Dropbox Software Evaluation and Redesign for an Academic Environment

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I. Introduction

Cloud storage and file backup software have become an essential component of online computer supported collaborative work (CSCW). Cloud file hosting services provide a means for individuals to store and share data in a public and private cloud, and also help to synchronize file management within a team. An effective cloud service is an essential tool in any collective learning teams toolkit as it allows for more effective sharing, collaboration, and communication. Dropbox, developed by Dropbox Inc., is a popular online file storage application currently being used in CSCW. With 400 million registered users worldwide, Dropbox is being used as a tool for teams to store data, share files, and edit documents in a repository. This software has changed the face of the collaborative working environment (Chang, 2015). Dropbox allows for file sharing between users and is an essential software being used in CSCW. Filesharing is important in the academic setting for both researchers, academics, and designers. It is especially important in asynchronous work, which is a reality for many teams (Olson Olson, 2014). Dropbox simplifies scholarly collaboration by allowing researchers to share files and data easily across various platforms (Hicks, 2014). Teachers and students deem Dropbox an effective and successful tool since it allows for easy course management, thus showing that Dropbox is beneficial in an academic environment (Niles, 2013). With all of its strengths, Dropbox does lack certain features such as user pathname resolution, API sophistication, and video and audio integration (Hicks, 2014). It also does not include features related to calendar integration, security, editing, and annotation issues (Quora, 2013).

A study done by Parmaxi and Zaphiris (2015) looked at the dynamics of social technologies (such as Dropbox, Wikispaces, Google Documents, Facebook, and blogs) as social microworlds. Microworlds are an element of constructionism theory, which believes that effective learning occurs when individuals make sense of the world around them by creating connections between old and new knowledge, while interacting with others to create important artefacts (Parmaxi Zaphiris, 2015). This study found that all five social technologies used were needed to create a social microworld that would allow the participants to complete the tasks they were required to do (Parmaxi Zaphiris, 2015). Parmaxi and Zaphiris (2015) believe that the design of well-structured microworlds must acknowledge the needs and expectations of both teachers and students, and that the design must also acknowledge the affordances of the technology being used. The technologies chosen must be based on cultural trends in order for the social microworld to be adopted in a learning environment (Parmaxi Zaphiris, 2015).

Our goal is to design and prototype a social microworld based off of the current design of Dropbox that will include support for the features that are not currently implemented well by Dropbox. There are a number of other softwares that contain attractive and efficient features that we aim to incorporate in this microworld. We aim to explore these softwares and determine which features would prove to be effective in a social microworld and incorporate these features into Dropbox. By doing this, we hope to create one tool that will support most of the needs of individuals trying to complete collaborative work in an academic environment.

II. Project Motivation

With the study by Parmaxi and Zaphiris (2015) in mind, we believe that this project will help students and professionals who use a variety of CSCW software to have one main software collaboration tool that will fulfill the majority of their communication, design and collaborative work needs. Furthermore, it will be a tool which will bundle together all of the features which have been found to be successful in a variety of other software programs. While we aim to create one unified tool which performs a variety of tasks for a CSCW group, the goal of our research is not to create a single tool that will fulfill all the needs of a collaborative group and replace all other tools; rather, we aim to create a modified version of an already successful tool that will incorporate additional features from other successful tools. This tool wont be thought

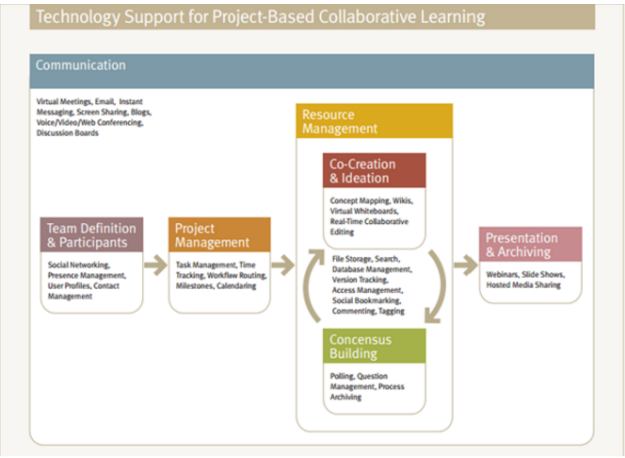
of to replace other tools, but it can be used as a primary tool with little need to utilize other tools while working on a project unless a very specialized task is being done. We would like our redesigned tool to fulfill most of the design and communication needs of a group. Using our methodologies, we are beginning to determine what makes a CSCW software effective. Furthermore, we have created a list of dimensions that we believe to be crucial for a successful CSCW tool. The impact will be far reaching as we plan to create a technical software mockup demonstrating our changes, and we plan to submit this feedback in a professional technical report back to Dropbox, along with guidelines on how and why they should be implementing these changes.

