Social Network-Based Course Material Transformations For A Personalized And Shared Ubiquitous E-Learning Experience

Timothy Arndt
Dept. of Computer and Information Science
Cleveland State University
Cleveland, OH, USA
arndt@cis.csuohio.edu

Angela Guercio
Department of Computer Science
Kent State University – Stark
North Canton, OH, USA
aguercio@kent.edu

Abstract—**This paper describes our preliminary work in progress on using social networks to form learning communities for e-learning. Today's learners are increasingly likely to engage in learning activities via some form of e-learning. In order to meet the needs of these learners, a personalized approach to web-based e-learning is very helpful. An adaptive approach is required to deliver courseware in such a situation. The e-learning system must adapt to the learner's particular likes/dislikes, study session length, and learning style as well as to the characteristics of the learning device – screen size, bandwidth, networked or not, etc. We have previously described an XML-based approach in which metadata describing the learner's situation are continuously collected and refined and may be transformed via XSLT to meet the learner's needs at any particular moment. One problem with such an approach is that the personalization may be carried to such extremes that the e-learner may lack a supporting community of colleagues who share a common learning experience. In this paper, we propose the use of social networks to form subgroups of e-learners in a class. The preferences of this group of learners will be harmonized in order to provide a common learning experience which can be exploited by the members of the group in order to meet their learning goals. Towards this end, an algorithm for determining the optimal group of friends (based on desired group size and social network connectivity) is given. This algorithm and the approach proposed will be further developed in our ongoing research by incorporating it with our previously developed customization system.**

Keywords - adaptive e-learning; personalized e-learning; social networks; ubiquitous e-learning

I. INTRODUCTION

Several trends emerging today point towards the growing importance of ubiquitous learning – learning which takes place at any time and at any place. Among these trends are a growing population of non-traditional learners. Many of these learners have full or part time jobs which require them to fit the learning into a crowded schedule. Learning must take place wherever and whenever possible and it is not possible to fit this learning into a fixed, rigid schedule. Older non-traditional learners often have family obligations which render them non-mobile as well – the learning must come to them rather than the other way around. Younger, more traditional, learners also bring new demands to the learning environment. This generation is used to being entertained when and where they want, and may find traditional learning methods to be too constraining. In order to meet the needs of this generation, a more flexible, adaptive approach to learning.

In our previous work, we have developed an XML-based approach in which both online course materials and user profiles (learning styles, viewing device, etc.) are described using XML documents. XSLT stylesheets for various devices have been developed to support ubiquitous e-learning. The XSLT stylesheets successively transform the course materials in a dataflow transformation approach, resulting in a personalized learning experience. This previous work is discussed in more detail in the following section.

While distance learning technology can make classes accessible to the groups described above, a potential problem is the isolation of the distance learner, especially when a personalized approach to e-learning is adopted. One advantage of classroom-based learning is the support network of colleagues which can be exploited to reinforce learning. The vital importance of a shared learning experience has been noted by many researchers [1, 2, 3, 4]. This paper describes our work in progress that is geared towards leveraging social networking technology to reduce the isolation of e-learners and to form cooperative learning groups. Such an approach is advocated via several researchers in the field of e-learning (see the related research described in Section 3).

 ISBN: 978-1-61208-171-7

The basic framework needed to meet these needs is clear – web-based e-learning will be the preferred method due to the ubiquitous nature of the web and its underlying facilities and protocols. Standards-compliant web browsers are available on all manners of platforms, from servers down to cell phones and tablets and are generally available on PCs in open labs and libraries. On the back end, metadata may be used to describe both the learning materials as well as to give learner profiles needed for customization [5]. The use of metadata allows for open, standards-based learning environments to be implemented, as demonstrated by SCORM [6].

In the following section, we briefly describe experimental prototypes which we have previously developed which illustrate different aspects of adaptability for ubiquitous e-learning. Section 3 surveys related research in social networks for e-learning. Section 4 presents a formal model of social networks and e-learning and an algorithm for forming learning communities in the e-learning context using social networks. This is the main contribution of this paper. Section 5 gives conclusions and discusses future research.

