CHAPTER 1

INTRODUCTION

1.1 OBJECTIVES OF E-LEARNING

Learning environment focuses on increasing the individual performance thereby increasing the organizational progress. E-learning is a terminology that represents an inventive shift in the field of learning providing rapid and meaningful access to information and knowledge. E-learning refers to the use of information technology techniques like internet to provide enormous knowledge (Tang and McCalla 2003). Based on this, e-learning is far ahead of the concepts of traditional learning because of the ability to provide both online and offline instructional materials anytime, anywhere and to anybody through many electronic learning methodologies like online discussion forums, online chat windows, virtual classrooms, web-based learning objects, and audio-video conferencing systems (Honglei Zhuang et al 2012).

Currently, the rapid advance in science and technology helps to revolutionize learning methodologies (Gagne et al 1992). Therefore, educational organizations are able to bridge organizational gaps. E-learning is not only beneficial to educational organizations, but is also used in situations where software organizations and other industries need to educate and train their vendors, employees, partners, and even clients to significantly improve their business intelligence or competitive intelligence. According to Cynthia Mulrow et al (1997), e-learning drastically reduces the learning time
compared to the traditional classroom setting. The major goals of e-learning are reduction in the necessity for classroom training, constant progress monitoring of the target audience, track training effectiveness, bridge between training and knowledge management, time-management, cost-effective, improved task performance, high supported business objectives, flexible and convenient learning environment.

The key advantages of e-learning are the ability to accommodate varying learning styles, provision of individualized learning objects, a complete learning management system to accommodate learning, evaluation and recommendation of learning objects, facilitating collaborative learning, stimulating self-efficacy, increased persistence and pair learning methodology.

1.2 FACILITATING FACTORS OF E-LEARNING

E-learning is performed by the application of information and communication technologies in order to enhance the performance of the learners. Hence, it is necessary to propose proper web usability and communication techniques (Bari and Lavoei 2007, Zheng et al 2000). The shortcoming of a compact and accessible electrical and telecommunication sector infrastructure is a big curse to both the economic and educational growth of a country (Wallsten Scott and Kosec Katrina 2005). According to them, any online learning activity must be able to achieve some of the vital objectives like efficient motivation to the learners, encouragement of critical thinking, constructivist learning methodology, and constant monitoring of the e-learners since this type of learning does not support face-face interactions as in a traditional classroom setting. The challenges in e-learning technique are classified based on the past literature under four broad channels namely organization of learning contents, characteristics of the learning individual, technological constraints, and contextual confronts (Andersson Annika et al 2009 and Ba-Omar et al 2007). Eastmond (2000) had described in
his work that a compatible learning style is an important criteria to be thought before developing a learning management system. Moreover, there is a strong relationship between learners’ personality traits and their success during e-learning instructional materials (Irani et al 2003 and Soles and Moller 2001). The nature of a highly complex and interactive e-learning environment is also one of the factors that are discussed by the educational developers. One of the possible ways to organize knowledge and speedy interaction can be exploited using the potential of software agents (Dawn Gregg and Steven Walczak 2007). Since, software agents can be used to extract and retrieve data or information in many possible intelligent ways, developing an intelligent learning management system is a facilitating factor in e-learning methodology. The facilitating factors are teacher, course contents, provision of support for the technology and the society as a whole.

1.3 PURPOSE OF E-LEARNING

E-learning is defined technically as “Anytime and Anywhere Learning” thus reducing the performance factors with respect to time, effort and cost. Thinking generically, the purpose of E-Learning is five fold.

- **Flexibility** – Providing learning materials anywhere and anytime.

- **Personalized Learning** – Accommodating any type of learning styles.

- **Develops Knowledge** – Acquiring updated information throughout their lifetime.

