Clustering of learning contents according to learning complexity levels has been suggested. But adapting to individual learner’s learning preference and characteristic is difficult.</td>
<td>To try out learner characteristics which could be processed through mobile agents for enhancing efficiency.</td>
</tr>
<tr>
<td>1</td>
<td>Lagoze, C, et. al. 2006</td>
<td>Self describing learning object designed purposely for linking objects for specific learning context has been suggested.</td>
<td>To tag/analyze learning objects and to determine learner options.</td>
</tr>
<tr>
<td>1</td>
<td>Gregg, D.G, 2007</td>
<td>Learner cantered agents have been tried out for effective utilization of various resources by assembling them together as whole as possible, so as to make interaction of learners better. Feedbacks on the effectiveness of the course are collected online by the agents for continuously monitoring learning outcomes. In addition, personalization agents continuously monitored progress of learners, analyzed and rated the usefulness of the materials.</td>
<td>To adopt social survey for validation. To monitor learner preferences and analyze their characteristics.</td>
</tr>
</tbody>
</table>

Additional references are cited in other chapters as and when needed.