II. ADAPTABILITY FOR UBIQUITOUS E-LEARNING

This section briefly reviews our previous research in adaptability for ubiquitous e-learning. In our present research, we take this previous work as a starting point and add the use of social networks in order to form learning communities with a shared (adaptable) learning experience.

In [7], we described our research in multimedia software engineering applied to distance learning – in particular the Growing Book project, a multinational research effort supporting multi-lingual, multi-modal and multi-level learning. The metadata for courseware was described using an XML language called TAOML whose definition was given. We also described a dataflow transformer, based on XSLT, for transforming the courseware from one desired output format to another. A prototype data transformer was developed in Java and demonstrated.

In [8], we further developed this approach, concentrating on ubiquitous e-learning and showing how the dataflow transformation approach could be used to support e-learning on different types of devices as well as diverse learning styles, described by user profiles. We moved towards standards-compliant metadata for learning objects and we developed a prototype system capable of generating learning scenarios for several different types of devices.

In the present research, we will leverage the use of social networking software in order to form shared learning communities so that students may be part of supporting group of learners, rather than have the completely personalized approach described in [4]. This approach is supported by several researchers whose results are given in the following section.

III. RELATED RESEARCH IN SOCIAL NETWORKS FOR E-LEARNING

In this section, we review some previous research involving the use of social networks in e-learning.

Before the emergence of social networking applications, researchers had already been working on ways to form groups of students for collaborative learning. Hoppe [9] described this as a matchmaking process driven by models of the students stored in a centralized repository. This idea was later implemented in such systems as Phelps [10] and iHelp [11], which formed profiles of students using characteristics such as knowledge, native languauge, cognitive styles, etc.

Haythornethwait and de Laat [12] provide an overview of social network concepts such as actors, ties, relations and networks as well as an outline of the concept of networked learning and discuss how a social network perspective can be applied in the networked learning context.

Chatti and fellow researchers present a social software driven approach to learning management [13]. They posit that social software can be used to build communities of learners as well as forming the basis of a personalized approach to learning. They also argue that today's teenagers, having grown up with this technology will be well-suited for such an approach. An emphasis of this work is on the similarity of Knowledge Management (KM) and Learning Management (LM).

Baird and Fisher [14] also note the reliance on and expertise in social software of the rising generation of students and proposes the use of social networking media to foster the building of learning communities as well as to facilitate self-paced and customized learning experiences in synchronous and asynchronous learning environments. This work reviews the literature in Social Learning Theory and lists various social networking media with hints of how they may be exploited in e-learning.

Vassileva [15] addresses several issues related to educating students of the "Digital Natives" generation with social learning technologies. Among

 ISBN: 978-1-61208-171-7

the issues addressed, the one most closely related to this research is finding the "right" people for the student to learn from or collaborate with. The author notes that with the rise of social network applications data about the relationships between users is becoming readily available to users. Among users not closely related to the user, trust and reputation are important mechanisms. The use of social networks to form a shared learning environment is not considered.

Stuetzer et al. [16] examine the social networks formed during collaborative distance learning and by analyzing the relationships define five different actor roles identified the relationship between network structure and learning processes.

IV. FORMAL MODELS OF SOCIAL NETWORKS AND E-LEARNING

In order to perform an initial study of the feasibility of this approach, we develop a formal model of the most important components of the system – the students in a class, their relations, and their learning preferences.

We model the students in a particular distance learning class using an undirected graph, $G = (V, E)$. Each vertex G in the graph represents a student in the class, and each edge V between two students V_1 and V_2 represents friendship between the two students. If no edge exists, no friendship relation exists between the two students. The graph represents the social network of students in the class. Furthermore, each vertex V has an associated vector of values $VEC = \{VAL_1, VAL_2, \ldots, VAL_n\}$ where each VAL_i is a member of the domain DOM_i, $VAL_i \in DOM_i$. There exists a special default value $DEF_i \in DOM_i$ for each DOM_i. A vector represents the set of learning preferences for a student. Each value is a particular preference (for example the degree of background that a student has in a particular related area may be represented by a value in the range 0 – 5).

