Chapter 8: Conclusion and Future Directions

This chapter summarizes the entire work presented in this thesis and discusses its implications. The major contribution of the thesis is the proposal of Knowledge Management in e-Learning Systems (KMeLS), a four-phased knowledge based framework. KMeLS paves way for integration of social opinion and Adaptive Content Sequencing (ACS) into e-Learning content designing process. A comprehensive analysis and validation of KMeLS has been conducted and presented herein. The review of the evolution of e-learning and e-content designing techniques brought to light that Adaptive Content Sequencing (ACS) is one of the best ways to design content as per learner requirements. The review led to the observation that significance of social opinion inclusion into the content designing process had not been explored much. The thesis, hence, has integrated the benefits of ACS and social opinion to design socially relevant as well as learner centered e-content. The chapter highlights the observations made in due course of research, discusses major contributions of this research work and identifies further research perspectives as future work.

8.1 Conclusion

The work described in this thesis has been grounded on the belief that technology enhanced learning or e-learning is a means of augmenting the ability of teachers and not that of substituting them. A nascent field a couple of decades ago, e-learning has emerged as a potential supplement, if not a substitute, for traditional education. It has opened new vistas for those who want to learn but cannot do so due to lack of time or having other commitments to fulfill. The thesis studied and compared the states of art in traditional learning and e-learning, formal and informal elements of learning and tools for online content management developed across the years. In due course of this
research work, certain observations were made. The observations and the issues that surfaced during the literature survey along with the contribution of the thesis in resolving those issues form the focal point of this chapter.

It was observed that the research in e-learning systems has moved from content-centered to learner-centered designs. Transition from static and instructor-centered to adaptive learner-centered methodology has shifted the reins of learning into the learners’ hands. An adaptive learning system creates a learner friendly environment due to its flexible content dissemination approach. It focuses on the needs of the learners and provides the content to them accordingly. This satisfies the short term goals of the learners that include, for example, choosing what to study or to qualify an examination. However, awareness of the social applicability of the knowledge being acquired by them is also very important. This awareness makes the learners informed of the expectations of the prospective employers. Literature study revealed that the significance of social opinion in content-designing had not been explored much. A need was, therefore, felt to design content in a way that would let the learners hone their skills accordingly with an eye on the social acceptability of the course.

Another important observation was the diversity and subjective nature of social opinion of the various stakeholders. Incorporation of social opinion into content-designing process thus needed quantification, and prioritization.

The thesis presented a four-phased knowledge based framework KMeLS that addresses the above mentioned issues. The four phases—Socialization, Externalization, Combination and Internalization worked towards integrating social opinion and adaptivity into content designing process in an e-learning environment.

One of the major contributions of the thesis is the reflection of potential benefits as well as the predicaments of incorporating social opinion into the process of content designing. The proposal involved not only direct but also indirect stakeholders into designing a socially-aware e-learning environment. The work addressed and resolved the issues in quantifying social opinion. While implementing this strategy, the following problems were encountered:
i) Heterogeneity in the input: Disparate social opinion over the design issues led to a pool of myriad viewpoints. The work required dealing with varied as well as mutually conflicting viewpoints.

ii) Uncertainty in decision making: Human perceptions are inherently fuzzy. Attention was directed to dealing with uncertainty crept in the decision making processes due to unintentional biases.

These issues were addressed by infusing AHP and Fuzzy techniques into the designing process. The opinions of the stakeholders were analyzed and prioritized using AHP technique. Fuzzy modeling helped in mapping the cognitive levels of decision makers into a rule-based fuzzy framework and provided a twofold solution - a) it enriched the system model with personal experiences of the experts and b) obscured the effects of their inherent biases on the system.

The process of eliciting opinion from diverse communities offered a multitude of objectives— i) initiation of learning community building through mutual interactions; ii) converging to concrete decision making notwithstanding the heterogeneity in the sets of opinion and iii) providing learners (end users) with prioritized, well-analyzed fine-grained learning content. These objectives form the pillars of the dynamic content designing process. The success of this process lies in catering to the immediate needs of both the society and the prospective learners who are the potential knowledge contributors to the society.

The work also contributed towards facilitation of online learners through a multi-agent framework for Adaptive Content Sequencing in e-Learning using Stigmergic Agents (ACSeLSA). The framework facilitated generation of customized learning content sequences as per the learner’s requirements. Personal Stigmergic Agents (PSA), implemented as a part of ACSeLSA, provided a dual mode of interaction among agents- direct communication and stigmergic (indirect) communication. The Ant based Adaptive Content Sequencing algorithm, ACSeLAnt formed the backbone of the ACSeLSA framework. ACSeLAnt allowed PSAs to mutually engage in stigmergic as well as direct communication. PSAs also possessed the ability to interact directly with other agents for registration and authentication of learners.
enrolled in the system; receiving learner profile details; receiving content details; and elicitation of expert opinions. Ability of PSAs to communicate with different types of agents lent this framework autonomy, parallelism, dynamism and adaptivity.

The integration of knowledge, social and technical contexts of the users, in the realms of mobile learning environment, was achieved through MACKSS, a MANet-based Context-aware Knowledge Sharing System. MACKSS facilitated formation of physical and context views through agents to facilitate information exchange among on-campus groups of learners and experts. Inter-agent communication and agent action-behaviour relationships were also discussed. The information captured in the process was used in the behavioural classification of learners. In MACKSS, a user (a learner or an expert) belongs to two views—(a) a physical view (PV) formed by cellular frequency ranges; and (b) a context view (CV) constituting users having similar interests or contexts. These views helped 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 first objective of CV and PV formation within MACKSS was to facilitate focused knowledge sharing among the users while on the move. The users were continuously aware of the presence of other users belonging to their own context through CVs. Availability of context information helped in building a conducive environment for the users and let them obtain relevant, timely and assured information. PV information helped in rendering information to the users even in the absence of local information resources with support of users (forwarding agents) present in the overlapping regions.

The data generated in the process of knowledge exchange paved way for behavioral classification of the users, the second objective of MACKSS. On the basis of the actions performed by the users during the experimental study, they were judged on the following parameters—Inquisitiveness, Responsiveness, Reciprocity and Cooperativeness. The study managed to bring to light how the users faired in the collaborative process of knowledge exchange.
8.2 Future Directions

The work presented in the thesis can act as a model to modify content designing processes in real life e-learning environments. The KMeLS framework was designed with a vision of scalability for further exploration into prospects of incorporating social opinion for building more socially relevant content designing systems.

It was observed during the study that the experts from different fields of the society have varied preferences towards the criteria and alternatives for selection of a particular course. Thus, a longitudinal study can be conducted to judge the wider impact of social opinion inclusion in learning environments.

The techniques implemented here are flexible and can be fine-tuned to cope up with heterogeneous requirements of any organization, institution or knowledge community. The proposed system captures learners’ behaviours, updates their knowledge levels and fine-tunes its strategies for performing ACS. The ant-based nature of the system takes into account decisions of the preceding learners and draws them together to provide solutions to the current learners in the system. The results obtained from the experimental setup illustrate the potential usage of the proposed algorithms in large scale adaptive sequencing of online courses. These results pave way for further research in the area of developing more effective instruction strategies and building intelligent learning systems by analyzing learner-instructor interactions.