- **Intelligent Tutoring System** – Providing intelligent teaching-learning methodology using software agents.
1.4 ROLE OF AGENTS IN E-LEARNING APPLICATIONS

E-learning environments have the capability of reaching learners even in a remote corner of the geographical area at reduced costs. The e-learning applications can be personalized through various personalization techniques like adaptive learning plans, learning objects, continual performance evaluation facilitated with the help of personalized intelligent software agents (Wang Minhong et al 2009). Moreover, the use of agent technology in these activities would considerably reduce the human intervention involved in managing e-learning processes. The primary aim in a human learning environment is to make the learners to advance. Systems that aid the human learners in such environments are called as Intelligent Tutoring Systems (ITS) (Sklar and Richards 2006). Such an ITS consists of the learning aided components namely domain knowledge, teaching component, user interface, student knowledge, system adaptability, and a central control component.

1.4.1 Pedagogical Agents in E-Learning

Innovative techniques in intelligent tutoring systems have made use of Artificial Intelligence (AI) techniques based on agents societies (Tai et al 2008). Wide varieties of interactive and adaptable systems have supported tutoring systems based on multi-agent architectures. The basics of the pedagogical multi-agent systems have proved to be very appropriate to design tutoring systems, since the teaching-learning problem could be handled using cooperative approach (Erin Shaw et al 1999 and Jennings Nicholas et al 2000). Erin Shaw et al (1999) in his research work indicated that pedagogical agents are animated characters that are designed to process in an educational setting.
to facilitate learning. Several advantages of pedagogical agents are proved in many application domains since they offer help and hints, demonstrate principles and procedures, and offer role-based tutoring environments (Li Jin et al 2007). The underlying principle of pedagogical tutoring system is that teaching and learning is an interplay relationship (Zhang Liang and Abbas Yongaçoglu 2000). An integrated and intelligent tutoring system must include the tutor, learners and a positive study environment, where this kind can stimulate the learner’s internal drive. Pedagogical agents offer help to the users when they need it, based on the model of the learner and the learning goals of the system (Bruce et al 2003). A different category of agents called animated pedagogical agents are also developed with the same notion of teaching-learning where the agents involved in the system are very similar to the human tutor in the traditional classroom setting (Lee et al 2012).

1.4.2 Peer Learning Agents in E-Learning

Peer learning agent type of e-learning involves agents and the human learners as peers. Peer-learning agents are mainly developed due to the reasons of providing believable situated environments and to provide a natural mode of interaction in such environments (Li Jin et al 2007). Moreover, an optimal learning environment in the state of real-world problem activities can be achieved only in safe environments where human learners and agents act like peers (Southey et al 2007). An ITS based on one-one tutoring has been used to tutor programming languages, since there are many drop outs in such courses (Stamper and Barnes 2009). Odekirk (2000), stated that one-one tutoring is very effective in helping students learn how to program. A variation of one-one tutoring system called as pair programming can help the learners to understand the programming concepts and organize their knowledge as a result of interaction and alternating roles (Delfina Malandrino et al 2002). As defined by Beck et al (2004), “Pair Programming” is a
software practice where two programmers work together at the same workplace with the same computer. Moreover, the teaching and learning activities that use pair programming strategy with human learners and agents acting as peers have had positive effects on learning achievements and motivation (Han et al 2007). The major intention of peer learning agents in pair programming helps to reduce the development time thereby supporting rapid development (Dekker et al 2009).

1.5 IMPACT OF LEARNING STYLES IN E-LEARNING

Learning Style is defined as a particular way in which an individual learns. A deep understanding and analysis of the e-learner’s learning styles can be used to implement better teaching–learning methodologies (Dunn and Dunn 1989 and Budny and Paul 2003). Moreover, James Allert (2003), has indicated that impact the different learning styles have shown a great impact on the effectiveness of e-learning. Moreover, the success of e-learning environments is greatly influenced by the factors like learning objects, content delivery, relevant information retrieval, performance evaluation and the maintenance of the psychological level through identification of the individual learning styles of the learners (Burr et al 2004). The psychological level of the learners in an e-learning environment is greatly attributed to the learning styles of the learners involved in learning. A deep understanding of one’s own way of learning can lead to a great personal empowerment and self confidence. This kind of deep understanding can be known by analyzing the behavior of the learners involved in an e-learning environment (Sanders and Bergasa-Suso 2010). Since, the learner is independent of a tutor in e-learning, the learning style is absolutely vague in nature.