We will also make use of a distance function for these vectors $DIST(VEC_1, VEC_2)$ which we will assume is defined (by the course instructor or some other actor) whose range is the set of non-negative real numbers. The semantics of the function is that learning preferences which are more similar should have smaller distances than those which are less similar. The function must be defined in such a way that any two identical vectors have a distance zero. We cannot in general use a simple Euclidean distance since the domains of each element of the vector may be different.

The idea is to form groups of friends who have a common set of learning preferences which after transformation of the learning materials based on those preferences, will lead to a shared learning experience. Since it is possible that we will not be able to find large enough groups of friends with identical learning experiences, we may need to harmonize their preferences by "averaging" the values of the vectors of the learning group members in order to achieve a common learning experience.

Given the practical limits on the size of online classes, the size of our graph G can be considered to be of reasonable size, so the types of algorithms which attempt to find communities on the massively sized graph which is the World Wide Web [17] are not needed.

The minimum size of a learning group MIN is given by the course instructor or coordinator as a parameter to the algorithm described with pseudocode below which forms the learning groups.

```
 ALGORITHM LEARNING_GROUPS

// Initialization phase

Let set GROUPS be an empty set of
(sub)graphs

G is the graph of students

MIN is the minimum group size

// Clique detection phase

Find all cliques of size at least
MIN in G

Add each of these cliques to the
set GROUPS and remove them from G

// Relaxation phase

If G is not empty then

      Find all k-edge-connected
      components of size at least
      k=|G|-1 in G

      Add each of these components
      to GROUPS and remove from G

      If G is not empty set k=k-1
      and repeat until G is empty
      or k=0
```

 ISBN: 978-1-61208-171-7

```
// Coalesce phase

If |G|>MIN, add G to GROUPS else

Remove a vertex from some element
of GROUPS with size > MIN and add
it to G. Repeat until |G|>MIN then
add G to GROUPS

// Consensus learning phase

For each element of GROUPS, replace
the vector associated with each
member of the element with the
average of all of the members
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The algorithm works by attempting to find groups of students from the graph with maximal connectivity that are at least as large as the size specified by the instructor. The algorithm first looks for minimally-sized cliques, removing them from the graph under consideration as they are found. In the relaxation phase, the algorithm looks for less well-connected sets of nodes, removing a group from consideration as it is found, and relaxing the connectivity requirement at each round. Finally, the left over nodes are put into their own group, and the preferences for each group found is calculated, based on the preferences of the individual members of the group.

V. DISCUSSION AND FUTURE RESEARCH

This work presents our initial research in incorporating social networking into our previously described approach to customized e-learning. The motivation for this work is the observation by several researchers in distance learning [1, 2, 3, 4] that students in distance learning perform better when they have a shared learning experience providing a support group of colleagues. Thus, we have modified out previous approach, which aimed at producing a customized learning experience for each student, based on a user profile containing preferences, as well as information on the device used. Now we adopt an approach which provides a customized learning experience for a compatible group of students (with the size of the group being a parameter which can be chosen by the instructor).

Possible weaknesses of this approach include the need to have available on social networking links for the students in the class. Hopefully, this will not be too much of a problem due to the popularity among the target group of students of such social networking sites as FaceBook and Google+. The approach also requires the instructor to be knowledgeable about the optimal size of a group to be input to the system.

As this research is in an initial phase, the major result presented in this paper is the algorithm for group formation presented in section 3.

As far as future research plans, we are currently working on a prototype system incorporating the group forming techniques described in section 3. This prototype will then be integrated with our previous systems for ubiquitous e-learning customization. A general learning model [18] will also be incorporated to allow modification of user profiles, and testing and validation of the approach will be done on a large class of undergraduates.

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 ISBN: 978-1-61208-171-7