A CHARACTERIZATION OF SOCIAL NETWORKS FOR EFFECTIVE COMMUNICATION AND COLLABORATION IN COMPUTING EDUCATION

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Abstract

Recently, the use of social networking has been transitioning from the recreational to more formal uses in corporate and educational contexts. As more businesses begin to adopt social networking as a means of communication and collaboration in the workplace, the effective use of social networks by students for formal communication (as opposed to recreational or informal) becomes an imperative skill for achieving efficiency and productivity. In this paper, we discuss our experience with different social networking sites (Twitter, Facebook, and Google+) to engage learners in various computer science courses at Miami University. Based on our experience, we have categorized the strengths and weaknesses of using different social networks by looking at generic activities that happen within the workplace and then identifying how a particular social network feature supports the given activity. Specifically, our experience encompasses several different use cases including using status updates as a means for addressing technical issues, social tagging to mark areas of interest, and video teleconferencing for virtual office hours. Our observations reflect some interesting trends in academic achievement and student engagement which may have implications for future use of social networks in education and, in turn, in the workplace.

Introduction

Effective communication is critical to the success of engineers in the workplace. While formalized communication is often our focus (e.g., creation of requirements specifications and design documents, or delivery of formal presentations), informal communications (e.g., impromptu meetings, water cooler discussions, etc.) are equally important. Other forms of communication also exist, including the communication that is built into the common tasks of writing emails or status reports and the engineering tasks themselves, such as reading code or writing code comments. One emerging form of communication that has gained widespread recreational use is social networking such as Facebook and LinkedIn. With its popularity continually increasing, social networking has gone beyond sharing mundane details of one's personal life to enhancing collaboration and communication in corporate and educational settings. Indeed, the use of social networks has seen an increase in acceptance in the workforce. For example LinkedIn is widely used to maintain a list of contacts. Increasingly, social networks are being used for day-to-day communication within the workplace in order to help share expertise across an organization.

Use of social networks by students is, for the most part, focused on the recreational, as exemplified by Facebook. However, for students, effective use of social networks for collaborative purposes in the context of computing tasks and common genres of software engineering is still a work in progress. In this paper, we describe our experiences, observations, and recommendations regarding the use of social networks in the context of a computing curriculum. Our approach is grounded in two desired objectives: to provide students with increased access to technical knowledge and to facilitate communication

between different stakeholders on projects. Our experience on the use of social networks has encompassed a variety of platforms including Facebook, Twitter, and Google+. We have used the platforms on a diverse set of courses in computer science, including courses on data structures, software architectures, web services, and the senior design/senior capstone where we have provided students with learning experiences that are not only relevant in the classroom but also closely model workplace activities. Based on our experience, we have categorized the strengths and weaknesses of using different social networks by looking at generic activities that happen within the workplace and then identifying how a particular social network feature supports the given activity. We have also made several observations regarding the effectiveness of social networking in an educational setting. Specifically, we note that the degree of usage impacts academic achievement in different contexts. Although our observations are not scientific by any means, they still reflect interesting trends which may have implications for future use of social networks in education and, in turn, in the workplace.

The remainder of this paper is organized as follows. We begin with background and related work for the area of social networking including the discussion of several features as well as contextual use of the technology. Next, we discuss our experience in using social networking in support of education. We then comment on how our use of social networking translates to an industrial setting, and finally discuss lessons learned.

Background and Related Work

In general

Boyd and Ellison define social networking sites as web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system [3]. Since the advent of popular social networking sites such as MySpace and Facebook, millions of people have made status updates and virtual socializing a part of their daily routine. Aside from MySpace and Facebook, hundreds of social networking sites have come into existence, each catering to a multitude of different interests. Book lovers (goodreads), academicians (academia.edu), sci-fi fanatics (elftown), and singles (quechup) alike can engage with other people sharing similar interests via social networking sites.

Recently, there has been a considerable amount of focus on the uses and benefits of using social networking sites in both educational and corporate domains. With Facebook, Twitter, and Google+ being some of the more popular solutions, we have attempted to incorporate these particular social networking sites into different academic settings at Miami University. This section gives a brief overview of these three sites. In addition, some of the literature featured in this section highlights several pre-existing sites and custom solutions that have been used to help people make the most of their social networking experience in the workplace and education.