Learning style has noticeable influences on the effectiveness and outcomes of technology-assisted learning. The use of personalized e-learning and Adaptive Educational Hypermedia (AEH) has become increasingly
important in recent years, with extensive research being devoted to finding different ways of tailoring the learning experience for individual students (Cesar Vialardi et al 2008). One such approach to user modeling is that of developing a model that is based on learning style preferences. Accordingly, learning styles are “characteristic, cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment” (Carver et al 1999). An understanding of learning styles can be used to identify and implement better teaching and learning strategies. Learning styles have also been shown to have an impact on effectiveness of online learning. Intelligent web-based systems, such as INSPIRE (Papanikolaou et al 2002), ARTHUR (Gilbert and Han 1999), AES-CS (Triantafillou et al 2002), Tangow (Paredes and Rodriguez 2002) and AHA (Bergasa-Suso et al 2005), have attempted to provide intelligent content adaptation based on learning style and previous knowledge, but these systems have to assess learner’s learning styles offline and through simple questionnaires. iLessons was a novel set of tools that overcame the limitations of other web-based educational authoring tools by giving teachers the ability to reuse materials readily available on the WWW (Sanders et al 2010). The Felder–Silverman dimensions of learning style model was a well-accepted model used in several adaptive hypermedia applications such as Tangow and the same has been selected for further study before fully coding the new systems because it provided four dimensions of learning style (Felder and Silverman 1988), that might be measured from data obtained from the computer systems namely timings, actions, locations, etc.

1.6 ONTOLOGY CONSTRUCTION AND ALIGNMENT

1.6.1 Ontology Construction

It is difficult to analyze large corpora of documents and process all the information contained in them. Standard text mining and information
retrieval techniques usually rely on word matching and do not take into account the structure of the documents within the corpus. Hence, automatic extraction of the topics covered within the documents from the corpus is performed which helps the user organize those concepts into topic ontology. Topic ontology is a set of topics connected with different types of relations. Each topic includes a set of related documents (Horrocks et al 2003). The size of the web has become so large that it has become very difficult to find out the necessary information from the web. Ontology is a knowledge representation technique that can be applied in many areas such as information retrieval, knowledge representation, knowledge management, etc.

Building a Natural Language Processing (NLP) system requires the analysis of linguistic phenomena resolution (Delmonte 2003 and Delmonte et al 2000). One of the most relevant tasks regarding these phenomena is the co-reference resolution (Morton 2000). Co-reference is defined as a semantic phenomenon and therefore apart from the morphological and syntactic information that is highly useful, adding semantic sources improves the capabilities of such a NLP system (Apple et al 2007).

Fok and Shing Ip (2004) proposed a system for the design and construction of educational ontology. This system helps in retrieving, organizing, and recommending educational resources for personalized learning. Personalized Instruction Planner (PIP) is a system that facilitates instructors to collaborate in using varied teaching instruction techniques to design lessons or thematic units. This system was developed by Gilles et al (1999). Hobb’s algorithm proposed by Katja Markert and Malvina Nissim (2005) uses a simple tree structure. The tree structure components contain the noun phrases and other words where the algorithm traverses the entire tree structure for replacing nouns in the appropriate places. Shalom and Herbert 1994 proposed a new algorithm called as RAP (Resolution of Anaphora Procedure) which aims to find the intersentential pronouns. Aone et al (1995)
proposed a trainable resolution algorithm. This algorithm uses feature vectors for the training samples that include lexical, semantic and syntax.

