University of Michigan – Flint

Developing an innovative educational environment using Web 2.0

by

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ABSTRACT

Collaborative work has become an essential part of education, especially in higher education. Educational institutions are increasingly making use of web-based technologies to support communication and collaboration among students. In this thesis, I address the problems of complexity and inflexibility in collaborative tools provided by educational institutions, such as Course Management System (Blackboard) and the different collaborative features it provides. There have been research studies that indicated the unsatisfactory adoption rate of collaborative features in CMS by students and teachers due to the complication and inflexibility of these tools (Guidry and BrckaLorenz, 2010; Papastergiou, 2006; Rosato et al., 2007). An examination of the key features and success factors in existing collaborative tools can provide insight into the design of a collaborative tool that better addresses students' needs. First, I conducted a survey study with students in an urban university in Midwestern U.S, through which I identified the key features and success factors in collaborative tools from students' perspectives. Second, through the integration of Web 2.0 technologies, I designed and developed *U-Connect,* a dynamic and interactive collaborative tool that allows students to easily and quickly create or join groups and share their ideas, thoughts and resources with each other while working in groups. Third, I conducted a pilot study to evaluate *U-Connect* and proposed a set of additional features and design recommendations for collaborative tools to better support academic group work.

DEDICATION

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents, Adel Ragab and Mona AbdelHalim who's words of encouragement and push for tenacity still ring in my ears. My brother Sherif have never left my side and is very special.

I also dedicate this dissertation to my many friends who have supported me throughout the process. I will always appreciate all what they have done, especially Mostafa Shemis for giving me the courage to face anything in this world and Omar Aly for helping me with my web development skills.

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Thanks to my father, Dr. Adel Ragab. No one can ever replace you in my heart. Thank you for the trust you had in me and continuous support you given me.

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1. Introduction

The research described in this thesis aims to investigate the tools used by students in support of communication and collaboration for achieving group work, and to design technology to support collaborative work. In particular, I will present some of the key features and success factors in collaborative tools, which can be addressed using Web 2.0 technologies. I believe this will help designers who are working on similar tools for educational institutions. To ground this study, I will also present a prototypical collaborative tool called *U-Connect* that helps students collaborate more easily.

The motivations of this research can be summarized as follows:

1. *Students can benefit from collaboration making use of tools that let them initiate or join conversations in an easy way.*
2. *An examination of the key features and success factors in existing collaborative tools from student's perspective can provide insights into the design of a collaborative tool that meets the needs of students.*
3. *An investigation of Web 2.0 technologies and their use in higher education, and an illustration of how the integration of these technologies can help educators and designers improve user-experience and usability of collaborative tools.*

This research entails investigation in the fields of human-computer interaction and computer supported collaborative learning. In this chapter, I briefly discuss the importance of collaboration, and how it positively influences students' performance. I also discuss how existing computer-mediated communication tools support collaboration and why is it important to research collaborative tools. Next, I briefly introduce Web 2.0 technologies

and their use in support of communication and collaboration. Finally, I state the problems this research addresses.

1.1 Group work and Collaboration

Working in groups is an essential part of the learning process, especially in higher education. Weir (1992) pointed out that “students who work together on real world problems show increased motivation, deeper understanding of the concept and an increased willingness to tackle difficult questions that they cannot answer alone" (Weir, 1992). Through collaboration, students demonstrated higher academic performance than those who worked alone (Mastin and Yoon, 2013).

Computer-supported collaborative learning (CSCL) has received increasing attention by educational institutions (William and Roberts, 2002) as it showed that collaborative work helped increase students’ motivation (Resta and Laferrière, 2007), and enhance their critical thinking and cognitive skills (Gokhale, 1995). Furthermore, the increasing demand for higher education expressed by adults with different ages and needs, as well as the increasing access to the Internet from higher educational institutions, has introduced new forms of online learning for both on campus and off campus students (Papastergiou, 2006). Thus, institutions of higher education are increasingly adopting web-based technologies to facilitate collaboration and communication among students, and to help them find solutions for addressing the temporal and spatial barriers prevalent in higher education.

1.2 Tools used for collaboration

With the emergence and wide expansion of online learning and distant learning population, web-based technologies play an important role in bringing on-campus and off-campus students closer together. Allowing them to communicate and collaborate more effectively,

and to access course content in an easier, more flexible way. The aim of these technologies that support collaboration and communication is to increase student engagement and the quality of communication, and to provide them with tools that allow them to interact and collaborate effectively so that students can easily participate in meaningful discussions. To better achieve this, these technologies should allow collaborators to initiate and manage workgroups easily, and offer better accessibility and usability.

Current technologies offer a range of web-based tools that offer different features and characteristics that support collaboration. Email often serves as the main form of communication between students, such that asynchronous communication occurs through the exchange of messages. Instant messaging services offered by different organizations like, Facebook, WhatsApp, or Skype offers real-time communication, and opportunities for easy group creation. However, tools that provide this form of communication between students are rarely provided by educational institutions.

On the other hand, media sharing allows users to easily download, upload, and share a variety of documents with each other. The means of media sharing on the web range from video-sharing websites (YouTube), picture sharing (Flickr), to more general file sharing websites (Google Drive, OneDrive). The goal of providing media sharing services is to allow users to share a variety of files with each other and to allow collaborators to work on projects easily.

1.2.1 Why is it important to research collaborative tools?

Much research in computer supported collaborative learning focuses on using technology to support collaboration (Papastergiou, 2006; Haack et al., 2013). A variety of collaborative tools have been developed for supporting communication and collaboration between

students (Rosato et al., 2007). These technologies focus on helping students manage their course work (e.g. Course Management Systems - CMS), communicate and engage in meaningful discussions (e.g. Discussion boards), and also provide features to support collaboration (e.g. Blackboard collaborate). However, in practice, most of these technologies fall short in their flexibility in supporting collaboration for students to easily share their ideas (Haack et al., 2013). My interest in this research focuses on improving the accessibility and usability of collaborative tools. As a result, students can collaborate and share their knowledge more easily, resulting in an innovative educational environment.

1.3 Web 2.0 Technologies

Web 2.0 technologies offer new opportunities for communication and collaboration through a social interface that allows easy ways for connecting people, sharing and discussing ideas (Conole and Alevizou, 2010). Although "web 2.0" is defined in different ways, there is a widespread understanding that these technologies are associated with a wide set of functional characteristics within the context of computer mediated communication (Conole and Alevizou, 2010). In essence, Web 2.0 is a combination of existing web-technologies and this integration provides new possibilities for developing dynamic and interactive tools to support communication (Van der Vlist, 2007).

1.4 Problem Statement

I will address the following problems in the areas of computer-mediated collaborative learning and knowledge sharing.

1.4.1 We do not know the key features and success factors in collaborative tools from students' perspective. The adoption level of collaborative tools by students is unsatisfactory (Papastergiou, 2006; Rosato et al., 2007). A wide range of features can be

used for collaboration; however, it is important to identify the features that students need for collaboration. In order to design better collaborative tools for students, we need to identify the use of these tools, and the problems encountered with these tools. I will identify the key features and success factors in collaborative tools, as well as the ways these tools are used by students through conducting a survey study. I will design and build a collaborative tool for students that addresses their needs.

1.4.2 We do not know if the issues of flexibility and usability with existing collaborative tools offered by higher education institutions can be addressed through Web 2.0. With the prevalent use of mobile devices, platform independence and ease of use are major factors that must be considered when designing collaborative tools. I believe that improving the usability and user-experience of collaborative tools will motivate students to use them and to communicate actively with each other. To do that, I will design and develop a prototype tool called *U-Connect* that is platform-independent and provides important features desired by students for collaboration. The prototype will be a web application built using Web 2.0 technologies including HTML5 and Ajax. We do not expect this tool to address all the students' needs for collaborative work; instead, it will serve as an example collaborative tool for motivating students to collaborate efficiently, and will help us understand the students' attitudes towards these tools.

To summarize, the goals of my research are to identify the shortcomings in current collaborative tools provided to students in higher education, and to present the design of a collaborative tool that addresses their needs through an integrated Web 2.0 technology. I will present the important features and success factors for such tools, which will help designers working on similar tools. I will also present and critique a prototype tool called

U-Connect that allows students to initialize and join group discussions, and to share their knowledge, thoughts and ideas regarding a specific topic in an easy and flexible manner.

1.5 Overview of the Thesis

Chapter 2 provides a literature review on the fundamental issues of this research - collaboration and knowledge sharing, collective intelligence, and collaborative tools in higher education. I consider how effective collaboration and knowledge sharing leads to innovation and how technologies offer new opportunities for student interaction and engagement. I also discuss some of the existing tools and technologies used for group work and collaboration.

In Chapter 3, I present a survey study to investigate the use of collaborative tools by students for group work. I also present the key features and success factors in collaborative tools from students' perspective, and then the challenges and issues they encounter while working in groups.

In Chapter 4, I describe the collaborative tool prototype, *U-Connect*. I present the technologies used to design and develop this tool. I also introduce how the integration of Web 2.0 technologies helped us address issues of accessibility and flexibility. Then, I present the functionality of the prototypical tool, and how it can be used to initialize or join a group, and to interact with group members. In Chapter 5, I summarize the results obtained from a pilot user study performed to examine the functionality and design of the prototypical tool, *"U-Connect"*.

2. Collaboration and Knowledge Sharing – A Literature Review

My research focuses on collaboration and knowledge sharing, and the design of web technologies to support collaborative work. This literature review focuses on two main areas. The first area, briefly introduced in Chapter 1, is collaborative work and supporting tools. I will discuss the significance of collaborative work and knowledge sharing in achieving an innovative educational environment, and how technology can help facilitate collaboration. The second area is collaborative tools currently available to students at educational institutions. I will review and briefly discuss some of the tools that are used for supporting student-student, teacher-student, and teacher-teacher collaborations.

2.1 Collaboration and Knowledge Sharing

Studies have been conducted to examine the influence of knowledge sharing in organizations and firms, and how it can speed up the innovation process. By interacting and sharing tacit and explicit knowledge with others, an individual develops the capacity to define a situation or problem, and apply his or her knowledge so as to act upon and specifically solve the problem at hand (Nonaka et al., 2006).

Learning can be formal or informal. Informal learning is usually unstructured, and may even be unanticipated by the learner (Jubas, 2011). As such, there is an important need to provide learners with tools that support informal learning, specifically, tools that can be used regardless the situation, time, place or topic discussed. In fact, informal learning goes hand in hand, rather than isolated from, formal learning (Gikas and Grant, 2013).

Knowledge sharing and knowledge diffusion are both essential for the creation of new knowledge and innovation (Kimiz, 2005). When sharing knowledge about a specific topic or subject matter, everyone involved in the process will add a perspective of his own understanding, which provides opportunities for innovation and generation of new ideas. Establishing a communication medium through which students can interact and share their knowledge will help enhance their capacity to define a situation or a problem quickly, and at the same time allow them to apply their own knowledge to solve the problem (Nonaka et al., 2006).

