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# Role- and Relationship-based Identity Management for Privacy-enhanced E-learning

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**Abstract.** From a privacy point of view, identity management (IM) is primarily concerned with the presentation of oneself, and therefore, can provide users discretionary control over contextual representations of projections of their personal identity. In role- and relationship-based identity management (RRIM), role and relationship are used as two means of defining a context of representation. A role-based identity offers a common identity for all the users who take on a particular role, while a relationship-based identity allows a user to disclose limited information to another person appropriate for a particular mutual relationship. Moreover, in an e-learning domain, trusted public roles can be assigned guarantor privileges to vouch for an identity or to facilitate usage control over disclosed information. In an effort to evaluate RRIM, we implement the model to support privacy in an e-learning discussion forum. A pilot and a large-scale user study support that RRIM features help users manage their privacy.

**Keywords.** Privacy, Identity Management, e-Learning

## INTRODUCTION

An e-learning system performs a variety of tasks related to learning: supporting different learning scenarios (e.g. self-study or guided learning), authoring or accessing of learning objects, tutoring, communication, evaluation, annotation, administration, etc. While carrying out these tasks, users in various roles (e.g. student, marker, instructor, peer-helper, etc.) are expected to present themselves appropriately and act in line with each others expectations of privacy.

The fact that online learning brings together participants with a wide range of goals, attitudes, and ethical stances, raises concerns of participants who fail to protect their privacy. Moreover, due to lack of physical bodily presence, certain participants may not be as trustworthy and accountable in an e-learning environment as in a traditional classroom. E-learners are becoming more perceptive about the privacy implications of their online activities. Borcea et al. (2006) point out that privacy requirements are obviously important for e-learning, since they establish an unbiased environment without prejudice or favoritism.

A privacy-aware e-learning environment can increase awareness of privacy threats as well as understanding of privacy-enhancing mechanisms, since e-learning is intended to transfer knowledge. For example, spyware, known to aid phishing, has been partly responsible for this fraudulent activity and the Webroot survey reveals that 48 percent of teens and young adults have no understanding of phishing <sup>1</sup>.

In this paper, privacy is not viewed to be seclusion, rather privacy is treated in light of Goffman's observation (Camenisch et al. (2005)) that individuals selectively reveal and conceal information to maintain context-specific identity and social relationships. Inspired by the work of Goffman (1959) and Camenisch et al. (2005), we view identity management as an effective solution to privacy in the learning domains. In a privacy-enhancing identity management scheme, each user participates in a variety of relational contexts by assuming context-specific partial identities and potentially many identifiers or pseudonyms. That is, given a partial context, some of the participant's personal information (or misinformation) might be made available to others as the participant's persona, and that persona would be linked to an identifier or pseudonym.

With the understanding of a context, a person needs to decide on what elements of their true identity to expose to another person so that they can maintain a desired amount of privacy. Therefore, a user's identity attributes including relevant reputation need to be grouped according to the appropriateness of context. Depending on the context, users decide which information to disclose. In that way, learners need to be able to differentiate what personal information is revealed when acting within one role from acting within another role in an e-learning environment.

We implemented Role- and Relationship-based Identity Management (RRIM) as a contextual identity management solution to privacy in the e-learning domain. A context can be presented by an assumed role and relationships built by a participant for a specific purpose. In this approach, a role-based identity hides an actor in the crowd of actors with similar roles (one of many "classmates"), and a relationship-based identity allows an actor to disclose limited information appropriate for a respective relationship (in my interactions with Alice, my pseudonym is Bob, and as Bob, I share my views on religion but not politics). Moreover, trusted public roles are assigned guarantor privileges to vouch for the identity of an actor and to facilitate usage control over disclosed information (the guarantor knows that I am Bob and that if I use another pseudonym in another context, e.g. Classmate63, that Bob and Classmate63 are the same person).

A Role- and Relationship-based Identity Management (RRIM) solution has been implemented and validated by a pilot and large-scale user study in an e-learning environment. To validate RRIM, the main research question our study seeks to answer is the following: To what extent does RRIM help e-learners maintain their desired amount of privacy while participating in learning activities? The analyses of usage data and user survey data show that the system offers privacy by providing users with control over the choice and disclosure of their identity and contextual awareness of their identity and behavior.

This paper is organized as follows. Section 2 explains in detail the notion of context in the e-learning domain. Section 3 discusses the process of negotiating identity depending on context. In section 4, we present the model for supporting privacy through role- and relationship-based identity in e-learning. Section 5 presents the implementation of RRIM in an e-learning course discussion forum. Section 6

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<sup>1</sup>"Social Networking Sites: A significant threat to online security," Mar. 15, 2007. Available: <http://www.publictechnology.net/>

presents a pilot and a large-scale user study. Section 7 describes related works and Section 8 concludes and describes future work.

## Understanding Context

Privacy is dynamic across individuals, across contexts, and across time. Privacy protects us from being misdefined and judged out of context (see Cavoukian (2002)). The amount of privacy individuals seek mostly depends on the context in which information is shared. In an interaction, two partners seeking different amounts of privacy divulge their identities differently; their need for privacy evolves from one interaction to another. For example, we seek a maximum amount of privacy with total strangers. However, based on positive experience over further interactions (as trusting relationships grow), we may relax the need for privacy within a relationship.

In this paper, we grapple with privacy issues stemming from online communication, particularly in an e-learning environment. To address privacy from the perspective of identity management, it is imperative that we capture the notion of context. We start by examining how context arises in the e-learning domain. Every learning activity stems from some purpose for its participants. In other words, one user communicates with another in a context for a purpose. For example, a learner participates in a context of “course question and answer forum” for the purpose of seeking help or offering help. Therefore, purpose is the centrepiece of a context.

Users participate in a context by assuming roles and engaging in relationships with one another for a specific purpose. In e-learning, one context cascades into other more finely-grained contexts, attaching a dimension of direction to a role. The roles acting on the most generic context are omni-directional: the most public presentation of the self of a participant. On the other hand, the roles acting on the most specific context are uni-directional: the most private presentation of the self of a participant. For example, Fig. 1 shows a user’s involvement in contexts of various granularity, “member of the **university community**” being the most generic context and “registered student providing a **course evaluation**” being the most specific context.

A role manifests itself as a set of activities assigned to an actor or expected of an actor to perform. For example, an actor in a learner role is expected to be involved in various learning activities, such as attending lectures, participating in a course discussion, taking exams, etc. A relationship involves related entities (other actors) performing activities involving one another. Interactions between actors can be heavily influenced by roles. For example, in a learning-teaching relationship, both the learner and the teacher are expected to perform according to their respective roles. The nuances of activities warranted by each role are dictated by individual relationships. For example, two learners seeking help from an instructor are likely going to present themselves somewhat differently, despite the fact that their roles may be identical.

In every context, participants of different roles form various types of relationships among themselves. Each context and all the roles or relationships therein have temporal dimensions. For example, when a student enrolls in a course, their role as a registrant of that course or their relationship with the TA for the evaluation context ends as the course ends. The notion of a relationship is dynamic as it evolves from one interaction to the next.