1.6.2 Ontology Alignment

Ontology alignment consists of finding correspondences between entities of two ontologies (Noy 2004). Ontology matching can be considered one of the key technologies for efficient knowledge exchange and the successful realization of the Semantic Web (Berners-Lee et al 2001). Bridging the gap between different terminological representations is an indispensable requirement for a large variety of tools and technologies for example, distributed reasoning, instance migration, and query rewriting in distributed environments. In the past, ontology matching was commonly considered the task of detecting similar or equivalent concepts and properties in two ontologies (Calvanese et al 2001). However, this view on ontology matching seems too narrow for many application scenarios, and new requirements have motivated several extensions to the original task definition. Researchers typically study ontology alignments in the context of a single source and target ontology (Zhang et al 2006). As more and more of such alignments are being created and published, longer chains of equivalent or otherwise related concepts start to emerge in our data sets.

This work considers composition through equivalence mappings to be a trivial case because the result is an equivalence relation, and is assumed that equivalence is transitive. Researchers have already developed a plethora of tools for generating mappings and compared their performance at the Ontology Alignment Evaluation Initiative (OAEI). An open issue in alignment agreement is related to the inconsistency in the agreed alignment. Indeed, some selected sets of correspondences may relate the ontology in an inconsistent way. Most matching systems do not consider logic-based semantics in their algorithms. As a result, almost all matching systems
produce incoherent alignments. Although argumentation aims at resolving conflicts on the alignments generated by these systems, this process does not guarantee that the agreed alignment is consistent even if the initial alignments were consistent.

Measuring the distance between heterogeneous ontologies is useful for many applications: 1) retrieving ontologies on the web, e.g. finding an ontology to replace another, finding ontologies that can enrich other ones, finding people using same ontologies to create new collaborations, etc. 2) ontology evolution, in order to know the extent an ontology, especially its structure, has evolved 3) ontology fusion and data integration, to know in advance if it may be possible to make joint studies on data described by heterogeneous ontologies. Ontology alignment, which is addressed by many works and which consists in computing alignments between ontologies, i.e. determining correspondences between semantically related entities from heterogeneous ontologies, is a key idea enabling interoperability in the semantic web. It has brought solutions to some problems like finding ontologies for query translation. Accordingly, an ontology alignment is defined as a set of correspondences between ontological entities, i.e. classes, properties, and individuals, of two ontologies. Furthermore, it can be observed that ontologies evolve gradually, i.e. changes typically occur by adding / removing / modifying single entities while the largest part of the ontology remains unchanged.

Ontology alignment can be carried out either manually or using automated tools (Ehrig and Staab 2004). Such alignment becomes very critical when, it is performed manually as the size and complexity of the ontology structure increases. Hence, automatic ontology alignment became a well-known technique in many practical applications including information transformation, data integration, query processing, e-commerce and
e-learning. Several categories of ontology alignment techniques exist in the literature which includes string-based, language-based, constraint-based and semantic-based methodologies (De Marnee and Manning 2010). Since, Ontology Alignment is useful for discovering similarities between two ontologies and to determine the relationships holding two sets of entities incorporated with the domain knowledge, it is necessary to provide effective techniques for semantic analysis in ontology alignment. Semantic techniques (Giunchiglia Fausto and Zaihrayeu Ilya 2009) attempt to map the elements (concepts) in the two ontologies according to their semantic interpretation. The main objective of the proposed technique is to discover the similarities that exist between dominant and non-dominant terms associated with one concept.

Doan et al (2003) developed a system which is the first ontology alignment framework proposed in the literature. It is a system based on taxonomical structure and uses instance-based methodology for ontology alignment. Moreover, this system exploits the concepts of statistical computation analysis and then uses the taxonomical structure of applications for decision making. The developed system is more suitable for applications like computer vision, natural language processing and hypertext classification which adopts relaxation labeling approach. Lily (Wang and Xu 2007) framework is a generic ontology alignment framework based on extraction of semantic sub-graphs. The system uses the concepts of both linguistic and structural information in semantic sub graphs to iterate initial alignments. Moreover, it combines all separate similarities iteratively using some weights assignments and hence it fails to consider ontology constraints directly. Later, Tang et al (2006), Tang and McCalla (2003) proposed the ontology alignment technique called RiMOM (Risk Minimization based Ontology Mapping) which is based on bayesian networks decision theory. This system uses many kinds of taxonomical relationships like superClassOf, siblingClassOf, domain,
etc are resolved using this system. All these systems are suitable only for situations where taxonomical classification is possible.