2.1.1 Enhancing Student Performance

Establishing a collaborative learning environment is imperative to student learning. Through positive interdependence, individual accountability, and increased motivation, students working in collaborative environments demonstrate higher academic performance than those who work alone (Mastin and Yoon, 2013). The sharing and reuse of knowledge will speed up the innovation process and provide students with different perspectives to generate new ideas (Sanez et al., 2009; Kamasak and Bulutlar, 2010).

As such, knowledge sharing is highly encouraged in institutions of higher education. It is where students are required to make decisions in a variety of issues, from choosing the right major, to their involvement in the campus community. It is also where they learn to manage their personal networks, filter, syntheses, and use information they gather to form their knowledge, and subsequently the strategies they can purse.

2.2 Collaborative Work and Collective Intelligence

Collaboration allows collective intelligence, which is defined as the ability of a group to solve problems more effectively than any of its individual members (Heylighen, 1999). It

is essential to highlight the importance of collective intelligence and how it leads to a better outcome than any one person could achieve individually (Kaplan et al., 2010). The term "collective intelligence" is also often used to coin several web tools that aim to improve group performance, such as wikis, social networking websites, and other software programs that facilitate group collaboration (Olguin et al., 2010). The advancement in web-based technologies gave educational institutions the ability to develop better collaborative learning environments where knowledge is shared and reused resulting in the creation of new knowledge and innovation (Kimiz, 2005).

Studies showed that while students often collaborate with pre-existing social connections, they tend to use a large amount of online resources, whether to find information, or to help them communicate, coordinate and collaborate with their group members (Knutas et al., 2013). Moreover, the wide spread of online courses and distant learners have increased the need to provide students with better, more flexible collaborative tools.

2.2.1 Collaborative tools in higher education

Previous research has shown that the provision of online technologies to students has equally positive impact on student learning as supported by campus-based classes (Lockyer et al., 2001). Online learning environments are supported by research, and considered as powerful as campus-based classes (Lockyer et al., 2001; Romiszowski and Mason, 1996). A wealth of research has been conducted on the use of web-based technologies to support collaborative work. The concept of using collaborative tools for educational purposes is not new as educational institutions are increasingly trying to adopt web technologies in order to provide students and teachers with tools that can help them communicate and collaborate more effectively (Papastergiou, 2006). The Internet and the advancement in

web-based technologies enabled new forms of online learning for both off-campus and on-campus students, and offered solutions to address the increasing demand for higher education expressed by adults with different demographics and needs across barriers of space and time (Duderstadt, 1998; Papastergiou, 2006).

There are many examples of collaborative tools that were developed to allow teachers to collect data about students' understandings, whether to help them in creating instructional solutions (e.g. Content-Based Collaborative Inquiry) (Zech et al., 2000), or creating models of how students think and solve problems, then to use these models to help and guide teachers in developing instructional materials that address students' learning needs (e.g. CGI - Cognitively Guided Instruction) (Kedzior and Fifield, 2004).

Other systems, such as Course management systems (CMS), were developed to help teachers and students manage their web-based courses and to allow students to engage and interact with course content and other course members, including teachers and other students (Papastergiou, 2006). CMS offers students and teachers with tools that can be used for different purposes, like curriculum design, course delivery (e.g. course management, automated testing and scoring, grading), and communication (e.g. blackboard collaborate, discussion boards, e-mail). CMS and similar tools were found to enhance student learning and motivation, and also considered an interesting experience by faculty members (Papastergiou, 2006; Fasse et al., 2009). In the current study we are more concerned with the tools that enable better communication, collaboration, and coordination among students while working a group, and intended to help group members discuss, plan and monitor the progress of a project.

Despite the positive attitudes of teachers towards the adoption of CMS tools, several studies indicated that one of the major problems with CMS tools was the increased and significant workload that was demanded from teachers in order to learn to use CMS tools (Papastergiou, 2006; Guidry and BrckaLorenz, 2010). On the other hand, students were found to be satisfied with their online experiences and were positive with CMS tools for learning, considering it effective, helpful and beneficial (Papastergiou, 2006, Rosato et al., 2007). Students particularly appreciated the flexibility that these tools provided in terms of studying anyplace/anytime, and also the increased opportunities to participate in online discussions (Linge, 2003; Heeler and Hardy, 2002). However, students should be offered more opportunities for increased participation and interaction by means of CMS (Papastergiou, 2006; Rosato et al., 2007).

In a collaborative learning environment, the learning process takes place through group interactions. The interaction that takes place among students is one of the major components of computer-supported collaborative learning, and is vital in any collaborative learning environment (Williams and Roberts, 2002). These interactions that take place through tools like discussion boards in CMS can be fostered through the provision of flexible and challenging learning environments. Discussion boards are used as the primary medium for student interaction and engagement in CMS. In addition, CMS provides other features for supporting collaboration among students, such as Blackboard collaborate. However, studies showed that although CMS tools do support student collaboration, they still lack the flexibility needed to make this collaboration practical and user-friendly so that students can easily share their ideas (Haack et al., 2003; Rosato et al., 2007).

Web-based technologies provide powerful accessibility solutions that has transformed the way content can be accessed. However, most of these tools remain complex, limited in accessibility and sometimes challenging to use from different devices or browsers (Rosato et al, 2007). The advancement in web-based technologies offers new opportunities for improving user experience, content-accessibility, and usability of collaborative tools, through applications that are platform independent, fast, and easy to use.

2.3 Summary

In this chapter, I described the importance of collaboration and knowledge sharing among students and teachers in a learning environment, and how this helped generate new ideas and result in the development of an innovative learning environment. I then discussed how technology could help develop tools to bring students together, and to enable them to communicate and collaborate more effectively.

From the literature on collaborative tools, I described how tools provided by educational institutions, like CMS, offered helpful and effective means of communication for students to engage in meaningful discussions that were related to their course work. However, these tools were found to be unsatisfactory as they were complex and hard to learn.

In the next chapter, I will present a survey study that was conducted to help identify key features and success factors that students desired in collaborative tools. We acquire a better understanding of how students use collaborative tools and the challenges that they encounter while working on group projects. This knowledge helps inform the design of a tool to meet the students' needs.

3. Technological Support for Collaborative Work – A Survey Study

In the previous chapter, the importance of developing a collaborative learning environment was highlighted. Therefore, we aim to acquire a better understanding of the use of existing collaborative tools among students. In order to do this, we conducted a survey to investigate the tools used by students for collaborative work, and their user experience.

In this chapter, we present a survey study that was conducted with students in an urban university in Midwestern U.S. Many students indicated that it was challenging to work on group projects as existing communication and collaboration tools failed to support their group work. In particular, they found many of these tools inflexible and difficult to use. They indicated a strong preference for tools that are simple and customizable to meet their needs. Finally, we propose a set of design recommendations for collaborative tools to support group work.

3.1 Study Design

We conducted an online survey to investigate the existing technologies university students used for achieving collaborative work and the challenges they encountered with these tools. The goal is to (re)design technology for better supporting group work.

3.1.1 The Survey

A survey was created and sent to students (Appendix A). Students were asked about their experiences in their course group projects. The survey allowed us to acquire a better understanding of how online collaborative tools were used by students in achieving their respective group work.

Since the survey study aimed to investigate the respondents' experiences with existing technologies for communication and collaboration during group work, we explicitly ask questions on commonly used technologies such as email, Skype, Google Hangout, Facebook, Webinar, and the CMS used at the study university, Blackboard. The survey consisted of both closed-end five-point Likert scale questions, and open-ended questions for capturing the respondents' experiences and suggestions (Appendix A.2).

3.1.2 Data Collection

The online survey was emailed to all the students in our study university. All the respondents were entered into a draw for one of twenty-five gift cards of $20. Ninety-eight students completed the survey.

3.1.3 Data Analysis

The closed-ended questions were analyzed using descriptive statistics. The open-ended questions were analyzed using an inductive approach from grounded theory through open coding by identifying, naming, and categorizing themes found in the descriptive narratives.

3.2 Findings

We received survey responses completed by students from 18 different disciplines. 71% of the student respondents were between 18 to 30 years old, 18% were 31-40, and only 10% were 41 and older. Hereinafter, we use "group work" to refer to both students' group projects and collaborative scholarly work for simplicity.

3.2.1 Group collaboration experiences

Fifty-two percent (48/98) of the students have participated in at least three group projects and 33% (30/98) participated in more than five group projects over the last five years. A majority (82%) of the groups that the respondents have engaged in ranged from 2 to 4

members while no one has worked in groups that consisted of more than 7 members. Only 2 students had no prior group work experience. While most of the respondents met in person when working in groups, 38% (36/98) students collaborated with distant learners or online students in their group projects. Nineteen percent of the respondents communicated with their group members once a week, 59% at least 2-3 times a week, and 16 % on daily basis.

3.2.2 Preferred Tools for Communication

All respondents were aware of the social media technologies and collaborative tools currently available. In particular, 96% respondents have been active users on Facebook for more than 2 years.

Not surprisingly, students (75%) preferred using Email and other communication tools (e.g. Discussion board, or Facebook) to speaking over phone for communicating with their collaborators. Specifically, email was the primary communication channel for most respondents (75%) for asynchronous communication. For synchronous communication, they typically used video-conferencing tools like Skype and file sharing tools like Google Docs.

Although Facebook was the second most preferred tool for conducting group work because of the ease of creating closed groups and the associated group messaging feature, 77% of the respondents added that they typically used Facebook to get updates on their existing friends only.

3.2.3 Key features supporting collaborative work

We also identified what these tools were used for and important features and success factors in the collaborative tools asked in our survey. Our respondents used these

collaborative tools to discuss the project plan (47%), to track the project progress (30%), and to write reports or create presentations (20%).

File sharing and group messaging were the most frequently used features among our respondents as these features helped them “send links and messages to group members fast” and made it easier to “share thoughts and ideas about the project” with all group members.

Visual appeal and ease of use were the highest rated elements in all tools selected by all the respondents. In addition, respondents were concerned with the availability and ease of multi-party connections in any tool they use for collaboration.

3.2.4 Challenges encountered with existing collaborative technologies

Two key technological problems identified in the collaborative tools in our survey were version incompatibility (30%), and loss of connection (20%), but 50% of the respondents did not encounter any problems.

We also identified a variety of problems with the current CMS collaborative tools as follows:

- **Lack of user-friendliness**

It was repeatedly mentioned in the responses that one of the major problems with university collaborative tools is the hardship that students go through in order to learn how to use them. Students found university tools like blackboard and discussion boards to be very useful, but complicated and sometimes “horribly difficult to figure out”. They mentioned that most of the problems they faced were due to user errors. Students mentioned that they rarely use the tools in blackboard due to the additional workload required in order to learn how to use them. They preferred sticking to the traditional tools which they are more

familiar with like Email or Facebook. Responses showed that students are more concerned with tools that are easy to use. This is consistent with what we stated in the previous chapter about the unsatisfactory adoption of CMS tools by students and teachers.