Facebook, Twitter, and Google+

Since its launch in 2004, Facebook has grown to include more than 800 million active users [9.] Although the service was initially restricted to university students, Facebook has welcomed users from around the world (13 years of age and older) since 2006 [18], making it the second most visited site in the world and the United States [8]. The typical amount of time spent with each visit to Facebook is almost 25 minutes, with 49 seconds spent on each unique page view [8].

Twitter was launched in July 2006, and now has more than 300 million users [20]. With unique features such as the ability to view trending topics, Twitter has become the ninth

most visited site globally and the eighth most visited site in the United States [21]. The typical amount of time spent on each visit to Twitter is roughly 7 minutes, with 54 seconds spent on each page view [21].

Google+ made its debut in June 2011 to a select body of users [15]. In September 2011, Google+ opened its doors to the public [2] and is believed to have more than 62 million users [6]. If membership trends continue, Google+ may have 400 million users by the end of 2012 [11].

In the Workplace

Despite social networking sites having a high penetration in the workplace [17], their efficacy has come into question. Concerns such as time-wasting, security, and slander may prevent public social and security networking sites from being used by corporations [17]. However, Karoly and Panis claim that there is an increasing demand for a skilled workforce that is adaptable to changing technologies throughout the course of their career [14]. In addition, Asunda claims that social networking tools help users discover, extend, manage, and leverage professional and personal experiences online [1]. Specifically, Asunda argues that social networking sites improve networking, collaboration, information sharing, and can lead to new marketing opportunities for business entities [1]. Finally, Marshall argues that companies who allow millenials (those born in the nineties and early thousands) to use social networking sites may help employees achieve efficiency and increased productivity [16].

According to Rooksby et al., many companies that use social networking sites are using systems developed by third parties [17]. For example, Proctor and Gamble uses an online community application called PeopleConnect (supplied by Telligent), Best Buy uses an employee social network called Blue Shirt Nation (based on open-source framework Drupal), and BearingPoint, Deloitte, Dow Chemical, and IBM use the SelectMinds Corporate Social Networking Solution Suite (supplied by Select Minds) [17]. Rooksby et al. also list several large organizations that have developed their own internal social networking site [17]. For example, SAP (Harmony), Accenture (People Pages), Microsoft (Town Square), Deloitte (D Street), IBM (Bluepages and Beehive), and Hewlett-Packard (Watercooler) have all developed their own internal social networking systems [17]. Although literature evaluating these particular social networking systems is limited, both Microsoft and IBM have published research identifying different trends in using social networking sites within their respective organizations.

As mentioned above, IBM Research created an in-house social networking solution called *Beehive* [5]. Similar to other well-known social networking sites, Beehive supports the "friending" of other people, provides an individual profile page for each user, and allows media sharing in the form of photo and list sharing. In evaluating user behavior and motivations for using Beehive, IBM Research uncovered some interesting trends. For instance, although professionals initially connected to close colleagues, they ultimately used internal social networking to build stronger bonds with their "weak ties" and reach out to employees they did not know. In addition, users also used the site for career advancement and campaigning for projects and ideas. Based on their experience, IBM Research noted that it is becoming increasingly important for companies to provide internal social software tools to help bridge generational gaps and keep corporate information and communication within the company's firewall [5].

Microsoft Research, on the other hand, explored the extent and nature of use of public social networking sites within the company [19]. In their case, LinkedIn and Facebook were the most heavily used by employees. Although discussions of social networking often focus on identifying benefits, they found that benefits such as locating expertise and finding answers

to questions did not manifest themselves through social networking sites. Similar to the work done by IBM Research, Microsoft Research discovered that the principal benefit of using social networking within the workplace was the strengthening of weak ties among colleagues. Despite lack of evidence supporting improved productivity and tensions experienced from mixing personal and professional connections, Skeels and Grudin anticipate rapid adoption of social networking in the workplace [19].