1.7 SEMANTIC ANALYSIS

A central theme of the semantic web is of casual users collecting, merging, and repurposing information from multiple sources. Automatic exchanging and reusing of data or information in the universal medium for information exchange (WWW) is very limited due to two main reasons namely the heterogeneity problem prevailing in the information resources and the non-semantic nature of HTML and URL. Information heterogeneity occurs in syntax, structure and semantics. Though enhanced techniques are developed to solve syntactic and structural heterogeneity problems (Giunchiglia et al 2009), the problem of semantic heterogeneity is still prevailing to be a great challenge. When two contexts do not share the same interpretation of information, semantic heterogeneity occurs. Several approaches were proposed in the past (Doan et al 2003) to solve semantic heterogeneity problems like synonym sets, concept lattices, features and constraints. However, all these existing approaches could solve this problem only partially.

Moreover, the semantic Web focuses on effective management of documents intelligently which are present in the web by considering the properties of the entities (terms) and the relationships involved among them. This conceptual organization is facilitated by building ontology pertaining to a particular domain (Gomez et al 2003). One of the major areas of research in retrieving the web information intelligently is the provision of learning course contents through online (e-learning). The prerequisite of the semantic-driven resource management and content delivery in e-learning web service has been facilitated in such systems by building ontology.
DLs are a family of logic formalisms whose basic syntax elements are concept names. The discovery of semantic relationships such as subsumption and disjointness is still a challenge in ontology matching (Giunchiglia et al 2012). Existing methods use logical reasoning over computed equivalence relationships or machine learning based on lexical and structural features of ontology elements (Gomez et al 2003). While these methods deliver good results for some cases, they are limited to the information contained in the input ontologies to be matched. Therefore, background knowledge in form of an additional ontology may be useful to detect semantic relationships. These semantic relationships can also be identified using machine learning techniques (Gao Shu et al 2007). The computation of subsumption relationships is considered as a binary classification task, i.e., a concept pair is classified into two possible classes: subsumption and non-subsumption relationship. Because ontologies are usually hierarchical structures, the subsumption relationships found in input ontologies can be used as training examples, making the process of classifier training independent of alignment computation.

ASMOV (Jean and Kabuka 2007) is an ontology alignment tool which calculates the similarity between concepts recursively by analyzing textual description. The tool effectively identifies the semantic inconsistencies like criss-cross mappings and many-to-one mappings. However, ontology alignment must focus on both matching for equality and also detection of inconsistencies. S-Match (Giunchiglia et al 2010) is an open source semantic matching framework that tackles the semantic interoperability problem by transforming several data structures including web service description into lightweight ontologies and establishes the semantic correspondences between them. The major limitation of the framework is that S-Match could identify only three kinds of XML relationships namely “is-a”, “part-of” and “attribute-
of”, whereas there are numerous relationships that are existing between the ontology for effective matching of them semantically. Therefore, it is necessary to extend the light-weight ontologies with axioms in order to provide heavy-weight ontologies. Content-based techniques (Partyka et al 2008) for ontology matching deal with examining the associated instance data from the compared concepts and apply a content-matching strategy to measure similarity based on value types. The major limitation of the content-based framework is that, it uses only syntactic structure of the two input ontology for analysis. Therefore, the system could not identify the major relationships like partial overlap, intersection and subsumption. This can be enhanced by introducing semantic axioms for enhancing the efficiency. MUPRET (Assawamekin Namfon et al 2009) framework is another Ontology alignment technique used in web applications. This framework actually uses a semantic matching procedure based on dominant words matching. The main advantage of MUPRET framework over the existing systems is that it considers relationships such as equivalence, subsumption, overlapping and mismatch. However, it is necessary to find inconsistencies in order to apply the resolution procedure.