- **Platform dependence hinder ubiquitous access and communication**

As students preferred using university tools, such as Blackboard, for communicating with their group members, they found it "clumsy" and inflexible. The respondents found it challenging to use these tools, as these tools were found to act differently depending on the browser or the device they are using. Some respondents also mentioned that "it was challenging to get everyone to use the same tool" and that they faced problems because "some members did not have a particular program and were reluctant to add it to their devices". Respondents were concerned with the "ubiquity of service" and the ability to use these tools regardless the device they are using. It is important to consider the level of accessibility and flexibility provided by these tools, and its role in motivating students to use them.

- **Difficulty of group creation and coordination**

Many students mentioned that they found it challenging to set responsibilities to each one in the group and to track the progress of the project. One of the major issues that students had was not being sure that "all group members are on the same page" and that everyone in the group gets the same information. The respondents were concerned with the process of creating or joining a group, and tracking the progress of the project. They tend to lean more towards tools that provide the simplicity of group creation, such as Facebook. The results show that students are looking for a tool through which they can "easily communicate with group members", "discuss plans", and "quickly share thoughts, ideas,

links" regarding a specific topic or project. They also found it hard to organize and set clear responsibilities to each of the group members, in order to make sure all group members are aware and doing their tasks.

3.3 Discussion

The main goal of this particular study was to identify the key features and success factors in collaborative tools from students' perspective. We aim to understand the challenges that students go through, as well as the purposes they would use a collaborative tool for. Our results provide some of the features and factors that became our user-centered requirements, and helped narrow our focus to better address student needs while planning the design of the prototype.

There are other online tools available for communication and collaboration in the market, however, students prefer using tools provided by the university for their course work or for communicating with other students on or off campus. Students tend to separate technologies they use for their personal needs from the ones they use for university work. As mentioned by some students, they prefer using tools like Facebook for personal purposes and not for university related work. Furthermore, some students found it hard to select one tool that all group members would be willing to use. Sometimes students did not have a particular software or were not current users of the selected tool that was used by their group members, which made it harder for them to equally communicate and coordinate with each other. This highlights the importance of providing students with tools through their educational institutions, and being focused on addressing their needs for effective communication.

3.3.1 Design Implications

In our study we identified several important features and factors in collaborative tools, which have a significant relation to encouraging and motivating students to use them. Many of the identified features and factors can be addressed by existing web technologies.

The results imply several important characteristics in collaborative tools that plays an important role in motivating students to use them. We also discuss the features that were suggested by participants in support of helping them collaborate more effectively.

To provide an easy to use interface. Students enter higher education with different levels of computer competency (Williams and Roberts, 2002). It is important to keep the student's abilities into consideration while thinking about the design of tools for students. Some students may not have the knowledge to use many of the tools that are made available for them by the university and some find them difficult to use. This puts responsibility on educators and educational institutions to provide students with tools that are easy to use in order to encourage them to use these tools.

Two of the main problems with collaborative tools were the complexity and inflexibility of these tools. Despite the continuous efforts by educational institutions to provide students with tools to help them collaborate and work together, many of these tools show high level of complexity in creating groups and the ability to bring all group members together (Rosato et al., 2007). This problem can be addressed through the design of a user interface that allows easy user interaction, without the need for additional workload on students in order to learn how to use.

To support platform independence. We agree that "an evidence based understanding of student's technological experiences is vital in informing higher education policy and

practice" (Kennedy et al., 2008). People are increasingly using smartphones and tablets for accessing the Internet, not just desktop and laptop computers. Previous studies discussed the advantages of using mobile devices by students in support of informal learning (Kukulska-Hulme et al., 2011; Traxler, 2010). These studies showed high adoption rate of the use of mobile devices by students, and how students acquire their own personal technologies for learning. Therefore, when providing tools to help them collaborate, it is important to make sure that these tools are optimized for all these devices in order to provide better user experience.

The survey results indicated that students are more interested in tools that can run regardless the device they are using. Many of the collaborative tools made available for students by the university are designed to support effective communication, but in our opinion lack accessibility and readability from different devices due to the excessive zooming and scrolling needed to navigate the content. Tools like CMS and websites like Blackboard, need to be optimized for all these devices in order to provide better user experience and content-accessibility (Mohorovicic, 2013).

Our study results suggest some features that are listed because they help students communicate with each other and manage their group work.

To support easy group creation. Many participants suggested that the process of getting people together and initializing the group is the most challenging. Students prefer using tools that allow easy group creation and that can be easily accessed by other students. There is a need to provide students with a communication tool that gives them the ability to initialize a group or discussion and that can be accessed by all members of the campus community. This will allow students to easily create or join group discussions, without

having to spend time searching for external tools that might be accessible to some and not to others.

To provide a forum for easy sharing of thoughts, ideas, and resources. The results showed that students are looking for a place where they can share ideas and thoughts with their team members. A medium where they can post something that can be seen by all group members.

To support file Sharing. Most participants mentioned file sharing as the most preformed task while collaborating with each other. This allows them to share documents, photos and other media files with other group members. File sharing is very popular, and considered an important form of communication especially between scholars.

We would like to point out that there are some limitations to the work presented here. One of these limitations is that we have collected data only from students. However, a deeper comparison of both student and teacher responses could have given additional insight. The survey could also have asked how these features and elements can answer respondents' group communication needs, but this would have made the survey heavier than needed to answer to our research goals.

3.4 Summary

This chapter presented a survey study to help us identify the key features and success factors that are needed by students for collaborative work.

From the study we determined a set of important features to be supported in our design. These features can be categorized into three points:

- **Group Creation:** ability to create and join group discussions in a fast and easy way.
- **Forum:** a place where users can easily share ideas, thoughts, and resources.

- **File sharing:** ability to share documents, photos and other media files.

The key factors in collaborative tools as identified by students include the following:

- **Simplicity and ease of use:** design a user interface that is simple enough to be used without the need of prior training.
- **Platform independence and flexibility:** improved user experience and content-accessibility regardless the device or browser used to access the tool. The ability to easily interact with the tool from different devices.

These features and success factors acquired from the study provide some clear directions for guiding our prototype design. We expect that they also provide some insight for other designers of similar tools.

In the next chapter we will briefly discuss the design of our prototypical tool *U-Connect* by integrating some of the existing web technologies that can be used to provide students with the features that support their collaboration while providing opportunities for enhanced user interaction and addressing characteristics like platform independency and ease of use.

4. U-Connect Prototype Design

In this chapter, I present the design of a prototypical collaborative tool, U-Connect, to allow users to easily create groups and share ideas and thoughts while collaborating in group work. U-connect aims to address the weaknesses in existing collaborative tools identified in our survey study presented in Chapter 3. I first discuss the technologies used for the implementation of U-connect, and how the use of advanced web-technologies can help improve user interaction, accessibility and usability of the tool. I then present the design of the prototype. Finally, I illustrate the functionality of the tool and how it can be used for group work.

4.1 Technologies used for prototype development

Existing web technologies can be integrated for the development of fast, easy to use, and platform-independent web applications such as U-Connect which allows students to easily and quickly share their ideas and thoughts related to a specific topic or group project. A brief review of the web technologies that I used for developing this collaborative tool with improved accessibility and usability is presented in this section.

4.1.1 Evolution of Web Technology

The advancement in web technologies facilitated the development of the technological environments within which modern education operates. Five technological trends were suggested to have significant impacts on education (De Freitas and Conole, 2010):

- The shift towards ubiquitous and networked technologies
- The emergence of context and location aware devices

- The increasingly rich and diverse forms of representations and stimulatory environments
- The trend towards more mobile and adaptive devices
- The global, distributed technological infrastructure

Web 2.0 has a great potential in propelling towards these technological trends.

4.1.2 Web 2.0 Technologies

There is no single or precise definition for Web 2.0. Grossech (Grosseck, 2009) defined Web 2.0 as "the social use of the web which allows people to collaborate, to get actively involved in creating content, to generate knowledge and to share information online", which is likely the most relevant definition to the current research. Every day new practices are emerging, such as sharing of images, videos and documents (YouTube, Google Drive), and also new mechanisms for communication and collaboration through blogging and social sites (Twitter, Facebook). Web 2.0 provides easier and faster access to information. It provides strategies and opportunities for collaboration, and for sharing experiences and resources, while keeping the creation of digital content a simple and easy process. Web 2.0 offers new ways of connecting people to share their ideas and to engage in discussions.

Web 2.0 technologies were selected for the implementation and development of U-Connect because they are different from the old web that we know in several ways. Web 2.0 facilitates flexible web design, provides a rich and responsive user interface, supports collaboration and helps gather collective intelligence (Conole and Alevizou, 2010; Crook et al., 2008; Murugesan, 2007). It allows users to both access the content from a website and contribute to it. It also allows developers to easily and quickly create web applications that are focused on content creation and modification (Murugesan, 2007). Through Web

2.0, the innovative usage and integration of existing web technologies, such as HTML5, CSS, AJAX, have provided web applications with enhanced accessibility and significantly improved user experience (Van der Vlist et al., 2007).

4.1.3 Web 2.0 for Education

Other definitions focused on different Web 2.0 platforms and their emerging role in transforming the teaching and learning process as an effective tool for telling stories (Alexander and Levine, 2008). Universities are making use of such web-based technologies to support collaborative work among their students (Haak et al., 2003; Conole and Alevizou, 2010; Crook et al., 2008). Web 2.0 technologies are increasingly getting embedded in educational systems, in support of both teaching and learning.

In higher education, the work of students is being seen as more collaborative in nature, and there is an increased emphasis on the need to provide ubiquitous, just-in-time, augmented and informal learning, which lead to the adoption of new technologies (Johnson et al., 2009). Engaging students in content creation and providing them with the needed support is very important for developing a student centered environment (Valk et al., 2010). A study that took place in three different universities to evaluate the use of Web 2.0 technologies in higher education found that there are potential learning benefits from student content creation and sharing (Bennett et al., 2012).

Web 2.0 technologies have been implemented to help support communication among people, and their power is being capitalized by different industries, ranging from entertainment to retail and marketing. However, there is one particular industry that is best suited to adapt to these new technologies – institutions of higher education (Rosmala,

2012). The effective use of Web 2.0 technologies can help enrich both formal and informal learning.

4.2 Design Rationale of U-Connect

U-Connect aims to provide a simple, clean, platform independent interface to help users to navigate through different groups/discussions where they are current members, and to share their ideas, thoughts and resources.