In Education

With younger generations being the primary adopters of social networking sites, some educators have attempted to evaluate and analyze the potential educational and social benefits of social networking. For instance, Junco et al. describe a semester-long study where they set out to determine if integrating Twitter into the classroom could impact engagement and academic achievement [13]. The study consisted of a total of 125 students; 70 belonging to the experimental group and 55 belonging to the control group. With the experiment group, Twitter was used for various academic-related discussions, including (but not limited to) book discussions, class questions, class reminders, and organizing study groups. In their analysis, they found that the experimental group had a significantly greater increase in engagement compared to the control group. Additionally, the experimental group exhibited higher semester grade point averages.

Ellison et al. also describe how Facebook can be used to increase social capital [7]. In their study, they surveyed 286 undergraduate students regarding their motivations and general behaviors in using Facebook. Unsurprisingly, they found that an overwhelming majority of participants used Facebook to keep in contact with high school friends and other acquaintances. Interestingly, they found that certain kinds of Facebook use can help students accumulate and maintain "bridging" social capital, a type of capital associated with the notion of "weak ties". Ellison et al. suspect that Facebook's affordances encouraged students to initiate communication more than other traditional forms of initiating communication [7]. In addition, they found Facebook usage was tied to psychological well-being, suggesting that it potentially could provide benefits to those experiencing low self-esteem.

Features of Social Networks

As stated earlier, social networks come in many different shapes and forms from the more specific (Foursquare for mobile-based location sharing) to the more general (Facebook). Some social networks are specifically intended to support two-way communication while others, like Twitter, are really intended for broadcast or multicast subscription-based communication. In this section we discuss a number of social media features and indicate how different popular social network systems support them. Finally, we discuss the relevancy of using those features for education.

There are a number of desirable features of social networks that have the potential to impact both educational and workplace activities. With the increased use of social networks in the workplace for supporting collaboration between different communities of practice within organizations, one of our goals is to provide students with experience using social networks within a technical context rather than a purely social one. The features of some social networks that we find most desirable are as follows:

- *Status Updates* - ability to post a message or statement that is broadcast or multicast to a set of participants in a network
- *Commenting* - ability to comment on status updates or other posts within a network
- *Positive Reinforcement* - ability to "like" or otherwise indicate approval or disapproval of some post

- *Social Tagging* - ability to mark content with keywords in order to indicate relevance to a topic
- *Linking* - ability to provide hyperlinks to content, including video
- *Video Teleconferencing* - ability to communicate with one or more members of a network via video
- *IM Support* - ability to "chat" with one or more members of a network
- *Document Support* - ability to create and share documents
- *Video Support* - ability to share video content
- *Recipient Filtering* - ability to filter which members of a network receive updates or access to content

Table 1 shows a summary of how different popular social networking sites support the aforementioned features. In particular, both Facebook and Google+ support an interactive style of communication and collaboration. Communication with these networks can be two-way. Twitter, on the other hand, is more of a broadcast medium than an interactive two-way medium. While it can affect learning [13], it is more difficult to use for collaboration.

Benefits

While we typically think of social media and social network sites as purely recreational or "social", the potential benefits go beyond establishing contacts and maintaining relationships. When used within a technical context, features such as status updates and commenting provide students (and professional developers in a workplace context) with a means for communicating about technical information, a way to identify experts in the network, finding information based on contextual needs, and directing information flow based on relevance. For instance, cross-cutting concerns such as information security can be relevant to several different projects across an organization. However, not every member of an organization is necessarily an expert nor directly involved in security issues. The social network provides a way for the security experts within an organization to share new information, experiences, and expertise across the network.

Potential Hazards

Much has been written about potential hazards of using social networks. These hazards include privacy issues and cyberbullying. In the context of educational use, much of the behavior of students is governed by acceptable use policies (AUP) although there is still a potential for abuses. In our experience, we have found that the AUP in the educational context has been sufficient for mitigating risks.

Our Experience in Using Social Media

At Miami University, we have piloted the use of several different kinds of social networking systems within courses including Facebook, Twitter, Google Plus, and Elgg (an open source social networking system). Our primary goals

Table 1. Comparison of Popular Social Networking Systems.