1.8 PERFORMANCE EVALUATION AND RECOMMENDATIONS IN E-LEARNING

The hottest and most critical topic in research of e-learning in recent years is the effectiveness and efficiency of e-learning, since scientific proof of the value of e-learning is needed. Effectiveness is concerned with the achievement of the intended objectives of the educational experience and efficiency is concerned with producing the maximum benefits possible for the given expenditure of public money. However, the evidence of whether the effectiveness and efficiency of e-learning is better than the traditional learning still remains unresolved. Gagne et al (1977) classified learning into five
categories according to the learning result: verbal information learning, intellectual skills, cognitive strategies, attitudes and motor skills. Intellectual skills are the capabilities that make the human individual competent. They make up not only the most basic but the most pervasive structure of formal education which ranges from elementary language skills like composing a sentence to the advanced technical skills of science, engineering, and other disciplines. A good understanding of this process is important to the design of courses in intellectual skills.

A recommender system supports users in identifying interesting items especially among large numbers of items. Among the popular approaches used in recommender systems are collaborative filtering, content-based filtering, and hybrid filtering. Collaborative filtering identifies the interesting items from other similar users’ opinions by calculating the nearest-neighbor from a rating matrix. New items that are of interest to the nearest-neighbor and that have not been rated by the users will be recommended to them. In contrast, content-based filtering uses features of items to infer recommendations. Hence, items with similar content to the current viewing item will be recommended to the active user. Recommender systems in e-learning can differ in many ways depending on the kind of object to be recommended (i.e. course to enroll, learning materials, etc.) and whether the context of learning is considered important (Osmar Zaïane 2002). Recent trends show that most of the researchers use data mining approach and information retrieval technique as the recommendation strategies. Erin Shaw et al (1999) proposed the use of web mining technique to build agents that could recommend online learning activities or shortcuts in a course website based on learners’ access histories to improve course navigation as well as assisting with the online learning process.
Mohamed Koutheaïr Khribi et al (2009) computed an online automatic recommendation based on learners’ recent navigation histories as well as exploiting similarities and dissimilarities among user preferences and among the contents of the learning resources. Soonthornphisaj et al (2006) applied the collaborative filtering approach to predict the most suitable documents for the learner. New learning materials are able to be recommended to learners with a high degree of similarity. They also proposed a new e-learning framework using web services that has the ability to aggregate recommended materials from other e-learning web sites and predicts more suitable materials for learners. Tang et al (2007) proposed an evolving web-based learning system that is able to find relevant content on the web, personalize and adapt the content based on the system observation of its learners and the accumulated ratings given by the learners without the need for learners to directly interact with the open Web. Mohammed Otair et al (2010) proposed a framework for an expert personalized e-learning recommender system by using a rule-based expert system that can help learners find learning materials that best suit their needs. The system addressed the essential elements of effective e-learning such as control of student’s skills and feedback between the students and their tutors. The feedback is obtained through the expressions given by the students after the lecture by building discipline-related ontology and then comparing it with a referral one. Among the benefits of having this kind of recommendation strategy are that it can ensure the recommended items remain in the current e-learning context and thus quality materials are able to be recommended.

Han et al (2010) have shown that the performances of the learners in learning a programming course is not same, since learning to program is greatly influenced by two dominating factors namely self-efficacy and mental efforts. Several factors affect the performance in learning a programming course and research is under progress to identify why most of
the students drop out from learning the programming courses. Learning a programming course is comparatively difficult than learning any other course in e-learning since, programming knowledge requires cognitive abilities, logical thinking and mastering the abstract concepts. Therefore, this situation is a significant problem in the field of computer science and engineering. However, since learning is done through web and in addition learning programming courses require sequential regression in mastering the programming courses, it is quite often very difficult in assessing the performance of the students. Moreover, the performance of the learners had to be monitored from time to time for successful e-learning. The learners can be evaluated using the traditional method of questionnaires. However, simple techniques for evaluating the learners may not be very accurate.