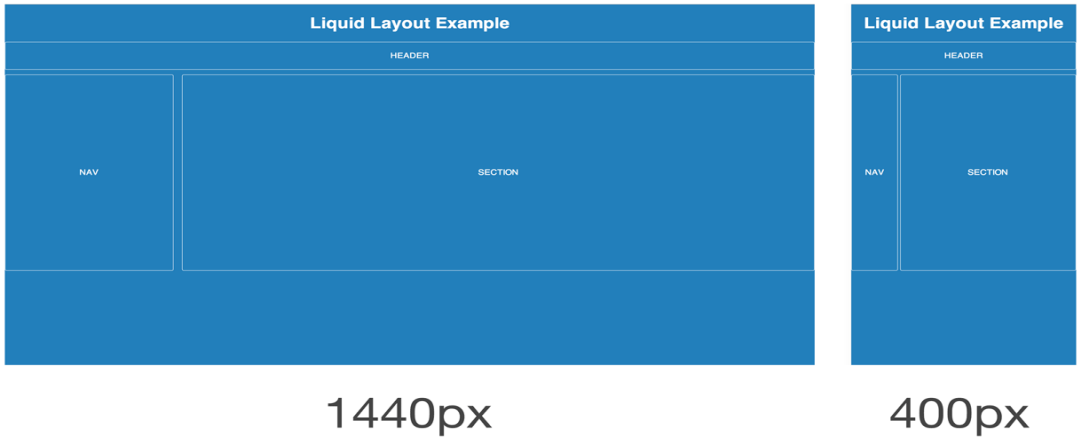
4.2.1 Responsive Web Design

In addition to desktop and laptop computers, smartphones and tablets are increasingly used by students for information retrieval. In particular, accessing web-based applications are prevalent. Thus platform independence, which is one of the most important characteristics that highlight Web 2.0 tools (Conole and Alevizou, 2010), must be considered in the design of web applications to allow users' access on any device.

U-Connect is designed as a web application that can respond to different devices and screen sizes. We used responsive web design which is considered "the only durable, flexible and future-proof approach to building websites for today's multi-screen world" (Savitz, 2012). The implementation of responsive web design helps in developing content focused, platform-independent websites. New web standards like HTML5 and CSS3 provide the ability to design and build websites that can respond to different contexts and device capabilities (Gardner, 2011). Ethan Marcotte (Marcotte, 2013) explained that responsive web design aims to combine HTML5 and CSS3 capabilities to provide a website architecture that would adapt to screens of any size. As such, responsive web design can provide websites with the flexibility to adapt to any device (Mohorovicic, 2013).

- **Fluid Layout**

One of the major elements of responsive web design is the fluid layout that uses a flexible grid, which ensures that a website can scale to any screen or browser size. In fluid layouts all components of the page have percentage widths, and thus adapt to the available space on the user interface, providing increased content accessibility (Marcotte, 2013). It automatically scales and adjusts content to various screen sizes (Figure 1, and 2), which helps achieve readability and navigation on any device with minimal resizing and scrolling (Mohorovicic, 2013).



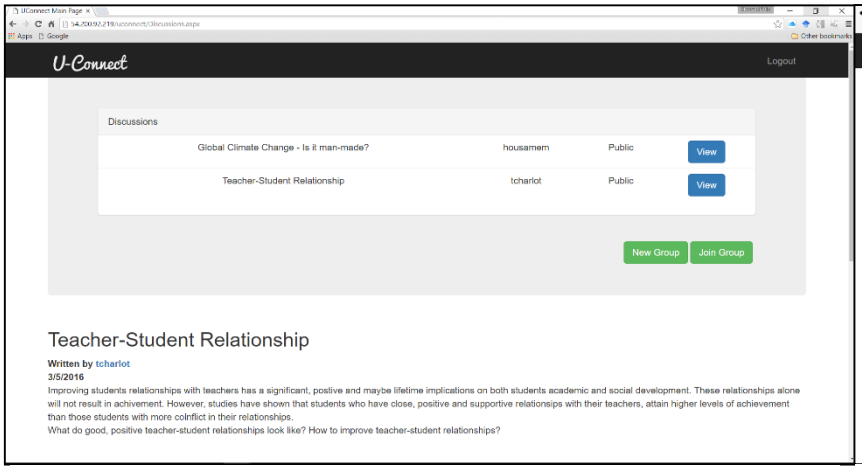


Figure 1: Main Page- Desktop Computer

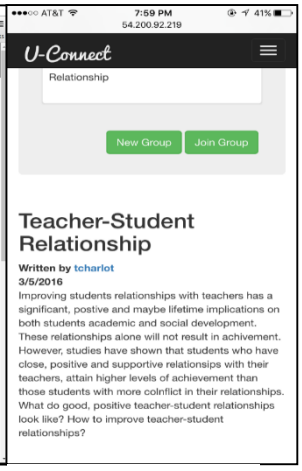


Figure 2: Main Page – Mobile Device

However, one of the biggest performance problems with using responsive web design is the slow loading that happens due to the over-downloading (e.g. extra CSS download, downloading and shrinking content) (Mohorovicic, 2013). This issue may be addressed by reducing page size and HTTP requests to allow faster page load and better performance (Mohorovicic, 2013).

4.2.2 Development Approach

I used AJAX which is made up of Asynchronous JavaScript and XML (Van der Vlist et al., 2007; Murugesan, 2007) as a development approach to address the page loading problem for the development of responsive web application discussed in the previous section. The use of AJAX enriches user interface, making it highly interactive and more responsive (Murugesan, 2007).

- **Single-page application design**

U-Connect is a web application that has a single-page application design, to provide a more fluid user experience. All tasks take place within the same HTML page, while only changing the content of the elements (e.g. sections, divisions, forms) on the page in response to user interactions. These elements get populated with the data requested from the server through an AJAX engine. This allows easy and fast interaction with the website, eliminating the start-stop-start-stop nature of interaction with websites (Garett, 2005).

AJAX, which is an essential part of Web 2.0, is composed of an integration of technologies (HTML, cascading stylesheets (CSS), JavaScript and XML) to provide real-time, asynchronous access to documents on the server (Van der Vlist et al., 2007). AJAX minimizes the amount of data that need to be transferred between the application and the server. It exchanges only a small quantity of data with the server, so that the entire page

does not have to reload each time the user requests a change, thus resulting in faster page loading and better performance. This makes web pages more responsive and enhances user interaction.

Traditionally, every time a user interacts with a website, it triggers an HTTP request to the server. The server then processes it, retrieves the data, does some calculations, and then returns an HTML page to the user. During which, the user is waiting for the refreshed page to load. This approach presents the basis for web applications. However, it does not make a great user experience. Studies showed that users expect a web page to load in less than 4 seconds (Mobile User Survey, 2014). The use of Ajax has significantly improved user experience by allowing user interaction and the ability to exchange data with the server without having to load a new page (Garett, 2005). The application of AJAX eliminates the delay of user interaction while processing server requests through providing an intermediary stage between the user and the server. Instead of loading a new webpage, an AJAX engine written in JavaScript is loaded by the browser. This engine is responsible for communicating with the server, allowing user interaction with the application to happen asynchronously and independent of the communication with the server (Garrett, 2005). Instead of triggering an HTTP request for every user action, a JavaScript call to the Ajax engine takes place. The AJAX engine then asynchronously handles actions such as data editing in memory, data submission for processing, loading of additional interface code, or retrieval of new data using XML, without delaying user's interaction with the application. The complete webpage-HTML, CSS, and other media-does not need to be downloaded and reloaded each time new data are requested from the server. Therefore, the use of AJAX

reduces the number of HTTP requests, and the amount of data transferred in each server request, resulting in a better performance and enhanced user experience.

4.2.3 User interface design

U-Connect allows users to login with their email address in order to be able to access their main page (Figure 1). U-Connect provides a simple one-stop design, where all user interactions occur without changing the page or reloading a new page. This eliminates the delay that happens while the data retrieval from the server is taking place, because the user can continue to interact with the web application and the requested information will be processed with the responses from the server, updating the page as it arrives.

4.2.4 Functionality of U-Connect

In the current prototype design, we focus on the features that are designed for supporting group-based and project-based collaboration.

- **Creating a group discussion**

U-Connect allows users to easily and quickly create a group discussion. It allows users to enter information about the group they wish to create (Figure 3). Each group discussion consists of a title, author, outline/body, date/time of creation and privacy settings (Public or Private). Users may choose to create a public or private group/discussion. Private group discussions are required to be assigned a password (Figure 3).

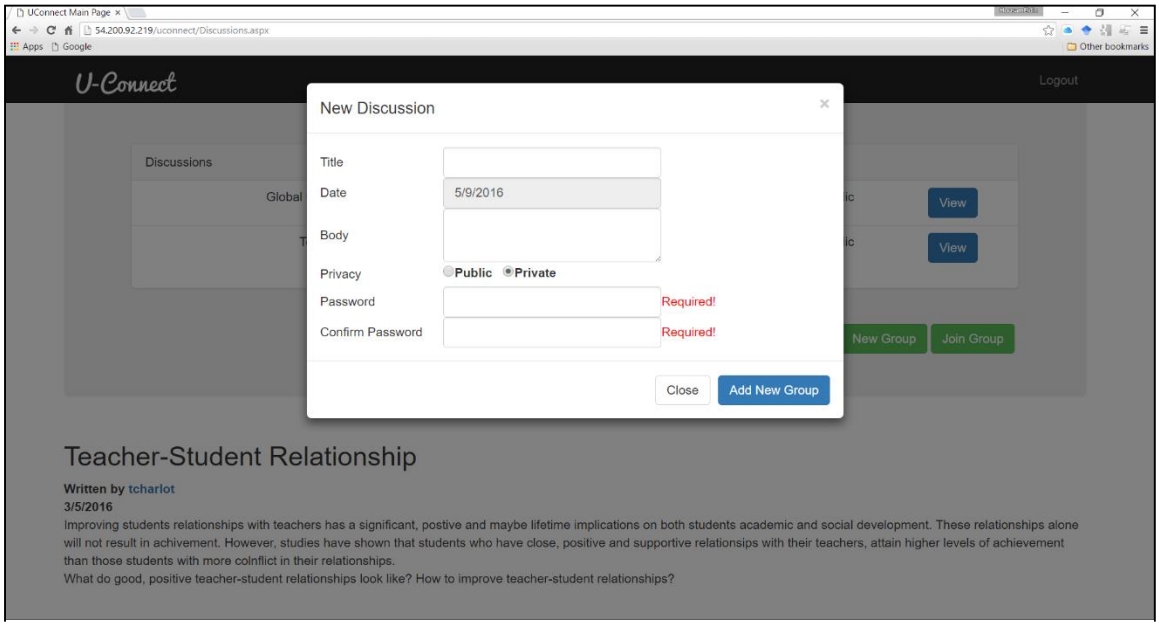


Figure 3: Create a group

- **Joining a group discussion**

The application allows users to navigate through the list of all existing group discussions. The list shows each group's title and privacy setting, from which the user can select the group they wish to join (Figure 4). Only if the privacy setting of a group is "Private", then the user is required to enter the group's password in order to be able to gain access to the group information.