III. Related Works

Olsen and Olsen (2014) believe that a collaborative team will succeed if: they assign independent work modules to one location to decrease the need for communication; it is made up of people that have worked together previously, have common ground, common work styles and like each other; it has a well-defined management style that makes decision-making clear, promotes an open and inclusive environment, and has details worked out; and uses technology that supports communication and coordination, helps with the sharing of information, and a powerful computational infrastructure. Barriers that prevent successful collaboration are: time zone differences, cultural boundaries and institutional differences, trust among collaborators, and communication between collaborators (Olsen Olsen, 2014). Based on what they believe makes a collaborative team successful, they broke down the technologies that support distance work into four categories: communication tools, collaboration tools, information repositories, and computational infrastructure (Olsen Olsen, 2014). Communication tools include: email and texting; voice and video conferencing; chat rooms, forums, blogs, and wikis; and virtual worlds (Olsen Olsen, 2014). Collaboration tools include: shared calendars; awareness tools; meeting support; large visual displays; and workflow and resource scheduling (Olsen Olsen, 2014). Information repositories include: databases; shared files; blogs or wikis; and online laboratory notebooks (Olsen Olsen, 2014). Computational Infrastructure includes: system architecture; the network; large-scale computational resources; and human computation (Olsen Olsen, 2014). The framework that Olsen Olsen (2014) suggest that teams use to choose a computational infrastructure has 11 domains that include: the speed of response; the size of the data, or how much computation is required; the security; the privacy; the accessibility; the various kinds of control of who can have read/write permissions; the richness of what is transmitted; the ease of use; the context information, like who is doing what and when; the cost; and finally, the compatibility with other tools that are being used. The definitions and the framework provided by Olsen Olsen will help us to identify the certain features in the different technologies we are investigating that will lead to the design of an effective collaborative tool.

One study done by Woodzicka, et al. (2014) implemented a multi-faculty, multi-project model that involved students and faculty from two different universities collaborating on a single research study. The students and faculty members used Skype, Dropbox and email to collaborate on the study (Woodzicka, et al., 2014). The study found Dropbox to be vital in helping the students and faculty share literature, stimulus materials, and data (Woodzicka, et al., 2014). Dropbox also allowed for synchronous file editing, which alleviated the need for email notifications every time a document was updated (Woodzicka, et al., 2014). Skype allowed the students and faculty to have scheduled, collaborative meetings, which enabled them to have face-to-face conversations about their study (Woodzicka, et al., 2014). The paper by Olsen and another study done by Rowe, Bozalek and Frantz (2013) looked at using Google Drive as a collaborative online authoring environment to facilitate a blended approach to authentic learning. Through technology traditional learning has changed dramatically. Our society is moving away from classroom learning and in some places adopting a blended approach to learning. Exposing students to enhanced communication and more engaging structures that encourage real life dialogue with no barriers to locations or class room books provides learners a unique experience that is developing important competencies such as critical thinking that is needed to be successful in the modern world (Rowe, Bozalek and Frantz, 2013). Empowering students to take control of their learning and developing the skills to do so is a shift from traditional learning. The standard of thinking within the confines and parameters of the textbook, is an obstacle in finding creative ways for solving problems (Rowe, Bozalek and Frantz, 2013).

Carnegie Mellon University published a paper about the role of teaching with collaboration tools (Deal, 2009), specifically how technology can be leveraged in project-based collaborative learning environment that requires students to engage in design, problem-solving, decision-making and analysis to create an end product. These technology tools help facilitate team communication, project management, co-creation, consensus building, resource management, versioning and live/remote presentations (Deal, 2009).