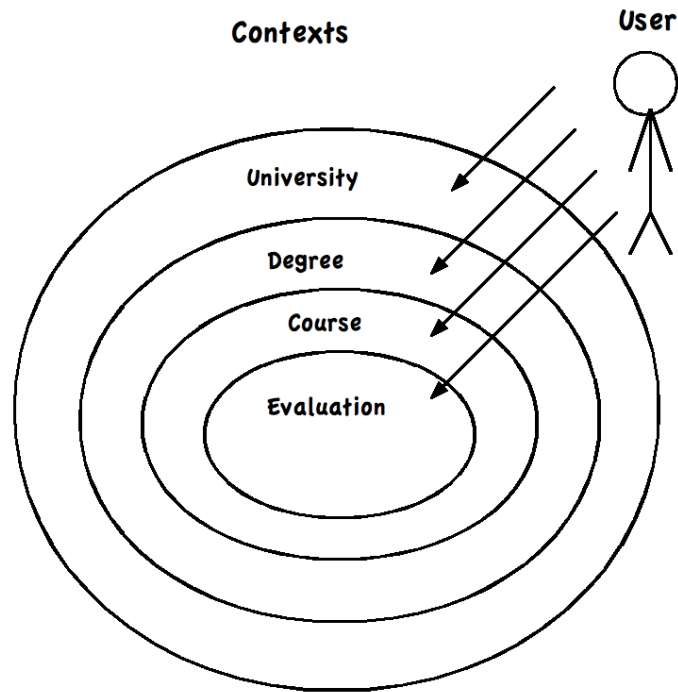


Fig.1. Contexts of various granularities in an e-learning domain.

In the RRIM model, roles of and relationships among individuals are used to capture the notion of context to address their privacy. Each context explicitly or implicitly manifests some purpose for its participants. Based on the purpose, a participant assumes an appropriate role or engages in a relationship. In an e-learning system, participants subscribe to various roles: learners, peer coaches, markers, tutors, and other learning support staff. In various contexts, each participant of an e-learning environment engages in the following types of relationships: one-to-one, one-to-many, many-to-many, and hierarchical.

In a one-to-one relationship, two participants want to be identifiable to each other and distinguishable from other participants. In a one-to-one relationship, the participants share personal information warranted by the role and purpose of the one-to-one relationship. In a one-to-many relationship, a participant wants to communicate with a group of actors (e.g., discussants in a forum) in the same manner. In a one-to-many relationship, for example, an instructor in a course wants to inform all the course registrants about course materials. A many-to-many relationship can be broken down into two one-to-many relationships: in a student-instructor many-to-many relationship, a student enrolls in multiple courses from different instructors and an instructor teaches different students in multiple courses in a semester. A hierarchical relationship serves to define a hierarchy. For example, a student in a marker role grades other students' work. An instructor working as a department head supervises other instructors.

The context of use of personal information is an important factor in making users comfortable with sharing personal attributes. The context could be formalized using purpose-based models of learning interactions, where a specific learning purpose (e.g. to evaluate a student vs. to provide help to a student) is mapped directly to attributes required to support it (e.g. student grades, learning styles, or online activity). Integrating this into an e-learning environment in an unobtrusive yet customizable manner is an important goal of a privacy-enhanced learning environment.

Therefore, it is important to operationalize "context" for building a privacy protection tool. In summary, this is how we formally define context. Let us assume the existence of a set of purposes  $P$ , a set of users  $U$ , a set of roles  $R$ , a set of relationships  $\rho$ , and a set of contexts  $C$ . We define the context assignment function  $f_c : U \times P \rightarrow C$ . The context dominance relation,  $CH \subseteq C \times C$ , captures the notion that each context may consist of more finer-grained contexts. The relation,  $RA \subseteq C \times R$ , assigns a subset of roles to each context. We could regard relationship as a function  $f_\rho : R \times R \rightarrow 2^\rho$ .

## Negotiating Identity

An identity is a representation of an individual through a dataset that holds information such as attributes (name, student number), traits (biometric information), and preferences (food choices, learning styles) (see Anwar et al. (2006)). A partial identity is a context-dependent identity model which is often published through user profiles. That is, some set of information held in a user profile, labeled with a pseudonym of some sort represents a partial identity for some individual. Each partial identity can be presented with arbitrarily many different identifiers or pseudonyms. An individual's behaviour is represented by a set of actions that the individual performs. Records of behaviour (or behaviour summaries) may be included in a user profile, and thus can become part of a partial identity.

When an observer monitors someone's behaviour with full knowledge of their identity, the actor being monitored is not afforded any privacy. On the other hand, when behaviour is observed while the

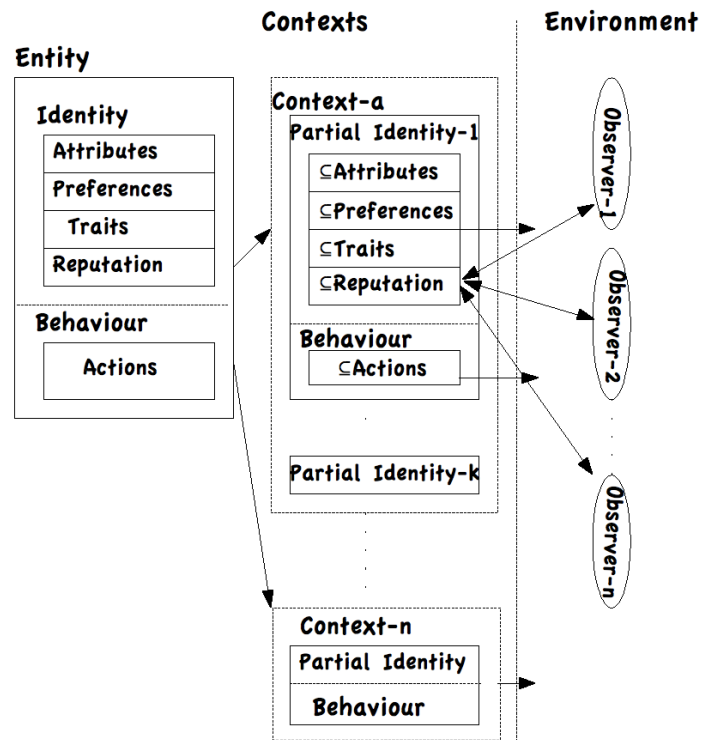


Fig.2. A Contextual Identity Model.

true identity of the actor being observed is not known (e.g., in the case of anonymous behaviour), the actor being observed enjoys privacy. In the former case, the observer can easily attribute some characteristics to the actual person being observed. In the latter case, the observer can still monitor the behaviour, but it is behaviour of a stranger. Since the observer cannot identify the person being observed, the stranger enjoys a degree of privacy. Therefore, we separate the dataset representing a person into two proper subsets: identity and behavior. For example, when Bob is seeking help from Alice, Bob may or may not only know Alice's true identity. Bob (or others Bob trusts) may have observed Alice's behaviour with or without knowing her true identity. Even though identity and behaviour are separable, a person's identity attributes (or partial identity attributes) may include information about reputation earned over the course of their behavior (cf. Fig. 2).

In line with Altman's view of privacy as contextual boundary regulation process (see Altman (1975)), our focus in this paper is to help users manage their identity contextually. Now that we have defined context (on page 3), we want to help users **negotiate their identities** among each other depending on contexts. We seek to partition identity along context, which can contribute to desired and limited disclosure which, in turn, contributes to privacy. For example, a graduate student holds multiple partial identities based on the role they play: a student, a tutor, an instructor or a marker. In the context of a course in which a student acts in a teaching role, their student id number may be extraneous information whereas in the context of a course in which that student acts in a registrant role, their employee id may be irrelevant.