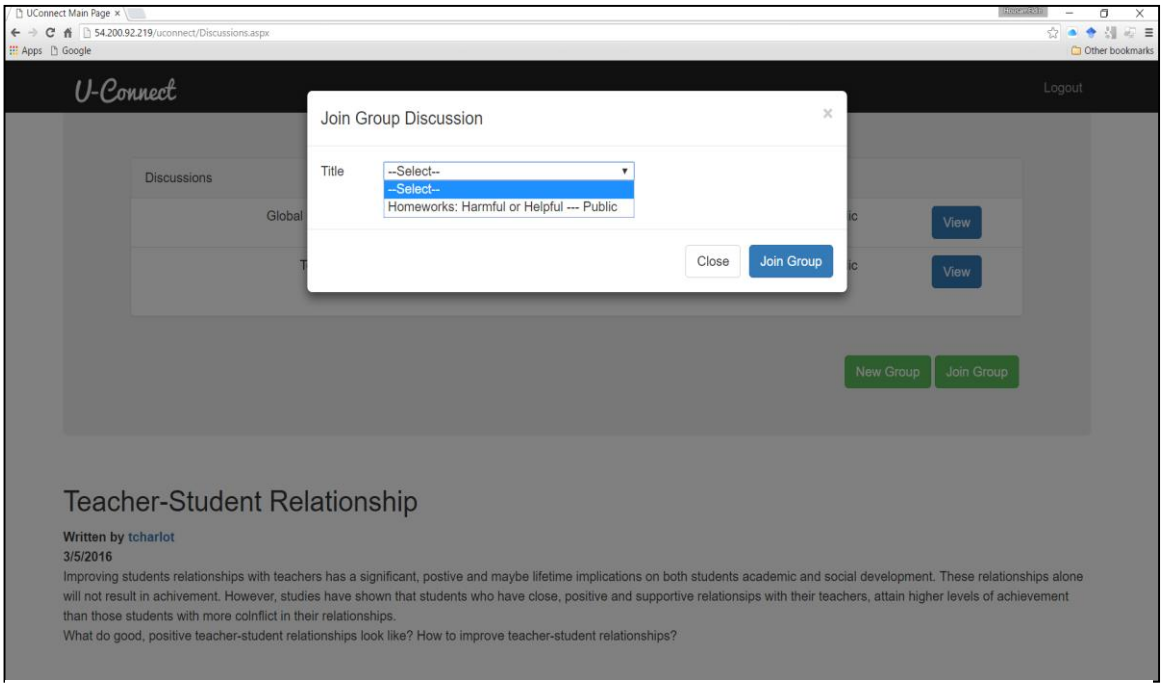


Figure 4: Join a group

- **Navigation between group discussions**

U-Connect allows users to easily navigate between group discussions where they are active members. It displays information about the selected group (Figure 5), including "Notes" shared by all group members. The tool allows seamless navigation between different group discussions without having to reload a new page or delay the interaction with the application. Selecting a group discussion only changes the content displayed on the page to be the information related to the group discussion that was requested.

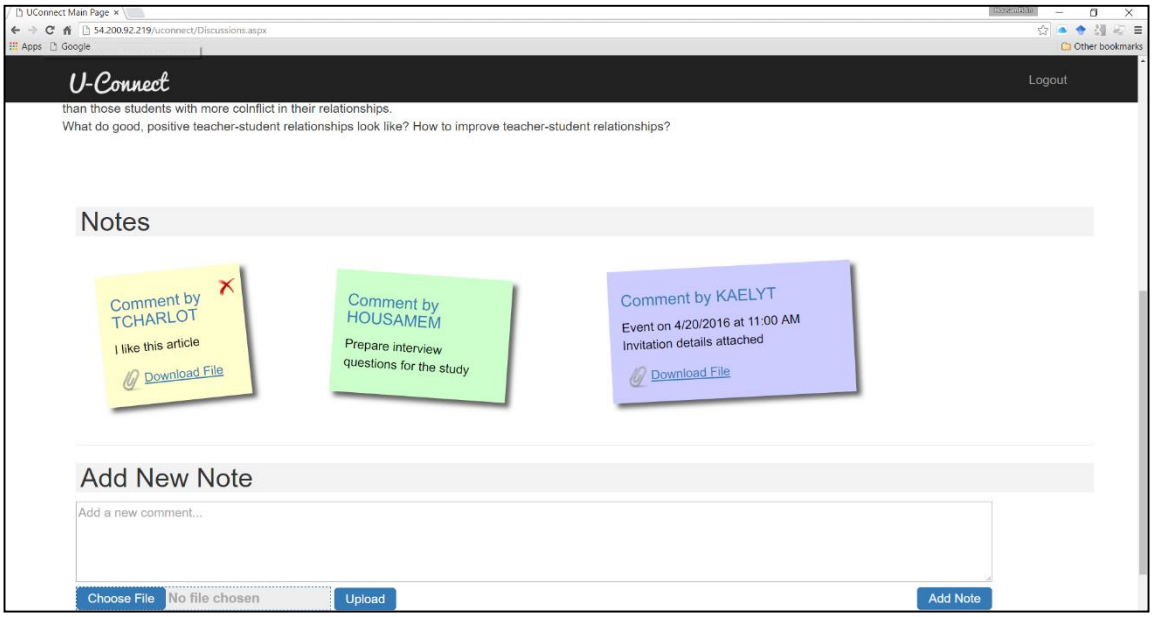


Figure 5: Main Page – Lower Portion

- **Sharing thoughts and ideas**

U-Connect allows users to share thoughts, ideas, links in the form of sticky notes. It allows users to enter text or links and then add it to the group in the form of a note (Figure 5). This gives users an easy and quick way to share thoughts and ideas related to a specific topic or project in a conspicuous communication space.

- **File Sharing**

U-Connect also allows users to attach multiple files to their notes. This allows group members to easily share files, including photos, documents or other media files with all the group members. Since U-Connect is platform-independent, file sharing can be achieved on different devices. Users may upload a picture, video, or a document directly from desktop or mobile devices to be attached to the note they are sharing. (Figure 6 shows the file sharing functionality from a mobile device).

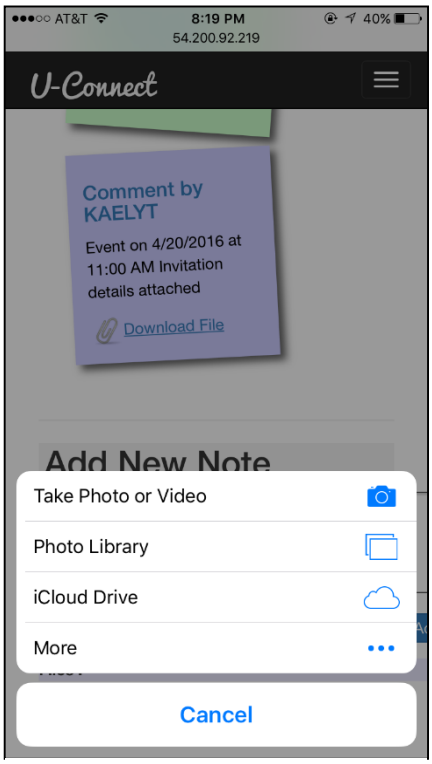


Figure 6: Upload a file

We understand that these are not all the features that can be included in a collaborative tool. For example, features like instant messaging, video/audio conferencing and screen sharing can be included in collaborative tools. However, for the current research, we focused on the system design that can provide a simple, clean, easy-to-use, and interactive interface for supporting group work. Therefore, we focused on the features particularly

important for collaborative work as identified in our survey. These features include group creation, forum, and file sharing.

4.3 Summary

This chapter describes the design of a prototypical collaborative tool for supporting group collaboration among students. Using this tool, students can easily share their thoughts, ideas, and resources. The tool was implemented using Web 2.0 technologies.

When designing the tool, I considered issues of platform independency, e.g. how to design a tool that can be used on different devices while providing the same content-accessibility and user experience. I also considered the development of a simple one-page design, specifically to minimize the overheads resulting from page loading that can influence the application performance and usability.

To deal with these issues, a responsive web design was used for the development of content-centered and platform-independent web applications. U-Connect allows students to easily create or join group discussions and share their thoughts, ideas and resources with other group members while collaborating on group work. Students can also quickly share sticky notes with their collaborators, and share files with them.

In the next chapter I will present a pilot user study of the U-Connect prototype for examining the functionality and design of the tool and gathering feedback from potential users.

5. U-Connect – A Pilot Study

In this chapter, I present a pilot user study to examine the functionality and design of the prototypical tool *U-Connect* for supporting group work. This study focuses on the use of U-Connect prototype for students to collaborate, coordinate and communicate with their group members. The user study was conducted by observing the end-users – students -- using this tool, and by interviewing them to gather their opinions on the efficacy of the tool. Our goal was to examine if the tool could serve as a collaborative tool to facilitate students' group work.

5.1 Methodology

5.1.1 Study design

Prior to the user study, the participants' university email was added to U-Connect's database. In this way, the participants were able to use the tool with their university email address without creating an account. We have also created *a priori* two groups/discussions for the user study so that the participants could choose to join an existing group.

The user study consisted of three stages. A pre-study interview was first conducted to understand the participant's background and experience with group work. Then the participant was asked to perform a set of eight tasks using U-Connect (Appendix B.2). Finally, a post-study interview was conducted to collect the participant's feedback on the features, usefulness, and usability of the tool.

Pre-study interview. We started by conducting a brief interview with each participant to learn about their educational background and previous experience with group work. We also asked participants about their experience with collaborative systems, especially the

one provided by the university, called “Blackboard” and the associated tools, such as Discussion boards and Blackboard collaborate.

Study session. The participants were introduced to the tool as an online collaborative tool that allowed them to create public/private groups/discussions and to share their thoughts or ideas in the form of sticky notes. Participants were also informed that the tool could be used on different devices and were encouraged to use the tool on their own mobile devices. Then they performed the prescribed tasks, one at a time, and were asked to think aloud during the study. Each study session involved a single participant and was approximately 20 minutes long. No time limit was given to each task. The participants were also asked to act like no one was there to ask. The study session ended when the participant has finished all the tasks on both a laptop computer and a mobile device.

Post-study interview. We conducted an interview with the participants after the study session has ended to collect their feedback. We asked the participants how easy it was to perform each task and if they found the tool useful and flexible in performing these tasks. The participants were asked to describe their overall experience with the tool, including its features and functionality. We also asked the participants for their opinion about some of the main design characteristics, like platform independence and single-page design. At the end of the interview, the participants shared their suggestions for additional features that could be useful in supporting group work.

5.1.2 Participants

Four university students (2 senior and 1 junior undergraduate students, and 1 graduate student) participated in the pilot study. All the participants were students attending the

same university but from different disciplines (Social work, psychology, business, and secondary education). They all possessed basic computer skills.

5.2 Findings

The data collected were thematically analyzed through open-coding. We identified some of the issues with CMS tools, and several reasons behind the limited use of these tools for group work among students. We examined the features and design of U-Connect for supporting group work. We also identified important characteristics in collaborative tools and their role in supporting collaborative work. Finally, we present several design recommendations for improving user experience.

5.2.1 Limited use of CMS for group work

All the participants have worked in groups for course projects that required them to communicate with other group members both on- and off- campus. The participants mainly exchanged phone numbers and used emails to communicate with each other. Their use of Blackboard (the official CMS used in the university) was limited to checking assignments, course information and grades. For example, one participant said, “I only go to Blackboard in order to check assignments or grades, I haven’t really gone any further than that”.

They also pointed out that they would use the discussion board in Blackboard only if it was required as part of the course. A participant said, “I use discussion boards but under a must have. I don’t really use it to communicate with other students”. Three participants also considered the Blackboard too formal for casual communication, as shown in the participants’ comments: “it felt too formal”, “does not look like a place that you can go and talk to people”, and “only feels like a place where you go to do academic work”.