Some other key takeaways from this paper include: groups generate better range of ideas and group participation is more equal when collaboration tools are used due to individuals being able to be more open when compared to being in an actual group discussion; the choice of collaboration tools should depend on the type and objectives of the project; and lastly, technology can help instructors better monitor individual and group performance, and prevents social loafing, which is defined as the likelihood that individuals piggyback on other group members to accomplish project goals(Deal, 2009).

IV. Methodology

For our methodology, we first conducted an extensive literature review to develop a baseline knowledge of CSCW concepts, and how these concepts can be related to our topic of redesigning Dropbox for an academic environment. We then created and submitted an ethics application in preparation for our user survey where we would be collecting data from various participants. Next, we generated a list of questions to evaluate how and why people use collaborative software tools, and to collect other contextual and demographic information. After analyzing our user survey results, we compared and contrasted Dropbox with six other collaborative software tools, and created a ratings matrix using the Olsen and Olsen framework to quantify these results. Based on our groups literature review, user survey results, and software comparison and review, we created a prototype mockup of Dropbox 2.0, which is an improvement over the current Dropbox. This prototype contained new features developed by our team, and included features from other existing collaboration tools. After our prototype was finished, we conducted a cognitive walkthrough on the prototype, and recorded the results. Finally, we will propose alternative methods and discuss the limitations of our current methodology.

Evaluating Computer Supported Cooperative Work software is a very difficult and intricate task. It is not simple and there exists a multitude of evaluation techniques to determine whether or not a software is effective (Dugan et al., 2003). A researcher must determine which perspective they will take to evaluate the software, whether from a Human Computer Interaction (HCI), or a social issue perspective (Dugan et al., 2003). Our group has chosen to focus on our evaluation from a technological CSCW perspective.

We evaluated Dropbox, in detail, using an extensive literature review. We acquired our articles from online databases using Summon 2.0 (UVic library website) and Google Scholar. We analysed the different collaborative tools based on the list of considerations provided by Olsen and Olsen (2014), which included:

- Speed of the software response
- Computational requirements (size of the message/data)
- Security
- Privacy
- Accessibility
- User control (who can read, write, and edit)
- Richness of data transmitted
- Ease of use
- Context information (who did what, and when)
- Cost
- Compatibility with other software and applications
- Communication

While completing the ethics application, we began formulating our survey. The survey contained 11 questions, with the goal of discovering which features of a software were important to our current demographic. The survey was sent out through email and was posted on Slack. We surveyed students from the University of Victoria (UVic), and also a few faculty and staff members from UVic. The survey was used to determine what students do and do not find effective in Dropbox and other softwares. The survey was then combined with the objective results obtained from our software comparison. Based on our literature review, user surveys and software evaluations, we have determined which elements are of importance for CSCW software and tools, and we considered these elements when we created our Dropbox 2.0 prototype mockup. After many group brainstorming design sessions, the Dropbox 2.0 mockup was created using Photoshop and Invision. Photoshop was utilized to create the screens for each potential task scenario, and Invision was used to turn these screen images into a clickable and interactive working prototype.

A. User Survey

The main goal of the user survey was to find out the general opinions/attitudes that our respondents had about various software collaboration tools as well as their demographic details. This will later help our prototype creation by allowing the team to base design changes on objective information. Since our research paper is about redesigning Dropbox software for an academic environment, we targeted our survey questionnaire towards other students, professors and working professionals within our personal network. These respondents have had experience working with various software collaboration tools in an academic environment and can communicate to our team what features/functionalities are most important. The user survey was created with Google Forms and distributed to survey participants via an e-mail link. We decided to use a self-completion questionnaire because this method was low cost, non-biased and produced a large sample size quickly with dependable and comparable results. The types of questions asked in the survey were meant to provide our team with data about:

- Who used software collaboration tools
- What type of software collaboration tool is primarily used and its frequency of use
- What is the main purpose for these tools
- How are these tools being used and what features/functionalities is most important

The user survey results were collected over a period of two weeks and after tabulating and analyzing the data it produced quantifiable and actionable findings that is discussed further in section 5.2 Survey Results of this paper.