## Role- and Relationship-based Identity

We introduce a purpose-based recursive notion of context for e-learning. For a well-defined purpose, each participant creates a context by assuming some type of role and negotiating some type of relationship. Each context exists until its underpinning purpose is achieved. Since each role or relationship is contextual, any role or relationship is not valid any longer than that of the relevant context. A context may spawn another more granular context, which in turn may spawn yet another context and so on. A context rewinds all its descendant contexts before it comes to an end. A participant in a context may use either their context-specific temporal (i.e. until the context lives) identity or more generic identity from any of its progenitor contexts. For example, in a Computer Science course context, a student may use their context-specific role-based identity of type "CS 100 course registrant", or the student may choose to use more generic role-based identity such as that of "computer science major", from the degree context (i.e. progenitor of the course context), or even more generally, that of "university student".

In building a role and relationship-based identity management (RRIM) system, we have identified the following tasks: identifying relevant roles for different contexts, crafting role-based identities to be used by each participant of a role, allowing each participant to assume multiple roles as they qualify and to switch between roles, facilitating the creation of relationship-based identities for roles to build justifiable relationships, and allowing a public role with guarantor privilege (e.g., a course instructor) to link historical data to their owners to thus make them accountable for their actions. A system implementing RRIM should facilitate the creation of a context for a purpose (e.g. a course context for the offering



of a course CS111), roles for various job functions in a context (e.g. a registrant role in the context of Course- CS111), and relationships for various job functions among roles (e.g. a supervisor-supervisee relationship between an instructor and a marker role).

After authentication, the system generates a context hierarchy for a user, in which each context-node corresponds to the affiliation of the user in a context. Once roles are identified (i.e. a set of tasks expected of a role to perform in a given context is grouped under a role name), a role-based identity creation involves assigning a user to a pertinent role, generating a role-term pseudonym for the user on the assumption of a role, and creating an identity dataset consisting of only role-specific information. Based on their assumed role within a context, the system should allow one user to choose an appropriate relationship with another user, help a user create a relationship-specific identity dataset, and generate a relationship-term pseudonym for the user to be used in a relationship. For providing awareness cues to a user, the system should display the hierarchy of contexts relevant to them together with their assumed roles and relationships therein.

Even though a role-based identity from one context can be used to all the descendent contexts, a relationship-based identity in one context is irrelevant in another context. For example, instead of using her context-specific pseudonym as a particular registrant of a course, `CS111registrant43`, a student may choose to appear as `cs37`, revealing her affiliation to the Computer Science department without showing affiliation with a specific course. Other enrollees of that course would not know whether `cs37` is a co-registrant in the respective course, an instructor of this course, or a student in the department who may or may not be enrolled in that course. When `cs37` seeks technical writing help from the learning centre and creates a relationship-based identity with a writing help tutor, she may choose to reveal more personal information – perhaps selecting a pseudonym like `Alice`. Due to the temporal dimension of role or relationship, any information released under a role or relationship ought to be virtually unusable for the counterpart when the respective role or relationship expires. Anytime, a participant fears a privacy threat in a relationship-based identity, the participant may abandon their respective relationship-based pseudonymous identity and take refuge in their role-based identity. The participant can negotiate a new relationship at any time and craft a new relationship-based identity.

Ideally, a relationship-based identity is constrained by the purpose of a relationship, which in turn is constrained by the context of the relationship and contextual roles of the participants involved in that relationship. A relationship should not blow the cover of a role, and the identity revealed in a relationship in one context should not be linkable to another context. Since all the participants in the same role carry a similar role-based identity, the role-based identity approach provides a degree of anonymity to the participants of a role.

Illustrated in Table 1 are the types of identities available in RRIM. Suppose RRIM is deployed in the “question and answer forum” of a course CS111. In an individual-scope identity, the discussant is distinguishable from other participants. In a group-scope identity, the discussant is indistinguishable from other members of his group. Using a context-level group identity, a discussant conveys her affiliation (or belonging) to a context to other discussants. Using role-level group identity (e.g., `a-Tutor-for-CS111`), the discussant conveys to other discussants that he is one of the many actors who function in a particular role, say a tutor who helps learners of CS111. Instead of using multiple fragmented identities, a person may also choose to use a monolithic user-level or global identity.

Table 1  
Types of partial identities and their instances.

| identity-type | group-scope                    | individual-scope                                  |
|---------------|--------------------------------|---|
| role-level    | a-Peer-Helper-for-CS111        | Joe-Helper-for-CS111( <b>relationship-level</b> ) |
|               | a-Tutor-for-CS111              | Mary-Tutor-for-CS111( <b>relationship-level</b> ) |
| context-level | a-CS111-Discussant             | Bill-in-CS111-Discussion                          |
|               | a-learner-in-CS111-Assignment1 | Alice-in-CS111-Assignment1                        |
| user-level    |                                | Bill  |
|               |                                | Marry   |
| true identity |                                | Jim Greer   |
|               |                                | Mohd Anwar  |

The creation and maintenance of so many role- and relationship- based identities may seem like daunting tasks for users. However, in an e-learning environment, contexts, roles, and relationships are relatively predictable and well-defined. In our implementation, described in the next section, context and role assignments providing a default role-based identity for each role that the user may partake in are automatically generated. The system also enables users to engage in likely relationships (determined by their assumed roles in respective contexts) and provides relationship-based identities. To help users manage their identities, the system provides awareness to users through visualization of contexts, roles, relationships and pseudonyms of them and their partners.

## Implementation

We have implemented RRIM in iHelp Discussions, a component tool of the iHelp Online Learning System. The iHelp Discussions tool serves as a discussion medium for students, markers, tutorial assistants, instructors, guests, etc. in a university course. The iHelp Discussions system has enjoyed relatively wide use throughout the Computer Science curriculum at the University of Saskatchewan. This system integrates with the existing academic role structure in courses to seamlessly support the various kinds of users (students, markers, tutorial assistants, volunteer helpers, instructors, etc.) and the permissions and needs that they have with their courses. Postings fall into categories specified by the instructor (e.g. Midterm, Module1, etc.). It facilitates context separation by providing context specific interaction categories. For example, the iHelp Discussion category under the heading of CS 350-Assignment 1 would be open only to students in CS 350 as well as the instructor, teaching assistants, and other potential helpers. Learners post and respond, seeking help and offering help, and instructors can do the same.

Previously, in the iHelp Discussion System, participants have the option of posting either anonymously, or using their real name (i.e., first initial followed by lastname), or using a self-created alias. In implementing the RRIM model in iHelp, various features are added to iHelp Discussions in order to realize the following objective: help participants manage their contextual partial identities to enhance privacy.

The added RRIM features (shown in Fig. 8) of iHelp Discussions are implemented in *Java*, *JSP*, *JavaScript*, *DHTML*, *HTML*, and *XML* that use a *MySQL* database at the backend. The implementation makes extensive use of asynchronous JavaScript (i.e., *AJAX*) and *DHTML* to realize the

interactive markup effects. In the implementation, the system plays the role of a facilitator of identity and guarantor of reputation. Henceforth, we refer to our implementation as **iHelp Discussions with RRIM**. We could categorize all the features of iHelp Discussions with RRIM into 2 categories: context creation & awareness (Fig. 3), identity creation & management (Fig. 4).



Fig.3. A tree view of contexts and roles (the upper left pane of the main Window of iHelp Discussions with RRIM (screenshot from pilot study).

