Chapter 1: Introduction

The past decade has witnessed a remarkable shift from classroom-based pattern of learning towards technology-enhanced learning or electronic learning (e-learning). Traditional classroom based learning follows instructor-centered methodology where lessons are taught by an instructor to a class of several students at a definitive pace with possibility of revision. This teaching-learning process is conducted in an interactive and synchronous mode. In synchronous mode, both the learners and instructor are present at one place which facilitates face-to-face interaction and hence benefits both learners and the instructor. Interactions among the learners help them gather new ideas and provide a base for construction of their own thoughts about that topic. The learner-instructor interactions benefit the instructor also. First, interaction with learners in synchronous mode provides immediate feedback to the instructor about their needs. Second, face to face presence enables the instructor to analyze subtle mannerisms and behaviours of learners within and out of their peer groups. These feedbacks let the instructor modify her/his teaching style in accordance to the needs of the learners.

Though classroom based system is the oldest, time-tested and highly valuable method of teaching till date, yet this system has certain constraints that led to the emergence of e-learning. Presence of learners and instructor at one place forms the very basis of traditional classroom based method. This requirement becomes a constraint for those who wish to attain education but are unable to make it to their choice of institutions due to various reasons, like institutions being located at a faraway distance, having limited number of seats or being too expensive. Further, although the classroom based method of learning is interactive, yet slow learners are left behind in due course either because of their hesitation to ask questions in front of their peers or due to compulsion on the instructor to finish up the course within stipulated time period. Learner-instructor ratio also plays an important role in establishing a viable relationship between a learner and an instructor. The higher the
learner-instructor ratio is, the lesser attention an individual learner gets from the instructor. In classroom based method of learning, the learner-instructor ratio varies from 15:1 in developed nations to 40:1 in under-developed populous nations (UNESCO Report, 2008). Moreover, in this method, the course presented to the learners is limited by the syllabus and flow of content as designed by the course designers.

E-learning seems to be the right solution to address these issues. E-learning is a ubiquitous form of learning that facilitates anytime-anywhere resource accessibility to the users. It also adheres to the notion of learner-centered methodology. A learner-centered approach revolves around the assumptions that the students are self-motivated human beings who are accountable for their own learning and are capable of exercising control over their learning outcomes. Learner-centered methodology allows a learner to take decisions concerning the issues like—what to learn, when to learn and how to learn.

E-learning has witnessed myriad phases to evolve from a static environment, providing text-based content to the students through CD ROMs or print, to a much advanced multimedia-enriched content. Current e-learning systems focus more on content development rather than on learning activities itself (Dalziel, 2005; Zin, Othman and Yue, 2009). These systems promote e-learning course developers to make contents more interesting and appealing to learners without paying much attention to the actual need of the learners. Advances in the development of learning objects have led to emergence of isolated and impersonal environments offering static e-learning content, causing decrease in learner motivation and engagement (Nor Azan and Wong, 2007).

In a traditional education system, face-to-face interaction allows for all queries, whether related to subject or personal, to be discussed and solved through mutual discourse. An online learning environment provides ubiquity to the learning and teaching processes but at the same time presents the content to the learners in a mechanized way. The absence of able human guidance leaves the learners isolated and frustrated. The lack of human touch increases the risk of dropouts among the
learners during the course schedule. Learners often get overwhelmed by the availability of large volumes of learning content in e-learning systems. The content is presented to the learners either statically or with numerous hyper-links for navigation. The choice of content varies according to the requirements. Hence, a static sequence of content modules cannot satiate different learners enrolled in a course. Sequencing the content according to the learners’ needs is the objective of designing adaptive systems.

In e-learning systems, learners are more independent unlike in traditional classroom learning, where a teacher can monitor learner interactions and react in accordance to their behaviours during interactions. Though independence comes paired with self-regulatory form of learning, yet it needs to be controlled so that the learners do not wander away from their own objectives while going through the content. They sometimes tend to be indecisive regarding what approach suits them the most. There exists a need, therefore, to move away from the ‘one size fits all’ paradigm and to develop methods whereby personalized courses are presented to learners in accordance to their requirements.

1.1 Motivation

Research on designing adaptive learning systems is going on since 1990s but has gained momentum in recent years (Maycock, 2010). Development of Adaptive Educational Hypermedia Systems (AEHS) (Brusilovsky, 2001; De Bra, Aroyo, and Cristea, 2004) has paved way to provide a customized learner-centric solution to each learner associated with the system.