Feature / Network	Facebook	Twitter	Google+
Status Updates	Yes	Yes	Yes
Commenting	Yes	Indirectly	Yes
Positive Reinforcement	Yes (Like)	No	Yes (+1)
Social Tagging	No	Yes (Hashtag)	Yes (Hashtag)
Linking	Yes	Yes	Yes
Video Teleconferencing	Yes (Skype)	No	Yes (Hangouts)
Instant Messaging	Yes (Chat)	No	Yes (Google Chat)
Document Support	Yes (Notes)	No	Yes (Google Docs)
Video Support	Yes	No	Yes
Recipient Filtering	Yes	No	Yes (Circles)
Groups	Yes	No	Yes (Circles)

in using these social networking sites were to attempt to increase engagement between students, between instructor and students, and between course participants (faculty/students) and project stakeholders (customers). In addition, we were interested in moving away from e-mail as a communication medium and in decreasing the amount of repetition required to address questions or other issues that require multi-cast communication. In the past, we employed other online approaches with little success including forums and wiki pages.

There were four courses in the recent past where we employed social media to varying degrees: data structures, service oriented computing, software architecture and design, and senior design. In these courses we applied the use of an *inverted classroom model*, where lectures were recorded and provided to students outside of class, with class time devoted to hands-on learning activities, collaboration, and interaction[12,10]. In this model, students also work on significant programming assignments outside of class. The primary reasons that we employed social networks in the courses were to facilitate making announcements to students and to provide a means for answering questions outside of class. In addition, we used social networks to facilitate group work by using facilities such as Facebook groups.

Below we describe our experiences in using Google+ in the context of a data structures and data abstraction course at Miami University. Much of what is reported in this paper are observations made while using the technology and is not based on a formal framework. However, we did from the onset of the course intend to form hypotheses that could be used for a more formal study of how social networks can be used in CS education.

Status Updates as Broadcast Messages

One of the most highly used aspects of social networks is the *status update*. Typically, status updates are used to share a short message with people in your network. In the context of our courses, we used status updates for a number of broadcast purposes: ***reminders*** to students to refer to content to be covered in an upcoming class session, ***assignment*** announcements that informed students of the availability of assignments and exams, ***commentaries*** that provided insight and hints on how to complete assignments, and ***content*** sharing used to point students towards links and other online content relevant to the course. Used in this manner, the status update was a broadcast to students by the instructor. The primary difference that we observed was the ability of students to be able to engage in a conversation about the broadcasted message. For instance, Figure 1 shows a conversation that occurred after an announcement about an exam. Had such a conversation occurred over email, the clarification would have been strictly to one student. With the social network, the conversation was shared with the entire course.

In other courses, we have used Twitter to post messages to students with a hashtag to direct the message to specific contexts. The issue with this approach was three-fold: first, few students were regular twitter users; secondly, Twitter messages have a short lifetime and so historic messages cannot be readily retrieved; finally, Twitter lacks a convenient commenting mechanism, making it difficult for students to follow a thread of discussion regarding questions or other issues related to a particular post.

Questions and Comments

When students made status updates, we noticed a number of variations including **true status updates** (e.g., "I'm done!") and as a **direct messaging system** (e.g., "Can I meet with you?" and "When are your office hours?"). Used in this way, the status update was merely replacement for e-mail. The primary way that students used the status update feature was to ask questions. There were two different kinds of questions that we typically encountered: **implementation questions** and **foundational questions**. Implementation questions were