We expect that different configurations of RRIM are possible based on different pedagogical purposes. Sometimes, all the participants may play just one role - their affiliation to a context (e.g., all discussants share personal experience on a particular issue). Sometimes, the same set of roles deems appropriate across contexts (e.g., addressing multiple social issues from the perspectives of a set of social roles). In the form of a pilot study (see on page 13), we formulate one configuration where discussants from one context are allowed to participate in other contexts, and each context offers a different set of roles to its participants.

In the large-scale study (see on page 14), iHelp Discussions with RRIM provides the online discussion component (see Fig. 9) of *Introduction to Sociology* course. The system creates a context for each controversial topic, addressing a social or behavioral question chosen by the instructor of the course. As per specifications of the course instructor, the system creates a set of roles for students to participate across contexts. Since there are no hierarchical relationships among these contexts, a context-level identity (i.e., a partial identity that highlights contextual affiliation) is considered redundant. As a result, the version of the system in the large-scale study does not offer context-level identity creation.

## Context Creation

In iHelp Discussions with RRIM, the system creates all the potential communicative contexts as categories of discussion. The system also creates potential roles that can be associated with each of the categories. The creations of contexts and roles are done as per specifications of the course instructor. The system assigns appropriate roles to each category and assigns fitting roles to each user so that each user may participate in a communicative context representing various perspectives of their intended role(s). The participatory contexts and roles of each user are organized hierarchically and presented persistently at the left pane of the discussion window as a tree view (see upper left pane in Fig. 8). For posting a new message or replying to a message (see Fig. 5), each user is presented with all the possible contexts and roles of their participation.

## Identity Creation and Management

A discussant can have three types of pseudonyms to represent their three types of partial identities respectively: user-level, context (or category)-level, and role-level. Both context- and role-level partial identity types can further be categorized into group-scope and individual-scope. Based on their group memberships, group-scope identities are created for discussants by the system. The system provides user interface facilities for creating individual-scope partial identities. An individual-scope role-level partial identity is better known as a relationship-level partial identity. The system also provides a user-level identity based on the true identity of a discussant. The system allows discussants to create as many user-level partial identities as they like.

When seeking more openness (for recognition or publicity), a discussant may use a user-level identity across multiple contexts. For example, *BobTheDiscussant* pseudonym, when used across multiple contexts to represent a user-level identity, allows a participant to be identified across these contexts or sub-contexts. Articulating a relationship, two discussants may use a relationship-level (self- created) identity to communicate with one another. For example, two discussants may communicate with one another as *BobTheHelper* and *MaryTheHelpee* to maintain a helper-helpee relationship.

Both the context-level and role-level identities can be represented by a group-scope pseudonym or a user-defined individual-scope pseudonym. Based on the context and role of participation, each participant is provided with pseudonyms to represent their different context- and role-level group identities. To allow user easy distinction, a group-scope pseudonym ends with a #. In the Fig. 3, *ABR#* is a context-level group pseudonym, which makes a discussant indistinguishable from other discussants in the discussion context of *Abortion*. It also provides the discussant a group identity. On the other hand, *Opponent#* is a role-level generic identity representing the discussant as a member of the group of individuals taking the *Abortion – Opponent* role.

In replying or posting new messages, discussants are presented with a list of their pseudonyms to choose from, representing all the pertinent partial identities under a given context (Shown in Fig. 5 from pilot study and Fig. 10 from large-scale study). The discussant is expected to select a suitable role or relationship partial identity for each posting or reply they make. Each posting carries the discussant's "role name" to help the readers of the posting understand the context of the posting. To help discussants identify their own postings, even when group identities are used, each of their own posting carries a (*me*)

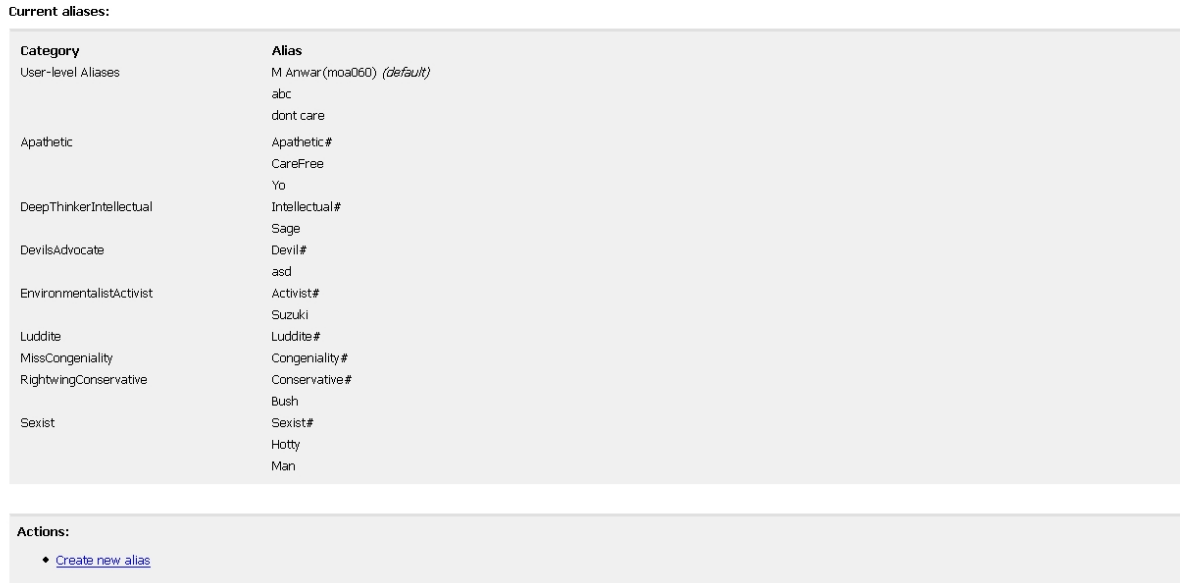


Fig.4. A sample of partial identities in iHelp Discussions with RRIM (screenshot from large-scale study).

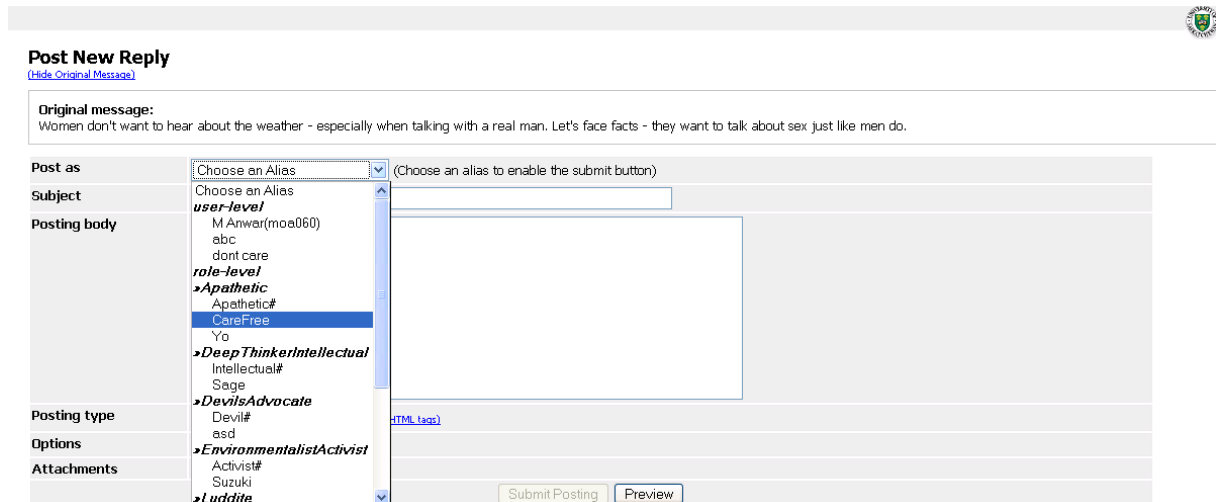


Fig.5. The reply window of iHelp Discussions with RRIM (screenshot from large-scale study).

marker next to the poster's pseudonym. When a role-level individual identity is used, the "role name" followed by a (*me*) marker is attached next to the poster's pseudonym to make the poster aware of the "role" they assumed in posting a particular message (Shown in Fig. 6). As a result, it helps participants maintain the integrity of their identities in their postings through awareness of which posting they made themselves and which postings came from others. The integrity of identity helps maintain privacy by making multiple partial identities non-linkable.