5.2.2 Unaware of collaborative features in CMS

Only one participant was aware of some of the collaborative features provided on Blackboard, like Blackboard Collaborate, but she has never used these features before. The other three participants were unaware of any of the collaborative features in Blackboard. A participant said, “I have never been told to do anything on Blackboard, other than checking my grades, course information, and sometimes posting on discussion board”.

5.2.3 Easy to create or join a group

Two participants said that they preferred using tools that provide the simplicity of creating or joining a group. The participants looked for tools that most group members are already familiar with, like creating groups on Facebook. One participant found CMS tools “complicated and required a lot of time to learn and explain to group members”.

In contrast, U-Connect enabled the participants to create groups without asking for help or explanation. From our observations, creating a group discussion took each participant 10-15 seconds. All the participants showed an interest in the simplicity of creating a group in “U-connect”, and also in the ability to restrict access to the group for only authorized users using a password. Three participants found this an easy and quick way to initialize a group. Two participants desired a search option for joining a group. However, one of them appreciated the ability to navigate between different group titles through the dropdown list to check if something seemed interesting to them.

5.2.4 Sticky note metaphor for sharing ideas helps organize conversation threads

All the participants liked using the sticky notes on U-Connect to share ideas with group members. “It is a simple and clean way to share ideas with group members”. Two

participants suggested augmenting the feature to allow personalizing the display of the sticky notes. For example, allowing the users to change the color of the sticky notes and to group and categorize the sticky notes can be useful for group work.

5.2.5 File sharing crucial to group work

Three participants mentioned that file sharing is one of the most important features for supporting group work. Two of them were concerned about the limit of the file size that can be uploaded, which was a major issue with most of the tools they used for file sharing. Thus, they desired for tools that allowed them to share files of bigger size.

The participants were able to test the File Sharing functionality in U-Connect. Two participants identified an issue that confused them while uploading the file.

5.2.6 Mobile devices preferred for accessing CMS

The participants used both their mobile devices and laptop computers to communicate with group members when working on group projects. Yet, three participants preferred using their mobile devices for communication because they were more easily accessible. Two participants found Blackboard hard to access, and particularly difficult to use on mobile devices. Therefore, a participant explained, “students are not checking them, which makes it pointless posting there because most probably students will not reply”.

The participants found it easy to access and interact with U-Connect from their mobile devices. A participant stated that it was “very helpful to have the tool to work the same way” as on their laptop computers. Two other participants also liked having all the content on the same page and only having to scroll up and down. As two participants commented, “I do not like the websites that change the way they look or function depending on the

device I am using", and "sometimes I miss out on important things just because I'm using a different device".

5.2.7 Fast updates with single-page design improves user experience

The participants found it easy to navigate between different groups that they have joined, particularly without having to go to different pages, as a participant said that she felt frustrated when having to wait for web pages to load. All participants showed a positive attitude towards the single-page application design. A participant said that it "makes everything in one scroll" and two other participants expressed that being able to use the tool while staying on the same page makes it simpler and made the interaction with the application more fluid and fast.

5.3 Discussion

Our pilot study offered a closer look at the students' opinions towards using the collaborative features provided in the CMS (Blackboard) used at their university. The participants also recommended several features and design characteristics that collaborative tools should provide. They also proposed additional features that U-Connect should provide.

5.3.1 Limited use of CMS for collaboration and communication

In the pilot study, we acquired a better understanding of the students' attitudes towards using CMS for collaboration and communication, such as discussion boards and other collaborative features in Blackboard. CMS like Blackboard provide features for course management, and also other features to support communication and collaboration; however, the latter remains either unknown or unused by students. All participants used

discussion boards only when they were instructed by their teachers or when it was required as a part of the course. This highlights the teachers' influence on the students' adoption of these tools. Therefore, it is important to involve teachers in the design of these tools, in order to address teachers' needs and better support student learning.

On the other hand, students who were aware of the collaborative features in Blackboard found them complicated and hard to learn. They preferred using tools that allow them to easily create groups and or most group members are already familiar with, such as Facebook. The results also highlight the importance of addressing platform independence while designing collaborative tools, as it was clear from the participants' responses that they preferred using their mobile devices more than using their laptops for communication with group members.

5.3.2 Effective design characteristics to support group work

The main function of U-Connect is to help students collaborate through an easy-to-use interface that does not require a lot of time or effort to learn how to use it. Therefore, the primary purpose of this pilot study was to find out if this prototype can help students collaborate and communicate more easily while working in groups, and to learn if the simplicity and flexibility of the tool can encourage students to use it for knowledge sharing. The results showed that U-Connect is promising, and highlighted some characteristics in collaborative tools that can effectively support group work.

U-Connect allowed users to easily initiate or join groups, and to share their ideas with other group members through a dynamic and interactive user interface. The participants were interested in the clean and simple design of *U-Connect*. All participants found the tool easy to use and were able to perform each task without asking for help, which shows the

simplicity and clarity of the design. The participants were very happy with the flexibility of *U-Connect* and appreciated the ability to use the tool on their phones while being able to have the same user experience. The single-page design improved user experience by eliminating the "start-stop-start-stop" nature of interaction while a page is loading, which provided more fluid and fast user experience.

From our observation of the participants interacting with the tool, we identified several issues with the prototype that caused confusion to the participants while attaching a file to their note. These usability issues were related to the labeling and placement of buttons, and can be fixed in future prototypes.

The post-study interview showed a generally positive response to the *U-Connect* tool. All participants showed a great interest in this prototype, as they believed that this tool would serve as a very helpful and useful tool provided by the university for group work.

5.3.3 Additional features for future prototypes

We also identified some additional features that can better support communication between group members, and help them explore different discussions:

- **Personal profile**. Providing some basic information about each member in the group like their name, major and email address will allow students to learn more about the members in their groups, and directly contact any member if needed.
- **Commenting on Notes**. The ability to reply or comment on any specific note will strengthen the communication between group members and will allow them to reflect on each other's ideas.

- **Note Customization.** Allowing users to customize sticky notes, for example, by changing their color or moving them around will help them organize their thoughts and ideas in a more meaningful way.
- **Keyword Search**. Allowing users to search for a group using its title will help them explore different discussions that they might be interested in and will also help them quickly find a specific group.

5.3.4 Limitations

A major limitation of this study was the small number of participants in the pilot study. Nevertheless, we were able to get students from different disciplines to participate in the study. Furthermore, the study was conducted at a particular time point; a longitudinal study is required to assess how students use the tool while working on group projects in reality. In addition, more research is necessary to examine the potential of using Web 2.0 technologies for educational purposes and the effectiveness of the proposed features and success factors in supporting collaboration and knowledge sharing among students.

5.4 Summary

This chapter presented a pilot study to examine the functionality and the design of the prototypical tool, U-Connect, for supporting group work. We presented a closer look at the students' opinions towards using the collaborative features provided in the CMS (Blackboard) used at their university, as well as their needs and expectations when it comes to group work.

From the study, we identified simplicity and platform independence as important characteristics in collaborative tools, and how they might influence students to use these tools for collaboration and for sharing their thoughts and ideas with each other. We also

identified several issues, and additional features that should be implemented in future prototypes.

The study provided some clear directions for future prototypes of U-Connect. We expect that they also provide important insights for designers of similar tools.

6. Conclusion

This chapter concludes the thesis and discusses its research contributions. First, I revisit the research motivation and problems set out in Chapter 1 and summarize how these problems were solved. Second, I summarize the contributions that this research has made to Human Computer Interaction and Computer-Mediated Collaborative Learning. Finally, I describe directions for future work based on the research presented.

6.1 Research Problems and Summary

Through this thesis, I explored collaboration among students and the technologies that can be used to support it. The research was motivated by the general low adoption of collaborative tools by students and teachers due to the complication and inflexibility of these tools, and how technology can help students to share their knowledge and collaborate together through providing tools with enhanced accessibility and usability. The motivations of this research were:

1. *Students and teachers can benefit from collaboration making use of tools that let them initiate or join conversations in an easy way.*
2. *An examination of the key features and success factors in existing collaborative tools from an educational perspective (or student's and teacher's perspective) can provide insights into the design of a collaborative tool that meets the needs of teachers and students.*
3. *An investigation of Web 2.0 technologies and its use in higher education, and an illustration of how the integration of these technologies can help educators and designers improve user-experience and usability of collaborative tools.*

This research focused on investigating the tools used by students for group work within an educational environment, and designing a prototype of a collaborative tool to better support group work and promote knowledge sharing between students. Chapter 1 outlined two research problems in computer-mediated collaborative learning:

1. **We do not know the key features and success factors in collaborative tools from students' and teachers' perspective.** There are several features that can help students collaborate. However, supporting all features in one tool makes it complicated. We need to focus on providing students with tools that address their needs, but we do not know what features and factors in collaborative tools can support students in achieving group work.
2. **We do not know if the issues of flexibility and usability with existing collaborative tools offered by higher education institutions can be addressed through Web 2.0.** There have been research studies that indicated the unsatisfactory adoption rate of collaborative features in CMS by students and teachers due to the complication and inflexibility of these tools, such as Blackboard (Guidry and BrckaLorenz, 2010; Papastergiou, 2006; Rosato et al., 2007). We do not know if we can address these issues through utilizing new web technologies like Web 2.0.

I solved the first research problem by conducting a survey study to investigate the tools currently used by students for group work. I identified the key features required to help students collaborate, and the success factors that encourage students to use collaborative tools (Chapter 3). I solved the second problem by integrating Web 2.0 technologies to address some of the issues found in existing collaborative tools, like platform dependency and complexity of user interface (Chapter 4). Furthermore, I designed and built a dynamic

and interactive collaborative tool, *U-Connect*, that focused on addressing students' needs through providing the features that were identified to be success factors from the survey study (Chapter 4). I performed a pilot user study in order to evaluate the functionality and design of the prototypical collaborative tool, *U-Connect* (Chapter 5). While the pilot study indicated that the tool is useful and promising, additional features are required in order to better support collaboration and communication between students.

6.2 Contributions

This thesis makes two significant research contributions. First, I present the key features and success factors in collaborative tools that can help students collaborate. This includes the underlying reasons for which students use these tools, and the challenges they face while working in groups. I also presented technologies that can help us address some issues in existing tools. These will provide insights for designers who are developing similar tools for collaboration among students within an educational environment.

Second, I contribute the design of a collaborative tool, *U-Connect*, to make it easier for students to share their thoughts, ideas, and resources while working in groups. The collaborative tool enables students to easily and quickly initiate or join a group, and to interact with other group members (Chapter 4 and 5). Moreover, the identified features and factors provide useful insights to enhance collaborative tools including tools provided by educational institutions like Blackboard.

6.3 Future Work

This research raises new questions for the area of computer mediated collaborative learning. I describe several areas below that show promise for further research: further investigation of the features that support group work and extending the research to include

teachers, prototyping collaborative tools, and performing a field study on the revised U-Connect prototype.