B. Software Comparison and Review

Although Dropbox is an effective tool that can be successfully used in an academic environment, there are some limitations. The purpose behind undertaking an extensive software comparison and review is to identify and understand the target audience, primary functionality, advantages and disadvantages of each software collaboration tool within an academic environment. This is an important distinction because an academic

user will use a software collaboration tool much differently from a power user in an enterprise environment for example. Our group compared and contrasted Dropbox against six other popular software collaboration options: Box, GitHub, Google Drive, Microsoft OneDrive, Microsoft SharePoint and Slack. Each group member was responsible for using and fully exploring all features in Dropbox and one additional collaboration tool from the aforementioned options. Each tool was downloaded by a team member who tried to replicate most academic task scenarios to gain a better sense of overall functionality and design. Although some options offered a paid version of the software with more options/features/functionality, our team only analyzed the free or lowest cost version. The justification is that in an academic environment most users are either budget-constrained and/or dont require all the features of an enterprise solution. We then summarized our software comparison results into a ratings table that rated each tool on twelve dimensions (primarily based on Olson and Olson framework) to produce an overall score. These software comparison results and ratings are fully detailed in section 5.1 Software Comparison Results. Through this process, the team is able to identify areas where Dropbox excels and falters. In the prototype mockup, the team adapted and implemented features successfully executed in other software collaboration tools to address weaknesses found in the current Dropbox.

C. Prototype Mock-up: Design

Based on our results from the user survey and software comparison, we aimed to improve three primary features in Dropbox: communication, navigation, and collaboration. These features are apparent in our mock-up, which was created using Photoshop and Invision (prototype may be accessed at https://invis.io/RK55RDZAM). In terms of navigation, we especially aimed to simplify the user interface, and to make the navigation more intuitive. We also added the ability for the user to see the pathway from their home Dropbox folder from wherever they were in Dropbox. We incorporated a simplified navigation layout to assist the user in navigating between shared and private directories. The ability to easily navigate between file storage locations and between files is an important feature of an online collaborative software. There are some design

flaws in the current version of Dropbox, such as when a user clicks Paper, the user will need to return to the previous page in order to perform other tasks. In terms of communication, we attempted to introduce different ways to communicate in our design, which were based off of our survey results that demonstrated the importance of communication between team members. The importance of communication in a collaborative tool may be demonstrated by a users need to often switch from their current software to a new software in order to use a chat, audio, or video function. Currently, Dropbox does not contain any communication features other than the ability to comment on a file. These different communication channels focused primarily on audio and video, and stressed the ability of an individual to communicate with their team members in real time. We also increased the users ability to communicate from a variety of locations; no longer is an individual stuck communicating only while viewing a document. The user can chat using audio or video with team members from a variety of different areas of the website, such as from the Main page and from within a collaborative document. Finally, we focused on synchronous collaboration of files within the repository. Currently, users are not able to collaboratively edit documents within Dropbox. A user may view a document and download it to their local drive, but only one user at a time may edit it inside Dropbox. We have adjusted Dropbox so that multiple users can edit a document synchronously.

D. Prototype Mock-up: User Testing

Our mockup is heuristically designed for editing, sharing, and manipulating files. It simplifies the use of the existing Dropbox and similar tools. It takes the user straight to the point to complete her or his task on hand. We hope to learn from these user tests on how our mockup/interface could be made better in terms of usability, visual appearance, design minimalism and flexibility of file/data presentation.

Multiple participants were involved in our user testing. They are between the age of 25 to 40. The participants were asked to perform 2 tasks. These tasks took the participants to every aspect of the system as to give them full understanding of the tool. The exact task breakdown is attached in the appendix.

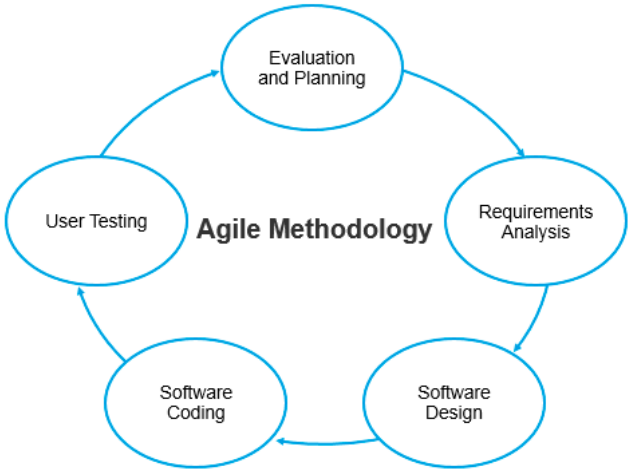
The users were initially given a verbal description on how a typical user would use it, but they were not given any practice time since we wanted to test the affordances and intuitive decisions in the design. The user study took place in a meeting room ECS 124.