## User Study

The RRIM model was implemented as an extension to the existing iHelp Discussions tool, an online discussion forum in use at the University of Saskatchewan as part of iHelp e-learning system. The evaluation of the implemented RRIM features was conducted in a pilot and a large-scale user study. The study was approved by the local Committee on Ethics in Behavioural Sciences Research (BSC# 2001-198). In the study, the following hypotheses are tested through analyzing usage data and user interview data: (a) Understanding and awareness of context contributes to privacy-preserving information sharing, (b) Role- and relationship-based Identity management positively supports privacy-preserving information sharing.

## Pilot Study

### Methodology

In the pilot study, the system was initialized to generate seven different discussion contexts for potential controversial topics : a. Same-sex Marriage, b. Abortion, c. Tibet Issues, d. Mission in Afghanistan, e. Collaboration vs. Plagiarism, f. Schools Kill Creativity, and g. Net Neutrality. Five (volunteer) participants used our system for over a two week period, making 112 substantive postings in these seven different contexts. The participants were Computer Science graduate students who were trained to use the system in a one-on-one session. Four of the participants were male while one was female. Here are some of the suggested roles for the discussants of some contexts:

- Same-sex Marriage: Proponent, Opponent, and Gay/Lesbian
- Abortion: Mother, Doctor, Religious Leader, Proponent, and Opponent
- Schools Kill Creativity: Student, School Administrator, Professor, Proponent, and Opponent

While discussing controversial issues, many people fear being embarrassed, looking foolish, or not being accepted. One of our contentions is that role- and relationship-based identity management effectively supports self-reflection types of activities, one of the reasons why privacy is so desirable Westin (1967). All of the participants chose more than one, sometimes even quite opposite, roles on a given issue substantiating our contention.

## Result

The average number of postings made using the three different identity types are the followings: user-level = 1.17 per participant, role-level = 10.5 per participant, and context-level = 7 per participant. The participants rarely used their **user-level public** identity. The participants could not correctly guess the number of different actual people who participated in the discussion. All the participants reported that they could rarely identify which postings belonged to which actual users. This is an indication that role-level and context-level identities effectively hide user-level identities.

This study was mostly an exploratory study on evaluating the usability of iHelp Discussions with RRIM. In this study, our aim was to use the system to offer a safe discussion forum to discuss controversial issues in an e-learning setting. Furthermore, here we formulate a configuration of RRIM where context-level identities are relevant, and each context offers a different set of roles to its participants.

## Large scale Study

### Methodology

In the large-scale study, the system was used to support online course discussions of 35 students in an intensive six-week undergraduate course on *Introduction to Sociology*. The study was done in 2 phases: (1) In the first three week period, the class made 173 postings using the original version of iHelp Discussions (without RRIM), and (2) In the next three week period, they made 302 postings using a version of iHelp Discussions with RRIM features. In each phase, the participants (students and the instructor) discussed topics under eleven contexts, each addressing eleven different social and behavioral questions. Prior to each phase of the study, users were trained to use the system. At the end of the second phase, 25 participants (of the 35 who used the system) took a post-use online survey to share their use experience and their attitudes towards privacy.

Throughout the course, the participants used iHelp Discussions to explore 22 questions, 11 questions in phase 1 and 11 questions in phase 2, using their personal experience and sociological knowledge. These questions are chosen by the instructor of the course as per the course objectives. In the first phase, students used the original iHelp, which required them to use their public identities (i.e., first initial followed by last name) to post a new message or to reply to a posting. For the phase 2, discussants used the iHelp Discussions with RRIM, which allowed them to create multiple role- and relationship-level identities, provided awareness support for contexts and identities, and enabled them to rate others and query others' ratings as well as monitor their own identity-specific reputation (ratings others assigned to them). The following eight roles were suggested (and offered in the system) for the discussants (to take on) to shed perspectives of respective roles on different contexts: *Devil's Advocate*, *Right-wing Conservative*, *Environmentalist/ Activist*, *Sexist*, *Apathetic*, *Deep thinker/Intellectual*, *Luddite*, *Miss Congeniality*. In summary, across the 2 study phases, the system offered three identity choices:

1. True identity. No privacy where learners are identified. It is the default option and presented by their real name.
2. Complete Anonymity, where learners can answer the questions with the alias "anonymous".

3. RRIM supported contextual identities (see Fig. 4), where learners can answer the questions of their course assignment using RRIM offered contextual identities.

In phase 2, in addition to the true identity, the system offered three types of pseudonyms to each participant: (i) a user-level pseudonym type to represent a discussant across contexts, e.g., Sam23, (ii) a role-level group-scope identity type for each role within a context, representing the group of discussants, participating in a given role in a given context, e.g., “a Devil’s Advocate”, and (iii) a role-level individual identity type for each role within a context, representing an individual participating in a given role in a given context, e.g., “Fred the Sexist”. Since there is no hierarchical relationship among contexts presented in the phase 2, the context-level pseudonym is omitted in this study.

## Results

After the iHelp Discussions with RRIM was introduced, participants made 4.40% of their postings anonymously, 35.59% of postings using their true identities, and 58.98% of postings using role-level identities. Within role-level identities, 22.03% of postings are made using system-provided group-scope identities (e.g. *Devil#* for *Devil’s Advocate* role), where as 36.95% of postings are made using individual-scope role-based identities (a.k.a. relationship-level identities). 1.01% postings are made using user-level identities. A significant use of role-level and both group-scope and relationship-level identities underlines the significance of role- and relationship-based identity management and appropriateness of operationalizing context in terms of roles and relationships.

The participants of this study had a chance to compare the original version of iHelp with the iHelp Discussions with RRIM. The following item from the survey is an example where the survey-takers are asked to compare their use experience of the two versions: *The system enabled me to act more candidly using my partial identities (in version 2) than I would have done using a single “real identity” (in version 1)*. On this item 52% of the survey takers agreed, while 4% of them disagreed. Table 2 reports survey responses as percentages (relative frequencies) of agreement and disagreement to different likert items.

An analysis of usage data indicates a 75% increase in participation from the original version of iHelp. Table 3 compares participations in original iHelp version with participation in iHelp Discussions with RRIM version. As we know that all learners do not participate equally in a discussion, we see a high standard deviation in participation for both the original and the RRIM versions of iHelp Discussions. Moreover, privacy does not equally matter to everybody. Those who cared for privacy and felt safe participated much more than others. Fig. 7 (*x – axis* = posters from least to most, *y – axis* = number of postings) shows a significant overall participation increase in the iHelp Discussions with RRIM from the iHelp Discussions without RRIM.