6.3.1 Prototyping Collaborative Tools

The identified features and success factors for supporting group work presented in Chapter 3, and the design characteristics and recommendations presented in Chapters 4 and 5, serve as a general guideline for designers to develop collaborative tools that can better support group work within an educational environment. Future work using these guidelines is expected to improve the current *U-Connect* prototype.

6.3.2 Evaluation of U-Connect

In the beginning of my research, my plan included developing *U-Connect* and deploying it to a small group of students for evaluation. I found, however, that the design and implementation of *U-Connect* was more complex than I thought, due to the time it required to find the right technologies and their integration (Chapter 4). For this reason, *U-Connect* has not been used in practice, but only evaluated through the pilot user study presented in Chapter 5. However, I have benefited from the pilot study as it allowed me to identify issues with the current version of *U-Connect*, as well as some additional features that can improve the tool to better support group work (Chapter 5). This can guide designers to develop similar collaborative tools. These design recommendations, features, and success factors provide a roadmap for the next design iteration of *U-Connect* and, more importantly, provide insights for future collaborative tools. Future research in this area can then focus on the design of collaborative tools along with deployment and field evaluations aimed at investigating how students use these tools to help them communicate and collaborate while working on real group projects.

Using the collaborative tool developed based on the identified features and success factors in (Chapter 3), a study can be carried out with different groups of students during an academic year during which students can use the tool for real course group projects. This allows us to examine if and how the tool supports group work among students, and to find out what features are needed to better support their group work.

6.3.3 Further investigation of the features that support collaboration

In Chapter 3, we identified the key features and success factors that formed the basis of our design through a relatively small number of students with very specific backgrounds and experiences as members of an academic community. While useful, these features and factors may not truly generalize to other potential users or even other students.

The survey study can be repeated to include teachers. The resulting features and success factors should be compared for similarities and differences. In this way, we will know how the tool should be altered to suit the teachers' needs to better support the learning process.

6.4 Conclusion

Working in groups has been an essential part of the learning process. Collaborative work has become very important in today's world, whether in education or at work. Technology to help students collaborate and communicate would be useful for knowledge sharing and reuse. The research described in this thesis has grounded the work in computer mediated collaborative learning from the perspectives of students, and has also motivated several areas for future work.

The main objective of the research was to examine the potential of utilizing advanced web technologies like Web 2.0 technologies to design tools that can help students collaborate and communicate through an easy-to-use and more flexible user interface. Through making

use of new web technologies, we identified ways to enhance the accessibility and usability of collaborative tools, such as using a responsive web design and/or a single-page application design, which will motivate students to use them to share their knowledge with each other. The support of knowledge sharing among students will lead to the generation of new ideas and will result in the development of an innovative educational environment.

REFERENCES

[1] Williams, S., & Roberts, T. S. (2002). Computer-supported collaborative learning: strengths and weaknesses. In Computers in Education, 2002. Proceedings. International Conference on (pp. 328-331). IEEE.

[2] Mastin, T., & Yoon, K. (2013). Benefits of Group Knowledge Sharing for Student Teams. College Teaching, 61(4), 153-154.

[3] Resta, P., & Laferrière, T. (2007). Technology in support of collaborative learning. Educational Psychology Review, 19(1), 65-83.

[4] Gokhale, A. A. (1995). Collaborative learning enhances critical thinking.

[5] Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. Business horizons, 53(1), 59-68.

[6] Lockyer, L., Patterson, J., & Harper, B. (2001). ICT in higher education: Evaluating outcomes for health education. Journal of Computer Assisted Learning, 17(3), 275-283.

[7] Romiszowski, A., & Mason, R. (1996). Computer-mediated communication. Handbook of research for educational communications and technology, 2, 397-431.

[8] Knutas, A., Ikonen, J., & Porras, J. (2013). Communication patterns in collaborative software engineering courses: a case for computer-supported collaboration. In Proceedings of the 13th Koli Calling International Conference on Computing Education Research (pp. 169-177). ACM.

[9] Kimiz, D. (2005). Knowledge management in theory and practice. McGill University.

[10] Seeman, L. (2004, May). The semantic web, web accessibility, and device independence. In Proceedings of the 2004 international cross-disciplinary workshop on Web accessibility (W4A) (pp. 67-73). ACM.

[11] Grosseck, G. (2009). To use or not to use web 2.0 in higher education?.Procedia-Social and Behavioral Sciences, 1(1), 478-482.

[12] Van der Vlist, E., Ayers, D., Bruchez, E., Fawcett, J., & Vernet, A. (2007). Professional web 2.0 programming. John Wiley & Sons.

[13] Zech, L. K., Gause-Vega, C. L., Bray, M. H., Secules, T., & Goldman, S. R. (2000). Content-based collaborative inquiry: A professional development model for sustaining educational reform. Educational Psychologist, 35(3), 207-217.

[14] Kedzior, M., & Fifield, S. (2004). Teacher professional development. Education Policy Brief, 15(21), 76-97.

[15] Haycock, K. 2007. Collaboration: Critical success factors for student learning. School Libraries Worldwide. (2007), 25.

[16] Mohorovicic, S. (2013). Implementing responsive web design for enhanced web presence. In Information & Communication Technology Electronics & Microelectronics (MIPRO), 2013 36th International Convention on (pp. 1206-1210). IEEE.

[17] Garrett, J. J. (2005). Ajax: A new approach to web applications.

[18] Gardner, B. S. (2011). Responsive web design: Enriching the user experience. Sigma Journal: Inside the Digital Ecosystem, 11(1), 13-19.

[19] Marcotte, E. (2013). Responsive web design (No. 4). Editions Eyrolles.

[20] Kamasak, R., & Bulutlar, F. (2010). The influence of knowledge sharing on innovation. European Business Review, 22(3), 306-317.

[21] Savitz, E. (2012). The Future Of The Web: The Case For Responsive Design, http://www.forbes.com/sites/ericsavitz/2012/12/27/the future-ofthe-web-the-case-for-responsive-design/

[22] Taylor, J. (2013). Reasons Why Responsive Web Design is the Best Option For Your Mobile SEO Strategy. Search Engine Watch.

[23] Mobile User Survey (2014). The state of mobile software quality. http://www.keynote.com/docs/reports/Keynote-2012Mobile-User-Survey.pdf, Retrieved on June, 6th 2016.

[24] Weir, S. (1992). Electronic communities of learners: Fact or fiction. Prospects for educational telecomputing: Selected readings, 87-110.

[25] Heylighen, F. (1999). Collective Intelligence and its Implementation on the Web: algorithms to develop a collective mental map. Computational & Mathematical Organization Theory, 5(3), 253-280.

[26] Olguín, D. O., & Pentland, A. (2010). Assessing group performance from collective behavior. In Proc. of the CSCW (Vol. 10).

[27] Duderstadt, J. J. (1998). Transforming the University To Serve the Digital Age. Cause/Effect, 20(4), 21-32.

[28] Papastergiou, M. (2006). Course management systems as tools for the creation of online learning environments: Evaluation from a social constructivist perspective and implications for their design. International Journal on ELearning, 5(4), 593.

[29] Linge, R. J. (2003). The good, the bad, and the ridiculous: Putting a course online with Blackboard. Journal of Computing Sciences in Colleges, 18(4), 355-364.

[30] Heeler, P. J., & Hardy, C. (2002). Implementing a web-based master's degree in instructional technology: A progress report. Journal of Computing Sciences in Colleges, 17(4), 72-76.

[31] Haack, C., Alagic, M., Gibson, K., Watters, J., & Rogers, G. (2003). Tailoring a website to meet the needs of global learners. Technology and teacher education annual, 4, 2396-2399.

[32] Jubas, K. (2011). Everyday scholars: Framing informal learning in terms of academic disciplines and skills. Adult Education Quarterly, 61(3), 225-243.

[33] Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. The Internet and Higher Education, 19, 18-26.

[34] Kimiz, D. (2005). Knowledge management in theory and practice. McGill University.

[35] Nonaka, I., Von Krogh, G., & Voelpel, S. (2006). Organizational knowledge creation theory: Evolutionary paths and future advances. Organization studies, 27(8), 1179-1208.

[36] Lorenzo, G., Oblinger, D., & Dziuban, C. (2007). How choice, co-creation, and culture are changing what it means to be net savvy. Educause Quarterly,30(1), 6.

[37] Rhoton, J., & Stiles, K. E. (2002). Exploring the professional development design process: Bringing an abstract framework into practice. Science Educator, 11(1), 1.

[38] Hiebert, J., Gallimore, R., & Stigler, J. W. (2003). The new heroes of teaching: Opening classroom doors for the good of the profession. Education Week,23(56), 42.

[39] Birman, B. F., Desimone, L., Porter, A. C., & Garet, M. S. (2000). Designing professional development that works. Educational leadership, 57(8), 28-33.

[40] Alexander, B., & Levine, A. (2008). Web 2.0 storytelling: Emergence of a new genre. EDUCAUSE review, 43(6), 40-56.

[41] Bennett, S., Bishop, A., Dalgarno, B., Waycott, J., & Kennedy, G. (2012). Implementing Web 2.0 technologies in higher education: A collective case study. Computers & Education, 59(2), 524-534.

[42] Valk, J. H., Rashid, A. T., & Elder, L. (2010). Using mobile phones to improve educational outcomes: An analysis of evidence from Asia. The International Review of Research in Open and Distributed Learning, 11(1), 117-140.

[43] Rosmala, D. (2012). Study of social networking usage in higher education environment. Procedia-Social and Behavioral Sciences, 67, 156-166.

[44] Chong, E. K. (2010). Using blogging to enhance the initiation of students into academic research. Computers & Education, 55(2), 798-807.

[45] Kietzmann, J. H., Hermkens, K., McCarthy, I. P., & Silvestre, B. S. (2011). Social media? Get serious! Understanding the functional building blocks of social media. Business horizons, 54(3), 241-251.

[46] De Freitas, S., & Conole, G. (2010). Learners experiences: how pervasive and integrative tools influence expectations of study.

[47] Conole, G., & Alevizou, P. (2010). A literature review of the use of Web 2.0 tools in Higher Education. A report commissioned by the Higher Education Academy.

[48] Johnson, L.F., Levine, A., and Smith, R.S. (2009) Horizon Report, Austin, TX: The New Media Consortium.

[49] Crook, C., Cummings, J., Fisher, T., Graber, R., Harrison, C., Lewin, C., Logan, K., Luckin, R. and Oliver, M. (2008). Web 2.0 technologies for learning: the current landscape opportunities, challenges and tensions.

[50] Murugesan, S. (2007). Understanding Web 2.0. IT professional, 9(4), 34-41.

[51] Kukulska-Hulme, A., Pettit, J., Bradley, L., Carvalho, A. A., Herrington, A., Kennedy, D., & Walker, A. (2011). Mature students using mobile devices in life and learning.

[52] Traxler, J. (2010). Students and mobile devices. *Research in Learning Technology*, *18*(2).

[53] Kennedy, G. E., Judd, T. S., Churchward, A., Gray, K., & Krause, K. L. (2008). First year students' experiences with technology: Are they really digital natives. *Australasian journal of educational* technology, 24(1), 108-122.