We gave each participant a laptop with the prototype initiated at the main screen and a sheet of paper listing the tasks. They were told that they were timed on their completion of each task. The participants were also asked to talk aloud about what they think the system is doing, what they were trying to accomplish, and what was confusing at that point in time. At the end of each task the prototype was reset to the main page by the researcher so that the next task could be started afresh.

E. Limitations of Current Methodology and Alternative Methods

Like most groups, the biggest constraint when developing a good methodology is the lack of time to perform each step in the process thoroughly. Aside from the lack of time, there are a few things that our group would have have done differently from the outset if we were to repeat this project again. First, reducing the amount of time allotted to collect user survey results would have freed up more time for other work. Doing face-to-face interviews with users utilizing existing software collaboration tools while we recorded how they used the software and how they responded to various task scenarios would have been very helpful in the prototype design/creation. Our groups final prototype was limited to one iteration of user testing involving members of the group not involved with the creation of the prototype. It would have been ideal to increase the number of participants in the user testing phase. Upon reflection, to expand the prototype user testing sample size and improve the prototype design stage, we could have possibly implemented an agile software development cycle when creating the prototype mockup. The agile methodology involves completing multiple iterations of software development cycle to rapidly deliver a working/prototype software

by using multiple iterative software development cycles to break the prototype creation into small incremental builds. This approach focuses on user testing/evaluation often and delivering functional parts of software as soon as its ready to end customers or for another software development cycle. By using an agile methodology, we could have potentially delivered multiple prototypes sooner while completing more user testing to produce an improved prototype in the end.



V. Results

A. Software Comparison Results

In our software comparison we have compared and contrasted Dropbox with six other software collaboration tools: Box, Microsoft SharePoint, Google Drive, Slack, OneDrive and GitHub. In the below table, for each software collaboration tool we have listed its audience, technical summary and advantages and disadvantages. Based off these results, we will analyze which areas Dropbox is most deficient in and propose which features from other collaboration tools can be reasonably implemented into Dropbox to improve Dropboxs overall usability, efficiency and functionality.

B. Software Comparison Ratings

Below is a table with a scoring breakdown on a five star scale of the different collaborative software. We analyzed each collaborative software based on the eleven dimensions from the Olson and Olson research paper How to Make Distance Work plus one more dimension, communication. The reason we included a communication dimension is that teams, especially distributed teams, require constant communication when working together. Below is a brief description of each dimension:

Speed of Software Response

- What is the total effectiveness of the system measured by throughput, individual response time, stability and availability

File Storage

What is the amount of storage space offered

Security

- What are the different types of embedded security features such as password protection, remote wipe, data encryption, data loss prevention, access tracking, and configuration management allowed

Privacy

- What are the different customizable levels of privacy and file sharing settings available

Accessibility

- What devices (desktop, web-based, mobile, tablet) can collaborative software be used on and how accessible is the system to all people regardless of disability/impairment

User Control

- What collaboration, content editing and role management features are provided by the software

Richness of Data Transmitted

- What types of files, documents, videos, photos and other multimedia forms can be uploaded/downloaded and shared

Ease of Use

- How intuitive and user-friendly is the software user interface

Contextual Info

- What type of contextual information is accessible (ability to create teams, share files, make comments and do file versioning)

Cost

- What is the monetary cost of the software for a given set of features

Compatibility with other applications

- What other applications (documents, communication, project management, etc.) are integratable into the software platform

Communication

- What built-in communication tools does the software provide

These ratings are based from our internal software comparison research, various software review platforms and Gartner Research. Gartner Research is a very reputable market research firm that publishes information technology insights such as Magic Quadrant matrices and IT vendor ratings. It is important to note that we only compared the features provided by the free or lowest cost software option because this is the option most likely utilized within an academic environment and also to keep the comparison consistent.