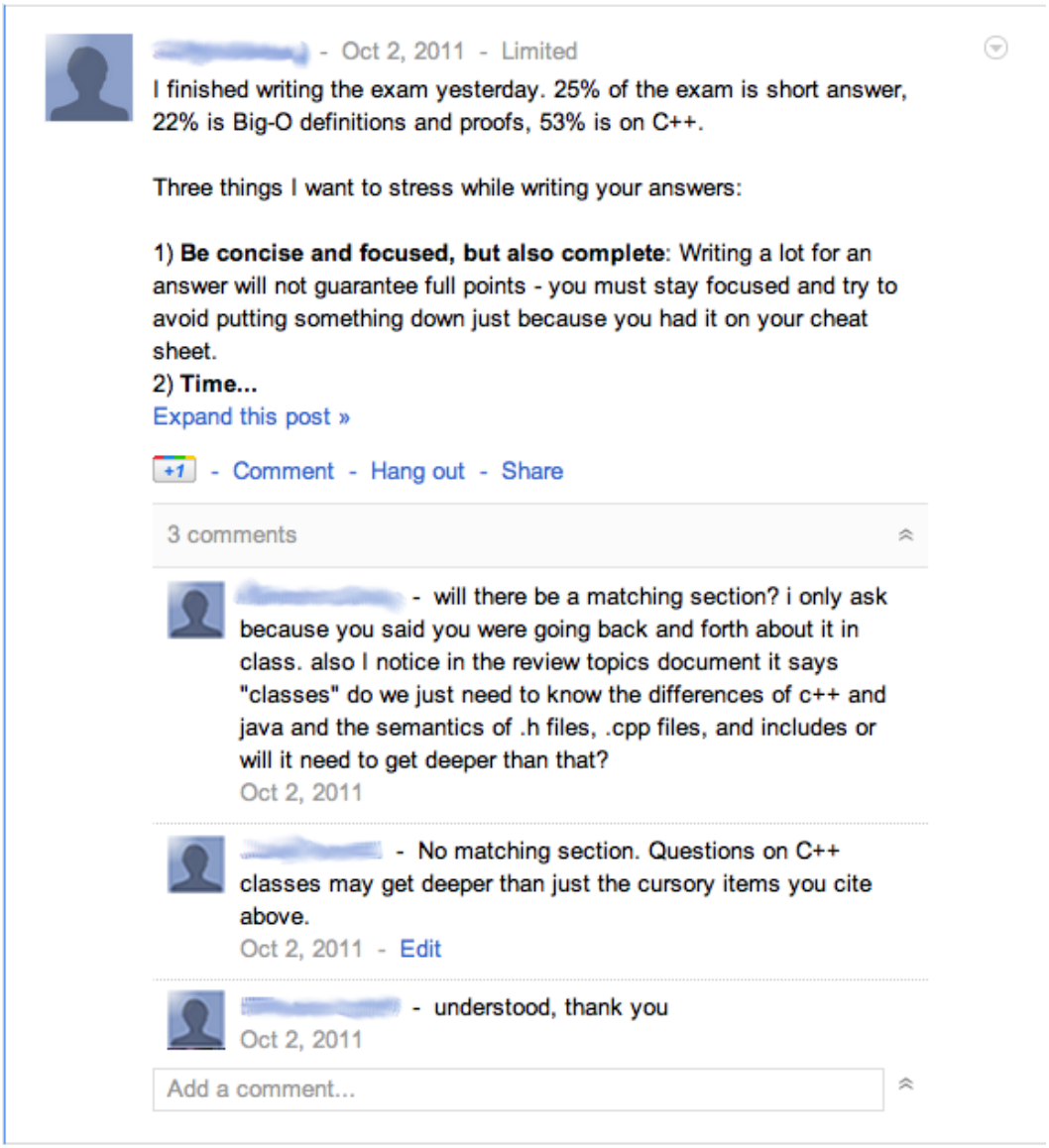

Figure 1. Announcement with Clarification Question.

typically focused upon the mechanics of completing a programming assignment including questions regarding debugging, clarification of assignment requirements, and other questions specific to an implementation. The foundational questions were typically focused on the theory of some concept as well as semantics of different data structures being studied.

Responses to questions were answered by any course participant: instructor, teaching assistant, or student. One of the most interesting aspects of the use of social media, in our experience, was the discussion that occurred in the context of the questions asked by students. Commonly, questions asked by students are questions that other students may also have but fail to ask. In addition, a widespread belief is that by explaining a concept, learners come to understand the concept better. For instance, Figure 2 shows a conversation regarding the concept of exclusive-or and difference in a mathematical bag. In the conversation, four students discussed, researched, and then validated an answer. Only then did they attempt to confirm an answer with the instructor.