Anecdotal accounts by the students and observations from the instructor also suggest that the privacy features greatly increased participation. Following are some remarks from the students and the course instructor:

“We are more comfortable participating in the 2nd version (RRIM) than participating in the 1st (original) version.”

The course instructor commented, “The quality of participation has improved in the 2nd



| Action: New posting [Go] SDC110-2 > Conversing Strangers [Next Unread]               |         |   |                         |  |
|--|---------|---|-------------------------|--|
| Subject  | Replies | Poster                                    | Date                    |  |
| Why do we typically start conversations with strangers in talking about the weather? | 6/17    | Anonymous[me]                             | Jun 30, 2008 - 3:51 PM  |  |
| Whether to talk about Weather  | 0       | Peaches(RightwingConservative)            | Aug 12, 2008 - 11:38 PM |  |
| Talking to other people  | 0       | Apathetic#(Apathetic)                     | Aug 06, 2008 - 11:47 AM |  |
| The weather is like the police service in Saskatchewan                               | 0       | The Funny Wanker(DeepThinkerIntellectual) | Jul 24, 2008 - 2:28 AM  |  |
| talking to women   | 4       | Macho Man(Sexist)                         | Jul 19, 2008 - 4:21 PM  |  |
| <b>RE: talking to women</b>  | 0       | Nicolas Chauvin(Sexist)                   | Aug 17, 2008 - 5:13 PM  |  |
| RE: talking to women   | 1       | Devil#(DevilsAdvocate)                    | Aug 08, 2008 - 4:12 PM  |  |
| <b>RE: talking to women</b>  | 0       | Little Miss Springfield(MissCongeniality) | Aug 17, 2008 - 5:08 PM  |  |
| RE: talking to women   | 0       | Devil#(DevilsAdvocate)                    | Jul 25, 2008 - 7:20 PM  |  |
| RE: talking to women   | 0       | The Funny Wanker(DeepThinkerIntellectual) | Jul 24, 2008 - 2:38 AM  |  |

Fig.6. Message List: The upper right pane of the main window of iHelp Discussions with RRIM (screenshot from large-scale study).

Table 2  
User survey response (large-scale study).

| Item  | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|----------------|-------|---------|----------|-------------------|
| Satisfied with Overall Privacy                        | 36%            | 40%   | 24%     | 0%       | 0%                |
| In-obtrusive  | 36%            | 12%   | 44%     | 0%       | 8%                |
| Satisfied with Privacy-preserving Info Sharing        | 44%            | 32%   | 24%     | 0%       | 0%                |
| Felt in Control of Identity Choices                   | 36%            | 40%   | 20%     | 4%       | 0%                |
| Satisfied with Identity Disclosure                    | 36%            | 24%   | 36%     | 4%       | 0%                |
| Act More Candidly Using Partial Identities            | 16%            | 36%   | 44%     | 4%       | 0%                |
| Found the System easy-to-use                          | 40%            | 20%   | 28%     | 8%       | 4%                |
| Found the System easy-to-learn                        | 36%            | 16%   | 36%     | 8%       | 4%                |
| System Helped Me Maintain Privacy                     | 32%            | 40%   | 20%     | 8%       | 0%                |
| Helped Me Communicate Appropriately in Context        | 36%            | 32%   | 32%     | 0%       | 0%                |
| Helped Me to Safely Disclose Info                     | 40%            | 28%   | 32%     | 0%       | 0%                |
| Helped Me to be Aware of Context                      | 24%            | 28%   | 48%     | 0%       | 0%                |
| Helped Me to be Aware of my Assumed Identity          | 24%            | 28%   | 44%     | 4%       | 0%                |
| Able to Separate my Postings from Others              | 32%            | 32%   | 28%     | 0%       | 8%                |
| Aware of Expected Behavior of Assumed Identity        | 36%            | 28%   | 24%     | 8%       | 4%                |
| Able to Link Postings                                 | 8%             | 28%   | 36%     | 16%      | 12%               |
| More Authentic in Privacy-augmented iHelp             | 28%            | 16%   | 44%     | 12%      | 0%                |
| More Direct in Privacy-augmented iHelp                | 32%            | 28%   | 32%     | 8%       | 0%                |
| Used Group Identity to Rant                           | 24%            | 20%   | 40%     | 8%       | 8%                |
| Intentionally Provocative because of Identity Choices | 28%            | 20%   | 44%     | 4%       | 4%                |

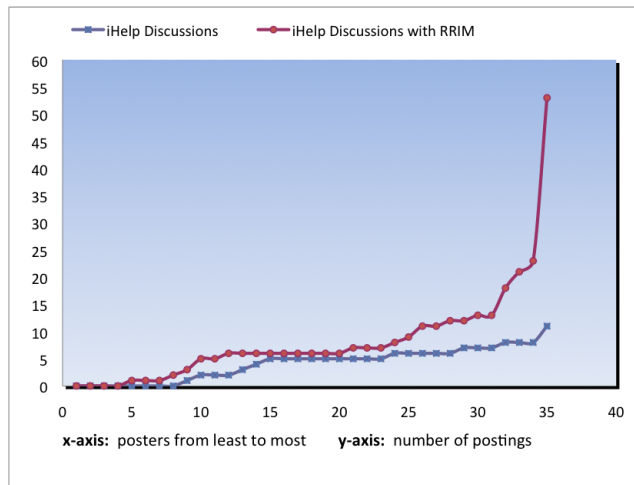


Fig.7. Participation comparison graph(large-scale study).

version (iHelp Discussions with RRIM). More open, more fun.”

“Very good idea, allows for discussion outside of class. Hope to see it utilized in other classes.”

“I found that I had to read the same postings more than once because there were different ways (different identity choices) to reply to the questions (comments).”

Table 3  
Participation comparison(large-scale study).

|                              | mean posting/participant | $\sigma$ | total posting | median posting |
|------------------------------|--------------------------|----------|---------------|----------------|
| (Original) iHelp Discussions | 4.75                     | 4.68     | 173           | 5              |
| iHelp Discussions with RRIM  | 8.44                     | 9.46     | 302           | 6              |
| Overall                      | 6.6                      |          |               |                |

The survey indicates that those who perceived that their privacy was maintained were more direct and authentic in their communication. Some of the participants who were satisfied with their privacy also experienced emotional release using their multiple partial identities. Further analyses of the survey data of Table 2 confirm our hypotheses about the relationships between privacy and each of context, and identity.

Hypothesis 1: Understanding and awareness of contexts contribute to privacy-preserving information sharing.

To test hypothesis 1, the survey takers’ levels of privacy satisfaction are considered dependent variables. This is compared against their agreement in the following two independent variables: (1) the system helped them communicate appropriately in a context, and (2) the system helped them to be aware of the context of a communicative episode. Thus we tried to predict levels of privacy satisfaction from

understanding and awareness of context. We see in Table 4 that the understanding and awareness of context contribute to privacy satisfaction.