	Audience	Technical Summary	Advantages	Disadvantages
Dropbox	Primarily targets the consumer user with Dropbox (free version) but has launched Dropbox Business to enter the enterprise market[1]	Dropbox is a central repository for a user's documents, files, photos and videos. Anything added to Dropbox, will automatically sync changes with all connected devices and Dropbox website[2]	-Clean user interface -Free and relatively fast file syncing with most basic plan -Different pricing plans (including a free version) allow individuals and organizations to choose the right blend of functionality vs. cost -Compatible with Microsoft Online, Adobe, Slack, Salesforce, Trello, InVision and a host of other applications natively[3] -Can be accessed on all devices (web, mobile, computer) -Intuitive file sharing with other users	-Does not support real-time collaborative editing for hosted documents and files - Limited integration with many collaborative applications (Skype, WebEx, etc.) -Poor cost-to-storage space ratio[4] -Ambiguous landing page layout that show unnecessary features -Versioning history is not customizable by team/folder and temporary for 30 days
GitHub	Git repository that offers a version control system for software development primarily, however users can adapt GitHub for other purposes	Mostly used as a software development code repository and provides the following services through a web, mobile or desktop GUI: • revision control • source code management • access control • bug tracking • feature requests • task management • wikis[5]	-Users and organizations can create a free account or pay for a private repository with increased features[6] -Offers superior distributed version control/tracking using three features fork, pull request and and merge -Makes tracking of contribution on project teams easier[7]	-Unfriendly user interface for novice users -Not ideal for project teams that have simple workflows as GitHub would increase user overhead [8]-Not the best tool for capturing creative process or for recording ideas -Branching may create transparency issues as people cannot see what other people are doing

[1] http://www.cio.com/article/2947902/online-storage/can-Dropbox-go-from-consumer-hit-to-business-success.html

[2] https://www.Dropbox.com/tour/1

[3] https://www.Dropbox.com/business/app-integrations

[4] http://online-storage-service-review.toptenreviews.com/Dropbox-review.html

C. Analysis of Survey Results

We were curious in discovering what team collaboration tools students and faculty members had used and how they felt about these tools. Therefore, we surveyed students from almost all faculties and faculty members in the computer science department. 84 people participated in our survey. According to the responses, out of 84 participants, 82 participants had used softwares for collaborating with others as teams(Figure 3). In addition, 82.9 percent of the participants had used these tools mainly for school work(Figure 5). These statistics suggest that team collaboration software tools are widely utilized in the academic settings.

In the survey, we asked the participants about which team collaboration tools they used. Out of 84 participants, 55 used Dropbox, 71 used Google Drive, 25 used Slack, 41 used GitHub, 22 used OneDrive, 3 used Box, 11 used Microsoft Sharepoint and 4 used other tools(Figure 6). After comparing the number of Dropbox users to the number of users of Slack, GitHub, OneDrive, Box and Microsoft Sharepoint, we found that Dropbox still was the third most popular collaboration tool. For example, if we compare the 65.5 percent of participants using Dropbox versus the 84.5 percent using Google Drive, it implies there are some potential factors causing fewer users to use Dropbox.

Based on our preliminary literature reviews and in-depth software comparisons, we found that Dropbox had the following weaknesses:

- Potentially ambiguous landing page layout (user interface)
- Main functionality is not clearly explained in some places which can lead to poor affordances(user interface)
- Unsupported real-time collaborative editing for hosted documents files (communication)