Figure 2. Question and Conversation on Conceptual Content.

In our experience, we have observed a few different models of inquiry are possible within an educational social media environment. These include ask first, search first, and consult first. In ask first, the student inclination is to ask the instructor first upon encountering a problem. In search first, the student inclination is to search via Google or other search engines for a resolution to a problem. Finally, in consult first, the student inclination is to consult the social network and participants in the network for assistance. While we have not performed a rigorous study on these models, our sense is that the consult first students performed better than

the search first students as their questions are answered within a context. Likewise, the search first students perform better than ask first students as they are engaged in the learning process and are self-directing their learning. Finally, ask first students are merely seeking an answer without any exploration.

Virtual Office Hours

Status updates and comments are asynchronous forms of communication and require participants to wait indefinitely for responses from others in the network. There are many instances where immediate feedback is necessary in order for students to proceed on a project or other learning activity. In the inverted classroom model, that immediate feedback occurs in the laboratory, although there are other instances where students require immediate feedback. While synchronous communication via instant messaging and video conferencing are not necessarily limited to social networks, they are increasingly being supported by social network sites such as Facebook and Google+. For instance, Google+ has a feature called "hangouts" that allows several people in a social network to communicate via video chat. We have often provided virtual office hours during uncommon hours (evenings) using different models including one student at a time, several students at once, and with and without screen sharing (although none of the current social networks currently supports this feature).

Directed Collaboration

One activity that we used the social network for was to have students collaborate on locating and sharing information on different subjects. Specifically, we asked students to find demo programs, videos, and other online content related to stacks, queues, and other list-based data structures. The purpose of the exercise was to have students identify relevant content with the hope that the content would be useful for studying course subjects. Students found a number of different movies and demos that were posted as part of the status update stream for the course. For instance, Figure 3 shows a short conversation with links posted by students of identified content.

Group Work

In project-oriented courses, we have used social networks to facilitate two goals: facilitate communication between group members and communication with project customers. Specifically, groups (group pages in Facebook and circles in Google+) were used to restrict access to content to specific student members. As was the case with regular courses, students in project courses (including senior design) used the social network as a way of posing questions although the goals were different. In the case of projects, questions were typically focused on figuring out some technology that was being used to implement a project solution. Students also used the social network to update each other with completion status and as such the network was being used as a project management tool as well as a communication medium.

The social networks were also used as a means for sharing progress with external customers. In particular, the social networks were used to post images, demos and other content that demonstrated the current state of a deliverable and to gain feedback from customers. This was particularly useful when customers were not local to the university or surrounding areas.

Facilitating Creation of Common Artifacts in Software Engineering

Carter et al. identified a number of common genres in software engineering and how practitioners employ a number of different communication modes during the creation of the artifacts in those genres [4]. Genre in software engineering refers to categories or types of communication that occur in recurrent situations. In this context, generic situations include activities such as *definition of a software project/problem, elicitation and specification of program requirements, creation*

Figure 3. Directed Collaboration.

Table 2. Common Genres in Software Engineering [4]

Definition of a SE problem Program requirements Design document Code and comments for software Developer guide	User guide Test plan Test report Technical report Installation and maintenance documents

of a design document, and so on. Table 2 lists the common genres as defined by Carter et al. While we often think of creation of specific artifacts along with these genres, various *reading, writing, speaking,* and *teaming/collaboration* communication modes are employed. For instance, one might *read* program requirements to meet a number of goals such as determining what needs to be known to generate designs, to revise the requirements to better reflect user needs, etc.

Many of the activities that we described in this paper (posting status updates, posting and answering questions, and directed collaboration) can be used to support communication that occurs within each of the genres found in Table 2. For instance, consider Table 3, which depicts social network support for the "program requirements" genre. Posting of status updates can provide project stakeholders with information about progress of completion of a requirements document, or to communicate the definition of a requirement to a customer. Posting and answering of questions can be used to help stakeholders both elicit and refine requirements. Directed collaboration can be used to have a group of stakeholders brainstorm during requirements identification. Based on our experiences using social networks and this potential to map social network use to generic software engineering situations, we believe that students gain experience in situations that mimic activities that occur in modern software development organizations.