Table 4  
Context contributes to privacy (larger-scale study).

| Dependent            | Independent                          | Coefficient ( $\beta$ ) | R-square | t    | p (acceptable < .05) |
|----------------------|--------------------------------------|-------------------------|----------|------|----------------------|
| Privacy Satisfaction | Appropriate Contextual Communication | .48                     | .54      | 2.6  | .016                 |
|                      | Awareness of Context                 | .47                     |          | 2.52 | .019                 |

The impacts of appropriate contextual communication and context awareness on privacy satisfaction are statistically significant ( $t = 2.6$  and  $t = 2.5$  respectively). Those who experience appropriate contextual communication also are satisfied with their privacy ( $\beta = .48$ ,  $p = .016$ ). Those who have greater awareness of context also are more satisfied with privacy ( $\beta = .47$ ,  $p = .019$ ). The R-square indicates that 54% of the variation in the users' level of privacy satisfaction is explained by the set of independent variables representing their understanding and awareness of context. Therefore, we can conclude that results from multiple regression in Table 4 confirm our hypothesis that the system provides adequate understanding and awareness of context contributing to privacy-preserving information sharing.

*Hypothesis 2: Identity management (awareness and control over identity) contributes to privacy-preserving information sharing.*

To test hypothesis 2, the survey takers' levels of privacy satisfaction are considered dependent variables. This is compared against their agreement in the following three independent variables: (1) they felt in control of their identity choices, (2) they were satisfied with the way the system enabled them to manage how they disclosed their identities, and (3) the system enabled them to act more candidly using their partial identities. Thus I tried to predict levels of privacy satisfaction from their satisfaction in the system's offered identity management features. We see in Table 5 that awareness and control over identity contribute to privacy satisfaction.

Table 5  
IM contributes to privacy (large-scale study).

| Dependent            | Independent                         | Coefficient ( $\beta$ ) | R-square | t   | p (acceptable < .05) |
|----------------------|-------------------------------------|-------------------------|----------|-----|----------------------|
| Privacy Satisfaction | Control of Identity Choices         | .69                     | .67      | 3.2 | .004                 |
|                      | Manage Disclosure of Identity       | .15                     |          | .81 | .43                  |
|                      | Act candidly using partial identity | .23                     |          | 1.6 | .12                  |

The control over identity choices has statistically significant impact on privacy satisfaction. Those who experience control of identity choices also are very satisfied with their privacy ( $\beta=.69$ ,  $p=.004$ ). Those who act candidly using partial identity may be weakly satisfied with their privacy ( $\beta=.23$ ,  $p=.12$ ). However, those who managed disclosure of identity are not significantly satisfied with privacy ( $\beta=.15$ ,  $p=.43$ ). The *R - square* indicates that 67% of the variation in the users' level of privacy satisfaction

is explained by the set of independent variables representing their satisfaction in identity management features.

Therefore, we can conclude that results from multiple regression in Table 5 confirm our hypothesis that the system provides adequate identity management support contributing to privacy-preserving information sharing.

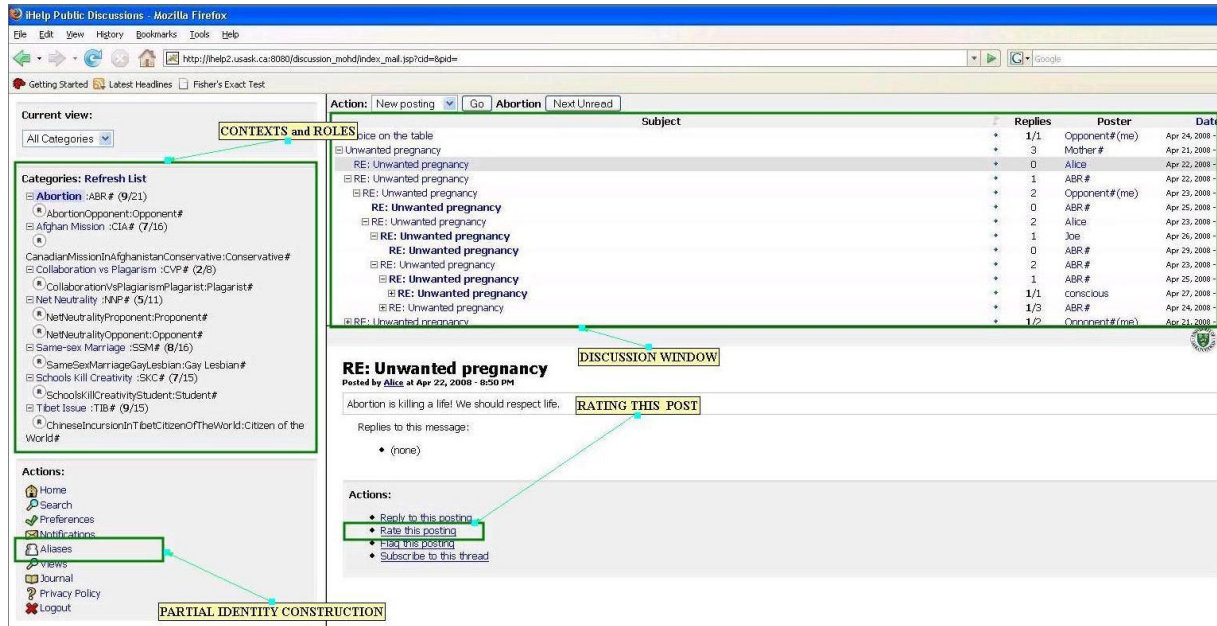


Fig.8. The main Window of iHelp Discussions with RRIM (screenshot from pilot study).

## Related Works

**Privacy concerns in e-learning** Privacy is required for personal autonomy, emotional release, self-evaluation, and limited & protected communications (see Westin (1967)). This is particularly true in the context of e-learning. Borcea et al. (2006) point out that privacy requirements are obviously important for e-learning, since they establish an unbiased environment. A learner should be able to act under different partial identities or anonymously. The separation of activities encourages learners to be unrestricted and allow them to learn without pressure. E-learning takes place in a collaborative work setting. The primary concern regarding privacy in collaborative work settings is “impression management” (see Patil and Kobsa (2003)). Since iHelp Discussions with RRIM provides context awareness, we believe that it would help discussants convey desired impressions to each other.

**Privacy and context** Altman (1975) conceptualizes privacy as a boundary regulation process, where people optimize their accessibility along a spectrum of “openness” and “closedness” depending on a