[54] Sáenz, J., Aramburu, N., & Rivera, O. (2009). Knowledge sharing and innovation performance: A comparison between high-tech and low-tech companies. Journal of Intellectual Capital, 10(1), 22-36

[55] Guidry, K. R., & BrckaLorenz, A. (2010). A comparison of student and faculty academic technology use across disciplines. Educause Quarterly, 33(3), 1-7.

[56] Rosato, J., Dodds, C., & Laughlin, S. (2007). Usability of course management systems by students. *Dept. Computer Information Systems/Computer Science, College of Scholastica, Duluth*.

[57] Fasse, R., Humbert, J., & Rappold, R. (2009). Rochester Institute of Technology: Analyzing Student Success. *Journal of Asynchronous Learning Networks*, *13*(3), 37-48.

A. Appendix - Survey Study

A.1 Consent to Participate in a Research Study

TECHNOLOGY DESIGN FOR COLLABORATIVE WORK

You are invited to participate in a research study about how individuals communicate for collaborative work.

If you agree to be part of the research study, you will be asked to complete this online survey.

You may not directly benefit from this research; however, we hope that your participation in the study may help (re)design technologies for supporting collaborative work.

We believe there are no known risks associated with this research study.

You can enter into our draw for winning one of twenty-five $20 gift cards of either Tim Horton's or Amazon.

Participating in this study is completely voluntary. Even if you decide to participate now, you may change your mind and stop at any time. You may choose not to answer any survey question for any reason.

If you have questions about this research study, you may contact Dr. Charlotte Tang at 810-762-3184 or tcharlot@umflint.edu.

The University of Michigan Flint Institutional Review Board has determined that this study is exempt from IRB oversight.

By selecting "I agree" below you are indicating that you are at least 18 years old, have read and understood this consent form and agree to participate in this research study. Please print a copy of this page for your records.

☐ **I agree**

☐ **I do not agree**

If "I do not agree" is selected, skip to End of Survey

A.2 Survey Questions

Q1 Gender:

- ❍ Male
- ❍ Female
- ❍ Prefer not to say

Q2 Age:

- ❍ 18 - 25
- ❍ 26 - 30
- ❍ 31 - 40
- ❍ 41 - 50
- ❍ 51 - 60
- ❍ 61 and over
- ❍ Prefer not to say

Q3 You are a/an

- ❍ Graduate student
- ❍ Undergraduate student

Answer if Undergraduate is selected

Q4 You are a

- ❍ Freshman
- ❍ Sophomore
- ❍ Junior
- ❍ Senior
- ❍ Not sure

Q63 What is your field of study?

Q5 How many group projects have you participated in the courses you have taken in the last five years?

- ❍ 0
- ❍ 1 - 3 projects
- ❍ 4 - 5 projects
- ❍ More than 5 projects

If "0" is selected, then skip to End of Survey

Q62 How many of the group projects you have participated in were part of an online course or involved distance learners?

- ❍ 0
- ❍ 1 - 3 projects
- ❍ More than 3 projects

Q6 How many members on average were there in your project groups?

- ❍ 2 - 4
- ❍ 5 - 7
- ❍ More than 7

Q7 How often did you communicate with your group members outside class time when working on the projects?

- ❍ Daily
- ❍ 2 - 3 Times a Week
- ❍ Once a Week
- ❍ 2 - 3 Times a Month
- ❍ Once a Month
- ❍ Less than Once a Month
- ❍ Never

Q8 How did you communicate with your group members?

	Never	Once in a while	Sometimes	Often	Always

If Communication Tools (e.g., ... is selected, then skip to End of Survey

Answer If How did you communicate with your group members? Technology mediated communication tool - Once in a while Is Selected or How did you communicate with your group members? Technology mediated communication tool - Sometimes Is Selected or How did you communicate with your group members? Technology mediated communication tool - Often Is Selected or How did you communicate with your group members? Technology mediated communication tool - Always Is Selected

Q9 How often did you use the following tools for the group projects?

	Never	Once in a while	Sometimes	Often	Always

If Skype - Never Is Selected, Then Skip To How often do you use Google Hangouts ...

Answer If How often did you use the following technology mediated communication tools for the group projects? Skype - Once in a while Is Selected Or How often did you use the following technology mediated communication tools for the group projects? Skype - Sometimes Is Selected Or How often did you use the following technology mediated communication tools for the group projects? Skype - Often Is Selected Or How often did

you use the following technology mediated communication tools for the group projects?

Skype - Always Is Selected

Q10 What features in Skype did you use during your group project?

	Never	Once in a while	Sometimes	Often	Always

Q11 Please rate the following in Skype.

	Excellent	Good	Fair	Poor	Terrible

Q12 For what purpose did you use Skype for? Choose all that applies.

- ❑ Discuss project plan
- ❑ Project progress
- ❑ Create presentations
- ❑ Write reports
- ❑ others _____

Q13 Did you encounter any problems while using this Skype to communicate with your group members? Choose all that applies.

- ❑ Lost connection
- ❑ Lost messages
- ❑ Documents corrupted
- ❑ Version comparability
- ❑ others _____

Answer If How often did you use the following technology mediated communication tools for the group projects? Google Hangouts - Once in a while Is Selected or How often did you use the following technology mediated communication tools for the group projects? Google Hangouts - Sometimes Is Selected or How often did you use the following technology mediated communication tools for the group projects? Google Hangouts - Often Is Selected or How often did you use the following technology mediated communication tools for the group projects? Google Hangouts - Always Is Selected

Q14 How often do you use Google Hangouts in general?

- ❍ Daily
- ❍ 2 - 3 Times a Week
- ❍ Once a Week
- ❍ 2 - 3 Times a Month
- ❍ Once a Month
- ❍ Less than Once a Month

Q15 What features in Google Hangouts did you use for your group projects?

	Never	Once in a while	Sometimes	Often	Always

Q16 How would you rate the following elements on Google Hangouts?

	Excellent	Good	Fair	Poor	Terrible

Q17 For what purpose did you use Google Hangouts for?

- ❑ Discuss project plan
- ❑ Project progress
- ❑ Create presentations
- ❑ Write reports
- ❑ Others _____

Q18 Did you encounter any problems while using Google Hangouts to communicate with your group members?

- ❑ Lost connection
- ❑ Lost messages
- ❑ Documents corrupted
- ❑ Version compatibility
- ❑ others (please specify) _____

Answer If How often did you use the following technology mediated communication tools for the group projects? Facebook - Once in a while Is Selected or How often did you use the following technology mediated communication tools for the group projects? Facebook - Sometimes Is Selected or How often did you use the following technology mediated communication tools for the group projects? Facebook - Often Is Selected or How often did you use the following technology mediated communication tools for the group projects? Facebook - Always Is Selected

Q19 How long have you been using Facebook?

- ❍ Less than a year
- ❍ More than a year
- ❍ Less than two years
- ❍ More than two years

Q20 Why do you use Facebook?

	Never	Once in a While	Sometimes	Often	Always

Q21 Please describe the features in Facebook that were particularly useful during your group project?

Q22 For what purpose did you use Facebook for?

- ❑ Discuss project plan
- ❑ Project progress
- ❑ create Presentations
- ❑ write Reports
- ❑ Others _____

Q23 Did you encounter any problems while using Facebook to communicate with your group members?

- ❑ Lost connection
- ❑ Lost messages
- ❑ Documents corrupted
- ❑ Version comparability
- ❑ Others _____

Answer If How often did you use the following technology mediated communication tools for the group projects? Webinar - Once in a while Is Selected or How often did you use the following technology mediated communication tools for the group projects? Webinar - Sometimes Is Selected or How often did you use the following technology mediated communication tools for the group projects? Webinar - Often Is Selected or How often did

you use the following technology mediated communication tools for the group projects?

Webinar - Always Is Selected

Q24 How often do you use the following features of webinar for your group projects?

	Never	Sometimes	Average	Often	Very often

Q25 For what purpose did you use Webinar for?

- ❑ Discuss project plan
- ❑ Project progress
- ❑ Create Presentations
- ❑ Write Reports
- ❑ Others _____

Q26 Did you encounter any problems while using Webinar to communicate with your group members?

- ❑ lost connection
- ❑ lost messages
- ❑ documents corrupted
- ❑ version compatibility
- ❑ Others _____

Answer If Have you ever happened to expect your tool to provide a functionality that you needed but it didn't? <o:p></o:p> yes Is Selected

Q28 Please describe the missing functionality that you expected the tool to provide.

Q29 In general, what did you or your group do when a problem occurred while communicating? Please describe.

Q29 Is there any functionality that you would like to be added to the tool you have used before?

- ❍ yes
- ❍ No

Q30 Were you ever the group leader in the group projects that you have participated in?

- ❍ Yes
- ❍ No

Answer If Were you ever the group leader in the group projects that you have participated in? Yes, Is Selected

Q31 Please describe the challenges you have faced with the communication tool being the leader managing the group?

Q66 Please enter your contact information if you would like to enter into our draw for winning one of twenty-five $20 gift cards of either Tim Horton's or Amazon.

Name

Email

Phone

B. Appendix - Pilot Study

B.1 Protocol for the Study

Introduce yourself,

- My name is Housam Mohamed. I am a graduate student, studying for my master's degree in computer science.
- I have developed a tool to help students collaborate and share their ideas while working in group projects. I'm now doing this study to see how this tool can help students working in groups and share their ideas. You're helping us by trying this tool and interacting with it to understand how students would use the tool for collaboration.

Tell them about the study,

- This tool allows users to create or join a group discussion. They can post ideas, thoughts, pictures or files on a specific topic.
- Since this study is primarily exploratory, the tasks you're going to perform are not well-defined. This means you're free to brainstorm your ideas and opinions during the course of the study. In so doing, you're indeed helping us identify the spectrum of features that deem required to be implemented in the tool, that can meet your needs.
- We'd also like to ask you to think aloud as you perform the tasks as we have found that we'll get a great deal of information if you speak your thoughts as you work. It may be a bit awkward at first, but it's really very easy once you get used to it. So, all

you need to do is speak your thoughts as your work. Please also tell us everything that you may think trivial because they can indeed be very important. If you forget to think aloud, I'll remind you to keep talking.

Tell the participant that it's OK to quit at any time.

- Although I don't know of any reason for this to happen, if you should become uncomfortable or find this study objectionable in any way, you are free to quit any time.
- Do you have any question at this point?
- Now, I'd like to explain a little bit about the tool you will use for this exploratory study and the different ways you can use it. (explain the tool, share the website url)
- Please feel free to ask any questions you may have. It's very important that we capture all your questions and comments.
- When you've finished all the tasks, we'll answer any questions you still have.
- Are there any questions about the study before you start?
- Begin Pre-test Interview

Participants should complete all tasks, one at a time, on both a laptop computer and a mobile device.

Participants will be interview after the study session ends.

B.2 Task list

1) Create a new group/discussion.
2) Join a group/discussion
3) Create a private group/discussion.
4) Join a private group/discussion. (This is the password *Example*)
5) View/Navigate to a specific group/discussion.
6) Share a note with other group members.
7) Attach a file to a note and then share it.
8) View an attachment in a note.