1.9 PROPOSED WORK AND THESIS CONTRIBUTIONS

In this research work, an integrated e-learning system based on pair programming strategy has been proposed. This integrated system provides efficient teaching-learning methodology with accurate and appropriate evaluation system. Moreover, the teaching-learning strategy aims at increasing the self-efficacy of the e-learners thus enhances their performance. Learning a programming language through e-learning is a challenging task since it requires logical thinking and problem solving capabilities. Therefore, teaching a programming course through e-learning is an important research issue. Hence, in this research work teaching and learning of ‘C’ programming language is considered for carrying out the experiments.

Initially, the learners take a pre-test to know their knowledge level in a particular learning domain. In this system, a new technique based on Felder-Silverman learning style model is proposed and implemented for learning style identification. Such learning style identification and suitable recommendations on the learning contents is helpful for increasing the
self-efficacy of the self learning learners. Subsequently, based on the pre-test marks the learners are recommended to choose any one of the learning methodologies namely self learning followed by peer-learning using agents known as self learned group, peer-learning using agents known as peer-learned group and pedagogical learning using conversational agents assuming the instructor role followed by peer-learning using agents known as conversation agent learned group. In this research work, the pre-test consists of 50 multiple choice questionnaires and therefore pre-test mark is 50. If the pre-test marks of the learners are between 0 and 20 the learners are directed to self learned group. If the pre-test marks of the learners are between 20 and 30 then the learners are directed to the conversation agent learned group and the learners are directed to the peer-learned group if the marks are greater than 30.

Subsequent to learning, the learners are evaluated either individually or as a group based on their learning methodologies. The learners are evaluated as a group using pre-test and post-test questionnaires marks. In the post-test a combination of the descriptive answer patterns and questionnaires are used for individual learners evaluation and only simple questionnaires are used for group evaluations. From descriptive answer patterns, ontology is constructed and a similar ontology is constructed based on a domain experts documents for the same. These two ontologies are aligned using a newly proposed ontology alignment technique for final evaluation. In case of the group evaluation, t-test is used when any two learning groups at a time mentioned above are analyzed and ANOVA (ANalysis Of VAriances) test is used when all the three target groups are analyzed.
1.9.1 Learning Styles Identification

One of the techniques employed for identifying the behavior of the learners in e-learning is their web browsing pattern since clear and deep identification of the learning style of the learner can be achieved through the browsing pattern. This in turn increases the measures for suitable recommendations or appropriate restructuring in the design of e-learning contents (Melody Siadaty and Fattaneh Taghiyareh 2007). In this research work, a fuzzy logic based learning style model is proposed by extending the classification provided by Sanders et al (2010). Therefore, the unknown groups in the existing model are further classified into reflective, medium reflective, medium active and active in this work. This new e-learning approach can handle the uncertainty in the inference found in the unknown category since it uses fuzzy rules for effective classification of learners. Uncertainty, in this context considers the degree or extent to which the learner is active or reflective. Queries based on the degree of activeness or reflectiveness is not addressed in the existing models. Moreover, this research work considers only the first dimension of Felder-Silverman learning style model namely active/reflective since, this dimension is sufficient to identify the learning styles of the learners from the web usage pattern of any media namely text, audio and video. In this research work, the symmetric Gaussian membership function for a fuzzy set A is used for generating fuzzy rules. This set represents the learning styles of the learners and is represented by

\[ f(x;\sigma,c) = e^{-\frac{(x-c)^2}{2\sigma^2}} \]  \hspace{1cm} (1.1)

The parameters \(\sigma\) (width) and \(c\) (center) alter the width of the membership function curve of the fuzzy set A, based on the input value \(x\). This fuzzy set A represents the learning style, and the parameter \(c\) denotes the mean of the membership function curve in this function (Shyi-Ming Chen and
Yu-Chuan Chang 2011). The symmetric Gaussian fuzzy membership function used in the proposed model identifies four categories of the learners’ namely active, medium active, medium reflective and reflective.