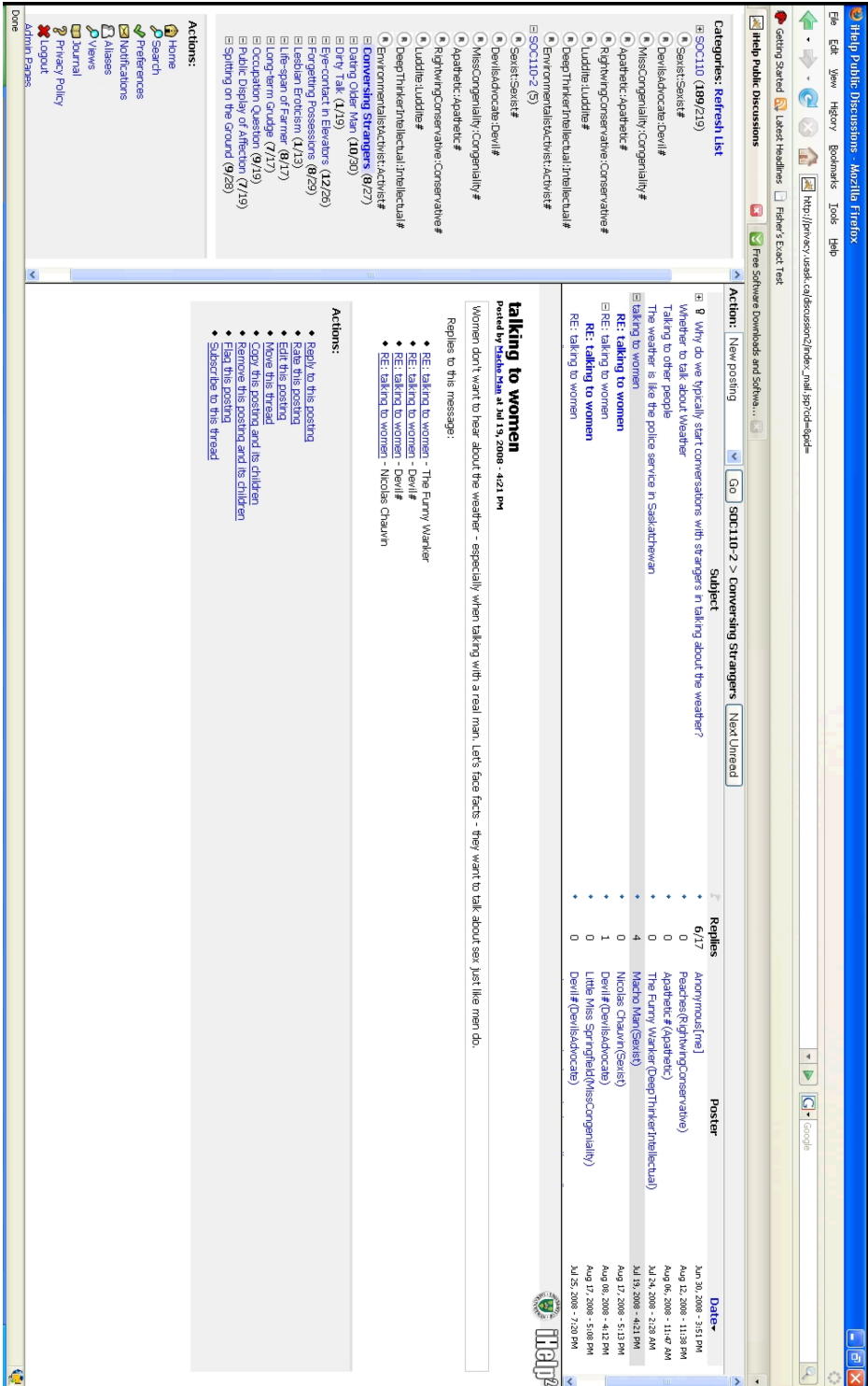


Fig. 9. The main Window of iHelp Discussions with RRIM (screenshot from large-scale study).

**Post New Reply**  
[Hide Original Message](#)

**Original message:**  
 Women don't want to hear about the weather - especially when talking with a real man. Let's face facts - they want to talk about sex just like men do.

**Post as**  
 Choose an Alias  
 user-level  
 M Anwar(moa060)  
 abc  
 dont care  
 role-level  
 → Apathetic  
 Apathetic#  
 Carefree  
 Yo  
 → Deep Thinker/Intellectual  
 Intellectual#  
 Sage  
 → Devils Advocate  
 Devil#  
 asd  
 → Environmentalists/Activist  
 Activist#  
 Suzuki  
 → Luddite

**Subject**

**Posting body**  
 (Choose an alias to enable the submit button)

**Posting type**

**Options**

**Attachments**

Submit Posting Preview

Fig.10. Reply Window of iHelp Discussion with RRM (screenshot from large-scale study).

context. According to Dourish and Anderson (2006), flows of information serve as markers of social boundaries, providing a means to negotiate, demonstrate, and sustain patterns of identity, membership, and affiliation in social groups. The goal of privacy is to achieve the desired state along the spectrum of openness and closedness. Therefore, in Altman's view, privacy is not simply a matter of avoiding information disclosure, but rather, context-dependent selective disclosure of personal information. The concerns over privacy seek a necessary balance between privacy and publicity. This balance can be achieved through maintaining the contextual integrity of information. Nissenbaum (2004) observes that information is only sensitive (or not) relative to the context and rules governing the flow of information from one party to another depending on the nature of context.

**Privacy and identity** Goffman's observations (in Goffman (1959)) that individuals reveal and conceal information selectively to maintain context-specific identity and social relationships set the stage to think about privacy in terms of identity. Demchak and Fenstermacher (2004) note that privacy is directly related to the knowledge of identity. A similar notion of privacy is manifested in the work of both Samarati (2001) and Sweeney (2002). A general doctrine of their works is to release all the information, but to do so such that the identities of the people who are the subjects of the data (or other sensitive properties found in the data) are protected.

**Identity management-based solution to privacy** Borcea et al. (2006) and Franz et al. (2006) underscore two aspects of personal data that pertain to privacy protection of learners: (a) Data parsimony-disclose as little personal data as possible, and (b) Data partitioning - partition data into partial identities. The European Future of Identity in the Information Society (FIDIS) project, investigating identity management by Jaquet-Chiffelle et al. (2006), views privacy enhancing identity management as a natural solution to privacy management online. We take the view, similar to Hansen (2008), that a user-controlled identity management system that aims at helping users manage their privacy is a key to the future of privacy. Our work is an effort towards building such identity management system.

**Suitability of RRIM** When in Role based Access Control (popularly known as RBAC- see Barkley et al. (1997)), a subject can access resources based on their assigned roles, conforming to the privileges granted to the respective corresponding role, RRIM uses the role of a communicating partner to determine the context of a communication episode. Since users in e-learning have distinct roles and each role has distinct tasks/interests (For example, Technical administrator, content manager, author, tutor, learner, moderator, anonymous user) (see Borcea et al. (2006)), RRIM is suitable for e-learning.

## **Conclusion & Future Work**

The privacy solution provided by our proposed role and relationship based identity management is two-fold: on one hand, the role-relationship initiation feature contributes to privacy by constructing contextual identity. On the other hand, forgetting of disclosed information is enforced by the following features:

disavowing a relationship, temporal aspect of role and relationship, expiration of context, and disclosure/obligation management.

An implementation of the Role- and Relationship-based Identity Management in the discussion tool of the iHelp e-learning environment was studied. A study was conducted with 25 students (actually 35 used the system) in a sociology class. These were consistent and reliable evidence, through the survey and usage data, that the system offered learners a satisfactory-level of privacy while allowing them to exchange their views (sharing information). Analyses of survey data confirm the following two hypotheses: (a) Understanding and awareness of context offered by privacy-augmented iHelp contribute to privacy-preserving information sharing (b) Identity management (awareness and control over identity) offered by privacy-augmented iHelp contributes to privacy-preserving information sharing.

The survey data also indicate that a significant portion of the participants were more direct and authentic in expressing their views in privacy-augmented version of iHelp than the original version without RRIM. Overall, the participants reported enjoying the privacy-augmented version more than the original version of iHelp. The participants of the studies found privacy-augmented iHelp to be a privacy-preserving information sharing tool. Specifically, statistical analyses of usage and survey data confirm the role of context and identity in preserving privacy. RRIM delivers privacy by contextualizing (associating each identity with a context) identity through role and relationship-based identity management. This research provides (in both the user studies) communication episodes and contexts that are rather controversial (high risk) in nature, and therefore, where privacy becomes more important.

We understand that the notion of context in other application areas like social networks are not so structured and rather dynamic. Our future work would involve operationalizing contexts in such domains so as to develop privacy enhancing identity management solution for such domains.

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