Google Drive	Initially targeted the consumer user but has implemented new cloud and Docs features to target the enterprise user[9]	Primarily a file sync and sharing product used by hundreds of millions of users to securely store/access their files from any mobile or computer device[10]	-Default free account size that offers users 15 GB with option to purchase additional storage space or upgrade to Google Drive for Work	-Storage space is shared with Gmail inbox space -Sharing and editing privacy settings cannot be done in bulk for many files simultaneously -Need export Google Drive docs to preferred file format to edit in another program sometimes causing translation issues -Due to large amount of Google Drive features, especially real-time collaborative editing, this can negatively affect user performance
			-Intuitive UI because part of well-known Google Apps suite which many users have already adopted -Allows collaborative editing on a variety of file types: documents, spreadsheets, presentations and drawings[11] -Offers standard AES-256 bit encryption for all users -Good document searching functionality -Can be accessed on all devices (web, mobile, computer)	
MS SharePoint	Targets teams of all sizes, primarily enterprise usage but can be used in an academic setting	Businesses, organizations and project teams can use SharePoint to create websites and/or as a place to securely store, share, organize and access information/files from any device[12]	-Highly integrated with other Microsoft products and other systems[13] -Can be implemented as a cloud or on-premise solution -Offers a robust set of features that covers almost all aspects of project management[14] -Customizable security features and increased social networking abilities -File retrieval and access is relatively fast because SP is built on top SQL Server -Strong search functions and rights management -Offers many variable pricing plans for teams that only want a certain subset of the features	-No freemium version available and software is not ideal for individual users[15] -Increased UI complexity due to extremely rich set of features/capabilities -Steep learning curve for new users [16]-Lots of planning and governance is needed for SP to be implemented properly for large project teams

[6] https://github.com/pricing
[7] http://techcrunch.com/2012/07/14/what-exactly-is-github-anyway/
[8] https://www.g2crowd.com/products/github/reviews
[5] https://github.com/features
[9] http://www.computerworld.com/article/2491274/web-apps/google-targets-business-users-with-cloud-docs-advances.html
[10] https://apps.google.com/learn-more/gartner-mq-efss.html
[11] http://www.cio.com/article/2684057/cloud-storage/cloud-storage-users-share-pros-and-cons-of-leading-services.html
[12] https://support.office.com/en-us/article/What-is-SharePoint-97b915e6-651b-43b2-827d-fb25777f446f
[13] https://products.office.com/en-us/sharepoint/sharepoint-2013-overview-collaboration-software-feature
[14] https://www.g2crowd.com/products/sharepoint/reviews
[15] https://products.office.com/en-us/sharepoint/compare-sharepoint-plans
[16] http://www.softwareadvice.com/ca/bi/microsoft-sharepoint-profile/

MS OneDrive	Offers a standard and enterprise version of OneDrive and is suitable for all users	An online cloud storage service that integrates with Microsoft Office and available with all Windows 10 computers	-Allows users to simultaneously edit Office documents via computer or online browser[17] -Generous file storage space (10GB) with option to increase storage if needed -Tightly integrated with Office 365[18] -Allows repository-like document management functionality -Good at viewing multimedia presentations -Allows file tagging for easier search capability -Can be accessed on all devices (web, mobile, computer)	-Syncing can utilize a large amount of system resources inhibiting performance[19] -Limitation on number of file items but has option to upgrade -Requires a Microsoft account to use services[20] -Complicated folder structure and rights management -Known issues with filename format
Slack	Customizable and scalable for students, academics, working professionals and any collaborative group	A team collaboration tool that offers real-time messaging, archiving and search that is divided by different communication channels (groups)	-Offers a powerful free version for individual use and small groups[21] -Enables teams to organize conversations via project, top, team or any other group -Private channels and direct messages is available for sensitive communications -Files and documents can be shared via drag-and-drop functionality and allows file tagging -All messages, notifications and files in Slack are automatically indexed, archived and searchable -Possible to connect all your Slack to receive all notifications directly within Slack[22] -Can be accessed on all devices (web, mobile, computer)	-Maximum capacity of 10K messages for free version -Replacement for e-mail but not as a file repository/storage substitute -File sharing can be easily lost in the messages -Features tend to be hidden in various dropdowns/icons -Cannot view multiple channels at the same time
Box	Primarily targeting the business user	A web-based application that allows users to use cloud storage to store/manage all content and to share this content securely with other team members[23]	-Free personal version available for file storage and sharing capabilities -Relatively intuitive UI -Secure storage size of 10GB -Strong document encryption and other security controls -Microsoft 365 integration -Advanced user analytics available	-Maximum file size of 250MB for free version -Expensive to upgrade to Personal Pro edition ($11.50/month) for more flexibility and space -Emphasis on business documents means less robust photo and video capabilities [24]-No automatic synchronization between mobile and computer devices