Adaptive Content Sequencing (ACS) is a process of recommending customized learning paths for learners in an order that suits their respective goals, preferences, learning styles and grasping capabilities. The content modules of the course are perceived as a set of nodes in a graph. The order in which a student navigates through the nodes, determines the actual sequencing of content units for him/her.

Performance of a course, once delivered to the learner, is judged by performance of the learner in the society. Hence it is essential that the opinion of society be
Adaptive Content Sequencing Incorporating Social Opinion in an e-Learning Environment

considered while designing the courses. Infusing recommendations of the stakeholders (experts) from various domains of society into the course designing process would ensure better acceptance of the course. Blending these recommendations into the course structure, through cycles of improvisations, helps in preventing obsolescence and enhances the quality of the e-course. Such a course would lead to student retention and steer the e-learning organization towards economical stability.

The development process of the course thus needs to follow an integrated approach in managing information within and outside the organization with a prime focus on a) managing the flow of learning content from the educators to the learners and b) implementing the recommendation from a subset of all the prospective stakeholders belonging to different walks of society into the learning content. Giving appropriate credence to social opinion is, therefore, imperative for designing a course that is relevant for the prospective learners and the society as well.

1.2 Objective

Recommendations from social representatives need to be incorporated into the process of course formation and updation. The stakeholders associated directly with an e-learning system are—learners, faculty members, administrators, content providers, designers, developers, subject matter experts, pedagogy experts, language experts and technology experts, who are the direct users of the system (Thukral, Sharma, Banati and Bedi, 2007). Another section of society that may not be associated directly, but is affected by the end product (students who have graduated out) of the system includes researchers, academicians, recruiters, policy makers etc. Infusing recommendations from all such segments of the society in designing the course content brings harmony into the system and setting of uniform policies leads to standardization of the processes (Paslwowski, 2003).

To address these issues, the thesis presents forth a framework, Knowledge Management in e-Learning Systems (KMeLS), implemented using Multi-Agent Systems (MAS). The system aims at providing socially-aware learner-centered
content as per the needs of the learners by implementing the ACS process. The system is based on the premise that the process of content designing should not only make constructive use of the facilities afforded by online environment but also map the advantages of face-to-face learning into e-learning by using those facilities.

1.3 Thesis Road Map

Chapter 2 discusses the evolution of e-learning systems. It highlights the differences between traditional learning and e-learning. The chapter next trends on various content creation and dissemination methods developed over the years in the field of e-learning. It finally introduces the perspective of incorporating social opinion in an e-learning environment.

Chapter 3 introduces Knowledge Management (KM) and puts forth the proposed KM based framework, KMeLS. The framework is based on the well known SECI Model (Nonaka and Takeuchi, 1995) and comprises four phases— Socialization, Externalization, Combination and Internalization. It formalizes the content designing in e-learning.

Chapter 4 elaborates on Socialization, the first phase of KMeLS. It identifies the roles of various direct and indirect stakeholders involved in e-learning. The interaction among learners and instructors is analyzed to predict the knowledge gain of learners. The learners are classified as prospective ‘gainers’ or ‘non gainers’ based upon their amount of interaction using Naïve Bayes Classifier. The preference of non gainers in terms of instructor-oriented v/s peer-oriented interaction is then obtained and used for customizing the content as per the requirements of the learners.

Chapter 5 discusses prioritization of social opinion that constitutes the Externalization phase of KMeLS. The chapter deals with elicitation of opinion from various direct and indirect stakeholders. An algorithm, Prioritizing Alternatives using Recommendations of Stakeholders in e-Learning (PARSeL) is proposed that prioritizes a list of content modules, required to be included into the course, generated through the processes of Analytic Hierarchy Process (AHP) and Fuzzy Modeling.
Chapter 6 discusses the Combination phase of KMeLS and presents Stigmergy-based framework, Adaptive Content Sequencing in eLearning using Stigmergic Agents (ACSeLSA) comprising ACSeLAnt, an ant-based algorithm. ACSeLAnt evaluates the level of a learner and recommends appropriate concepts to him/her. It is sensitive to the changes in learning behaviours of each learner and fine-tunes its strategies to recommend the next concept accordingly. The behaviours of past learners are captured and utilized to recommend content to prospective learners.

Chapter 7 proposes MANet-based Context-aware Knowledge Sharing System (MACKSS), a multi agent system to facilitate information exchange among on-campus groups of learners and experts. The chapter discusses the conceptual framework of MACKSS along with the inter-agent communication and agent action-behaviour relationships. The information captured in the process is used in the behavioural classification of learners.

Chapter 8 concludes the thesis.