Table 3. Social Network Support for the Program Requirements Genre.

Genre: Program Requirements	Social Media Support for Genre
Status Updates	Completion Status, Definition of a program requirement
Commenting	Feedback on a requirement, clarification on a requirement
Positive Reinforcement	Like or dislike of a requirement
Social Tagging	Categorization of requirements into different types
Linking	Linking to resources that elaborate on a requirement
Video Teleconferencing	Synchronous, face-to-face discussion of requirement
Instant Messaging	Synchronous online chat regarding a requirement
Document Support	Definition of the requirement in written form
Video Support	Video definition or discussion of a requirement
Recipient Filtering	Filtering of discussion of a requirement to specific stakeholder groups
Groups	Collaboration by several stakeholders on a requirement

Lessons Learned

Observations

When compared to wiki sites and forums, status updates do not really provide any new technical capability. However, the main benefit appears to be that students are used to communicating using social networks and as such, the engagement with the technology offers little barrier for adoption. In contrast, we have found that forums, wikis, and other similar media have been met with a lack of enthusiasm and that students eventually went back to the default mode of communication, namely e-mail.

While experience with using a social network for increasing communication was for the most part positive, there are potential issues, especially in the potential for increased cozenage between students. However, the potential for cheating exists whether or not the social network is being used in a formalized way and as such, students will choose to participate or not participate in cheating regardless of the technology.

Part of our goal in one course was to try to completely immerse the students in the use of Google apps and Google+. Specifically, all course materials and communication occurred using these technologies except for posting of grades and homework submissions by students. While Google+ was exceptional for communication, Google apps were a bit unnatural for common learning management system (LMS) operations such as posting and submission of homework. It became clear that Google apps are not a suitable LMS.

We found that while the support for communication in the social network was excellent, good written communication skills are still paramount to successful interaction. Specifically, students that were adept at writing short, well-articulated messages were more likely to receive and give quality help. In addition, we found in order for students to benefit from the use of the social network that they had to actively participate in its usage. This observation was consistent with the findings of Junco et al. [13].

Recommendations

Based on our experiences with social networks, we have identified a few recommendations as follows:

- Establish guidelines for using social media within your course - It is useful to establish guidelines and patterns for how the social media is going to be used in a course. For instance, one guideline could direct students on how to seek answers to questions in the presence of a social network that is based on self-directed exploration and followed by consultation

of the social network prior to seeking instructor assistance.

- Define acceptable use policies - Acceptable use policies help to provide constraints to students about the kinds of discussions and assistance that can occur in the network. Defining what constitutes legitimate student collaboration versus cozenage will help identify boundaries for students.
- Model desired behavior and usage - Instructors and teaching assistants should be active participants in the social network. Answering questions, directing collaboration and inquiry should be daily activities for instructors.

Conclusions and Future Investigations

Past research has found that the primary benefit of using social networking sites in the workplace was strengthening relationships between "weak ties" [5,19], which could potentially improve one's position within a company [5]. In our experience, the principal benefit to implementing social networking into the classroom was enabling students and project stakeholders to have quick access to specific information. In having this access, students were able to leverage the skills and knowledge of their peers, thus making them more productive and more likely to enhance their academic achievement. In addition, stake-holders were able to keep abreast of project developments in an efficient manner, and give and receive feedback as needed.

In using social networks for several courses, we have learned a number of lessons through trial and error. Our use of the networks have benefited from the experience that students already have in using social networks. While we often think of social networks being recreational in nature, their potential for impacting education is clearly emerging. Clearly, our work is to date anecdotal in nature and requires further study, including surveys to track student attitudes and analysis of student work in order to determine whether there is an impact on learning. However, our experience does seem to be consistent with some of the findings reported on by Junco et al. [13]. In addition, we plan on engaging with IT professionals to determine the degree to which the mappings we have defined between social media features and software engineering genres are employed.

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