Abstract

E-learning is learning facilitated through computers, portable devices and/or the Web. It allows access to learning content from anywhere and at anytime. Although the Web is flooded with varied e-learning courses, yet there are certain issues regarding the content designing of these courses. Firstly, most of the e-courses follow ‘one size fits all’ paradigm, providing the same content to all the learners enrolled in a course, irrespective of what they need from the course. This leads to loss of interest among the learners and eventually a sharp rise in the rate of learner attrition. Secondly, the course needs to have a concrete applicability in the society. Thus, a need is being felt to design adaptive courses that are relevant to the learners and fulfill the expectations of the society as well.

In light of the aforementioned issues, the thesis proposes to incorporate adaptivity in e-learning by incorporating social opinion into the content designing processes, so as to enhance both the learner-centeredness and the social bearing of e-courses.

The issue of incorporating adaptivity in e-learning can be resolved through a technique called Adaptive Content Sequencing (ACS). ACS offers customized learning content to the learners according to their needs. It allows the learners to get what they want eventually paving way for their effective learning. In ACS, a course is represented as a graph whose nodes correspond to the content modules. The nodes are sequenced in various combinations adaptively to comply with varied needs of the learners.

The second issue is of enhancing social relevance of a course that requires identification of appropriate learning content from the perspective of social representatives or stakeholders. This issue can be addressed by infusing the viewpoints of stakeholders, into the course structure, through cycles of improvisations at well-defined intervals. Hence, social opinion can act as an effective input for developing an e-learning course. An e-learning system thus developed makes the
Adaptive Content Sequencing Incorporating Social Opinion in an e-Learning Environment

learners informed of the social applicability of the knowledge being acquired by them. However, stakeholders hailing from diverse strata of the society may have diverse points of view regarding appropriate content. Thus, selecting content from multiple options on the basis of multiple criteria is a complex problem that calls for solutions based on intelligent decision making techniques that accommodate collective decisions of the stakeholders.

To address these issues, the thesis presents a knowledge based framework, Knowledge Management in e-Learning Systems (KMeLS), implemented using Multi-Agent Systems (MAS). KMeLS is based upon the knowledge-based SECI model (Nonaka and Takeuchi, 1995) that revolves around inter-transformation of two types of knowledge— tacit and explicit. Tacit knowledge refers to the intrinsic knowledge possessed by an individual in regard to a concept, but is hard to codify. Explicit knowledge, on the other hand, is easy to formalize and is transmittable. The SECI model identifies four modes of knowledge conversion— tacit to tacit, tacit to explicit, explicit to explicit and explicit to tacit. KMeLS adapts these modes in its four phases— Socialization, Externalization, Combination and Internalization for content designing in e-learning systems. The KMeLS taps the tacit and explicit knowledge possessed by various e-learning stakeholders to design e-courses that are socially relevant as well as adaptive to the needs of the learners.

The first phase, Socialization, refers to conversion of tacit to tacit knowledge and involves sharing of ideas by various individuals leading to construction of valuable knowledge mass. It identifies various stakeholders involved in an e-learning organization and analyzes the interaction among two key stakeholders- learners and instructors. This phase presents an algorithm to predict the knowledge gain of learners by analyzing their online interaction among each other and with the instructor as well. The knowledge gain is used to categorize learners as prospective ‘gainers’ or ‘non-gainers’ through Naïve Bayes Classifier. The learners who are predicted to pass the course are termed as gainers, whereas those who may not succeed are termed as non-gainers. With an underlying motive to foster the non-gainers, their interaction preferences are obtained. The interaction preferences are analyzed in terms of
instructor-oriented versus peer-oriented interaction. Remedial plans based on proven instructional strategies are subsequently adopted to help non gainers strengthen their weak areas. The actual knowledge gain of learners is evaluated by performing paired t-test on the previous and post-test score pairs.

The second phase, Externalization, deals with transformation of tacit knowledge to explicit knowledge. This implies codifying the ideas of stakeholders into concrete guidelines. To realize this, an algorithm PARSeL (Prioritizing Alternatives using Recommendations of Stakeholders in e-Learning) is proposed to manage knowledge of stakeholders during the process of designing an e-learning course. The stakeholders identified in the first phase are requested to give their opinion regarding selection of course contents. PARSeL prioritizes the content on the basis of these recommendations using Analytic Hierarchy Process (AHP) and Fuzzy Modeling techniques. AHP is a theory of eliciting opinion of users to rank multiple alternatives in the presence of multiple criteria and sub criteria. It also includes a measure to evaluate the inconsistency of the decision maker when eliciting her/his judgements. However, uncertainty is introduced into the system due to inherent though unintended human errors and conflicting perceptions of the experts. Fuzzy modeling of the recommendations tends to diminish the same. The effectiveness of the algorithm is established through an experimental study of prioritizing a set of programming languages for an online computing course.

The third phase, Combination, refers to conversion of explicit to explicit knowledge. The codified knowledge elicited from diverse sources is integrated to form a cohesive knowledge asset. This phase is realized through a Stigmergy-based framework, Adaptive Content Sequencing in eLearning using Stigmergic Agents (ACSeLSA). A Stigmergic Agent (SA) exhibits stigmergic behaviour by implementing Ant based algorithms for gathering information through indirect communication. MAS lend benefits of direct interaction among the agents. Each learner enrolled in the system has a personalized stigmergic agent (PSA) that employs ACSeLAnt, an Ant based algorithm devised to generate customized content sequence for him/her. By implementing ACSeLAnt, each PSA exhibits stigmergic behaviour by
producing its own pheromone trails and sensing those of other learners to generate the content sequence. The recommendations of other similar learners are elicited through direct communication with their PSAs and incorporated into the content sequencing process.

The fourth phase, Internalization, deals with conversion of explicit knowledge to tacit knowledge. This implies that the units of explicit knowledge obtained from existing stakeholders are comprehended by a new set of stakeholders who produce their own pieces of tacit knowledge. A multi agent system, MANet-based Context-aware Knowledge Sharing System (MACKSS), comprising agents to facilitate information exchange among on-campus groups of learners and experts is presented in the Internalization phase of KMeLS. In MACKSS, a user (a learner or an expert) belongs to two views—a physical view formed by cellular frequency ranges and a context view constituting users having similar interests or contexts. These views help in dissemination of user queries and responses within a group (multicasting) or their routing to the intended persons (of same context as sender but belonging to different physical views). The collaborative query-response-forward process among users leading to informal knowledge sharing and behavioral classification of the users is validated through an experimental study.

The research work presented in the thesis emphasizes the significance and potential benefits of incorporating social opinion into the process of e-content designing. The proposal involves participation of direct and indirect stakeholders into designing socially-aware e-learning courses. The thesis addresses and resolves the issues in quantifying social opinion by implementing AHP and fuzzy modeling techniques. The learner-learner and learner-instructor interactions are also explored to seek an insight into the interaction preferences of the learners. This benefits the instructors in designing content dissemination plans according to the preferences of the learners. The work also highlights that offering adaptively customized content to the learners decreased their cognitive overload. The research work presented in the thesis is validated through various experimental studies. The positive results obtained in due course of this work mark that the KMeLS framework is achievable in large
scale e-learning scenarios and pave way for designing e-learning courses that fulfill the requirements of the learners, engage them, promote learning and enhance acceptance of e-learning in society.

The thesis concludes that ACS can be promising in recommending appropriate content for the prospective e-learners and infusion of social opinion into the content designing process lends social relevance to the e-courses and allows the learners to frame and realize their prospective career objectives.