### 1.9.2 Agent-based E-Learning System

This research work aims at increasing the self-efficacy of the learners by identifying their learning styles. The self-efficacy of the learners is increased by allowing them to judge their own abilities, before they could pair to learn with agents to master a programming course. Moreover, as analyzed before the learners can perform well in learning a programming course, if they have prior programming experience since they have a good knowledge about the basic concepts. This experience is facilitated by recommending suitable e-learning programming course contents based on the individual learning styles which provides effective self learning computing experience. This helps in increasing the programming abilities when learning in an agent-based pair programming environment subsequently. Moreover, the proposed system analyzes the educational effects of the learners learning using pair programming agents based on increased self-efficacy. This learning methodology is compared with the other learning methodologies where the learners do not have self learning computing experiences. The experiments for analysis were carried out for ‘C’ programming language course. From the experiments conducted in this research work, it has been inferred that learners with prior experiences by self learning understand the concepts faster than new learners.

### 1.9.3 Performance Evaluation of E-Learners

The performance of the learners is evaluated both individually and as a group in this research work using a descriptive answer patterns test and questionnaires testing module. In the individual learner evaluation, the
descriptive answers written by the learners are converted into an ontological structure using an enhanced ontology construction technique proposed in this work. This ontology construction method considers propositional logic based approach and also resolves intersentential anaphors (Zhang et al 1996). Therefore, this system provides facilities for decision making efficiently by considering previous sentences. The learners ontology had to be evaluated for accuracy using a domain experts written document for the same question provided to the learners and hence ontology alignment technique is necessary.

It is necessary to provide an effective solution for ontology alignment that can help in learners performance evaluation. Simple evaluation techniques like feedbacks and simple multiple choice questionnaires may not be very accurate. Therefore in this research work, a rule-based solution for evaluating the learners using ontology alignment technique is proposed. For this purpose, rules based on Deontic logic are used and hence makes a positive attempt in analyzing the presence of even some of the non-dominant categorization of words like determiners, time clauses and modal verbs occurring in the text documents using standard Deontic rules. Therefore, a new framework that derives deontic relations from the input text documents for identifying non-dominant words which helps to perform better evaluation in an e-Learning environment is also proposed.

The experiments have been carried out on evaluating the learning of ‘C’ programming language using an e-Learning framework. In addition, a measure for similarity/conflict resolution between two ontologies is also proposed. In this research work, deontic relationships are used to perform ontology alignment instead of the traditional propositional logic present in the existing systems. The application of deontic logic allows to use universal and existential quantifiers in rules. Moreover, it enhances the efficiency of
semantic matching techniques through the use of additional predicates such as can, could, ought, each, every, any, before, after and when. This proposed framework considers not only the predicate logic features namely equals and partially equals, but also the newly added consistency checking deontic predicate ‘conflicts’ and hence it covers all the aspects of logic including unification, resolution, subsumption and conflict identification.

1.10 STRUCTURE OF THE THESIS

The remainder of this thesis is organized as follows:

Chapter 2 provides a survey of related works and compares them with the proposed work. Chapters 3 depict the architecture of the system proposed in this research work and briefly explain the subsystems present in the proposed framework. Chapter 4 details the analysis and the detection of learning styles in e-learning environments proposed in this research work and explain the agent based e-learning methodology using pair programming strategy developed in this research work. Chapter 5 describes the work on ontology construction knowledge representation technique which aids in evaluating the learners learning through web environments. Chapter 6 details the ontology alignment methodology for evaluating the learners and to provide appropriate recommendations to the learners. Chapter 7 summarizes the conclusions of the work and suggests some of the possible enhancements to be done in future.