[17] http://www.businessnewsdaily.com/6067-dropbox-vs-onedrive.html
[18] https://onedrive.live.com/about/en-ca/
[19] https://www.g2crowd.com/products/microsoft-onedrive-for-business/reviews
[20] https://onedrive.live.com/about/en-ca/
[21] https://slack.com/is

	Dropbox	MS SharePoint	Google Drive	Slack	OneDrive	GitHub	Box
Speed of Software Response	★★★★	★★★	★★★★1/2	★★★1/2	★★★1/2	★★★	★★★1/2
File Storage	★★★	★★★★	★★★1/2	★	★★★★	★★	★★★1/2
Security	★★★1/2	★★★★★	★★★1/2	★★★1/2	★★★★★	★★★★	★★★1/2
Privacy	★★★★	★★★★1/2	★★★★	★★★★	★★★★1/2	★★1/2	★★★★
Accessibility	★★★★★	★★★★	★★★★★	★★★★★	★★★★	★★1/2	★★★★★
User control	★★★1/2	★★★	★★★★	★★1/2	★★★	★★★★	★★★
Richness of Data Transmitted	★★★★	★★★★1/2	★★★★	★★1/2	★★★★1/2	★1/2	★★★★
Ease of Use	★★★★	★★★1/2	★★★★1/2	★★★	★★★1/2	★★1/2	★★★★
Contextual Info	★★★★	★★★1/2	★★★1/2	★★	★★★1/2	★★★★	★★★1/2
Cost	★★★★★	★★	★★★★★	★★★★★	★	★★★★★	★★★★★
Compatibility with other applications	★★★1/2	★★★	★★1/2	★★★★	★★★1/2	★★★	★★★
Communication	★★1/2	★★★	★★1/2	★★★★	★★★1/2	★★	★★1/2
Overall	★★★★	★★★1/2	★★★★	★★★	★★★1/2	★★★	★★★1/2

- Lack of built-in communication channels(communication)

These weaknesses related to user interface and communication were reflected in our user surveys. As shown in the survey, 65.4 percent of the participants rated the importance of user interface as 4 or 5(Figure 11). Also, 54.3 percent of the participants rated the importance of having video or audio calls as 4 or 5 while 28.6 percent participants thought it was important to have chat functionality included in the team collaboration tools.

D. Prototype Mock-up User Testing Results

Since the most essential part of any software device is client inclusion and software that is easy to use to ensure better overall results, we decided to conduct user testing. We used the cognitive walkthrough technique to inspect the usability of our Dropbox 2.0 mock-up. All four participants showed improvements in terms of task completion timing from one task to the next one. The mean time from task 1 to 2 were 1.320 and 1.275 respectively, with some improvements from task 1 to task 2. This could mean that after getting familiar with the system, the participants could easily accomplish their tasks.

Table 1: Participants task completion timings for each task

User	Task 1 (min)	Task 2 (min)
Beijia (Frances) Yu	1.17	1.00
Meric Demiriz	1.45	1.25
Jason Chen	0.49	0.80
Adnan Duale	2:17	2.05
Mean	1.320	1.275
Stdev	0.6954	0.5484

VI. Future Work

Based on initial feedback from presentations, results collected, and group reflection, the next steps that our research project needs are to continue to improve our Dropbox 2.0 mock-up, undertake a few more iterative cycles of user prototype testing, requirements analysis and prototype designing/coding to create a minimum viable product (MVP). Based on this MVP, we can either present findings and research to Dropbox or independently release a beta version to the public. Unfortunately, due to schedule constraints, co-op placements and graduation, some team members will not be able to continue on with this project.

VII. Conclusion

There exists a variety of software that a CSCW team may use to aid them in collaborative work. Software contains

different features that may either aid or hinder a teams work progress. Oftentimes, a team will have to use a variety of different tools to meet their design or work needs. By using a mix of subjective and objective software analysis, literature review, and user surveys, and by analyzing these results in terms of the framework proposed by Olsen and Olsen (2014), we were able to determine what features were effective in a collaborative tool. We took these features and incorporated them into a new Dropbox 2.0 prototype giving an already successful team software more value-added functionality.