Web-based shared workspaces for collaborative learning

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Abstract

There is growing agreement that group-based, collaborative learning approaches are more effective than traditional lecture-based instruction. Collaborative work is also an important trend in engineering practice. Team-based student design projects are very effective from a pedagogical standpoint, as well as developing skills in the collaborative design process. An important aspect of computer-based collaboration is a “shared workspace” to support a host of collaborative activities including communication and sharing of documents and information. This is the virtual equivalent of the traditional team project room, with its bookshelves and binders, filing cabinets, meeting table, whiteboard, and post-it notes. Despite their value, effective shared workspaces are not commonly available to student teams. As a result, students resort to more primitive means of communication and information sharing.

This paper outlines the general requirements for a computer-based collaborative workspace, and proposes the use of several complementary tools to support the requirements. In particular, preliminary experiences with Microsoft SharePoint Team Services are discussed. Initial student feedback has been very positive.

Background

In recent years, there has been a growing use of computer-based instructional technology to support learning. However, many of the tools and technologies have been developed and used without a clear idea of the pedagogical requirements. Bourne\textsuperscript{1} gives an excellent survey of the field of Asynchronous Learning Networks, which encompasses most instructional technologies. As this field becomes established, researchers are beginning to focus on designing systems based on pedagogical requirements\textsuperscript{2,3}. Pimentel\textsuperscript{4} starts with Kolb’s well-known experiential learning theory, and identifies the learning environments required to support different modes of learning (concrete experience, reflective observation, abstract conceptualization, and active experimentation). He shows that existing tools are suited to some modes and not others, and that some learning modes are poorly supported.
There is growing agreement that group-based, collaborative learning approaches are more effective than traditional lecture-based instruction. In addition, team-based collaboration has become a central element of the workplace as well. Broadly, collaboration involves a group of people working toward a common goal. Effective collaboration involves several key activities, including:

- Cognitive synchronization/reconciliation (establishing common purpose and goals)
- Developing shared meaning and shared memories
- Negotiation
- Communication of data, knowledge and information
- Planning and management of activities, tasks, methodologies

Many of the existing instructional technology tools have been developed to support content-delivery, and support for collaboration is weak. Curtis and Lawson analyzed student use of online technologies for evidence of collaborative behavior. Their study showed evidence of collaboration, but they speculated that the crude collaboration tools available to students probably affected the quality of collaboration. Chin and Carroll identified different modes of collaboration suitable for different activities, and matched them to existing technologies. They showed that no single tool supports all of the different modes, and that complementary tools are required.

There are many existing and emerging CSCW tools to support group collaboration in the workplace as well as in education. An important element of group collaboration is a “shared workspace”, which is a shared repository for all information and knowledge related to a project, including documents, drawings and models, analyses, presentations, schedules, messages, and so on. An effective shared workspace provides security and access control, protects data integrity through services like check-out/check-in and version management, prevents the creation of multiple inconsistent files, and is easy for designers and students to use.

There are a variety of collaboration systems available to support some of these functions. In the educational domain, systems include BSCW, Forum, and WebCT. General purpose commercial collaboration systems include Microsoft Exchange, Lotus Notes, and others. Systems intended for engineering design collaboration include Alibre Design and Ventro Collaborative Commerce Solution. However, many of these tools are either limited in collaboration functionality or are too expensive and/or complex for educational use.

An alternative approach is to use a collection of basic technologies to support communication and sharing of files among team members. These include:

- Email with file attachments
- A shared FTP network directory
- Microsoft Web folders
- Shared network folders

The author has experimented with various shared workspace methods over the past few years. A
simple and effective solution has proven to be shared network folders, which have been used to support team CAD projects in first year engineering graphics and fourth-year projects\textsuperscript{16,17}. The main disadvantages of shared network folders are that they are accessible only from the Local Area Network (LAN), and that they provide no collaboration support other than document sharing.

**Requirements for a shared workspace**

The following sections summarize key requirements for an effective shared workspace to support collaboration.

*Access control – accounts and roles*

It must be possible to restrict access to a shared workspace to members of the team. Different access rights must be possible, as well as different “roles”. A role is defined as a set of access rights for an identified group. For example, students would have different rights than instructors. Furthermore, access rights might change during the workflow. For example, documents that are submitted for marking should no longer be accessible to students, and when they are marked, the annotated document should be read only.

*Messaging and conferencing*

Support for communication among team members is a core requirement of any shared workspace. Generally, communication can be categorized several ways:

- **One to one.** This is communication between individuals.
- **One to many.** This is communication between an individual and the group. In a team, any member should be able to communicate with the group.
- **Synchronous.** This is real-time communication, in the form of an interactive dialog or conversation.
- **Asynchronous.** This is communication separated in time, where responses are not expected nor required immediately.

Teams communicate in all of these modes, using a variety of computer and traditional methods. These can be summarized in the following grid:

<table>
<thead>
<tr>
<th></th>
<th>Synchronous</th>
<th>Asynchronous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One to one</strong></td>
<td>Private meeting, telephone, on-line chat, desktop conference</td>
<td>Mail, fax, email, voice mail</td>
</tr>
<tr>
<td><strong>One to many</strong></td>
<td>Group meeting, teleconference, group on-line chat, desktop conference, videoconference</td>
<td>Email list, discussion board, website</td>
</tr>
</tbody>
</table>

To be most effective, any computer messaging system should have several attributes. Unfortunately, commonly used messaging systems have only a few of these attributes as described
Discussions threaded by topic. This is important for keeping messages grouped with responses so that the thread of a dialog can be easily followed. This is common with NNTP newsgroups and web-based discussion boards, but is difficult to achieve with email.

Messages archived and searchable. Messages are an important record of the team’s collaboration, and should be stored in a common, searchable message repository for future reference by all members of the team. Again, newsgroups and web discussions support this. Email typically relies on individuals to store and organize their own messages.

Notification of new messages. The system should notify team members whenever a new message is posted. Email does this automatically by putting messages into an in-box. Newsgroups and web discussions require users to explicitly check for new messages.

Multimedia content. Much communication within engineering teams is graphical and multimedia in nature. An effective messaging system should easily incorporate multimedia elements like sketches, diagrams, images, etc. Synchronous messaging systems incorporating whiteboards and application sharing have good capabilities in this area, but most asynchronous messaging systems need improvement. Including multimedia content currently requires complex methods like file attachments, HTML formatting, etc.

Information sharing and exchange
Teams typically work using a variety of software applications. In order to collaborate effectively, the team should use a common set of applications, with common file formats. Microsoft Office is a suitable de facto standard for many applications. Other standards should be established for common CAD and other engineering software. By adopting standards, team members can easily share and collaborate on digital documents and files.

Scheduling and calendaring
Scheduling tasks, milestones and meetings are common activities in teamwork. Excellent project management tools like Microsoft Project18 support some of the requirements. Scheduling of meetings can be facilitated by the adoption of group calendaring tools. Group calendars allow each team member’s calendar to be visible so that available meeting times can be automatically found without the usual cumbersome and time-consuming negotiations.

Workflow and task management
A team project typically involves the assignment of tasks to individual members. These tasks are interdependent so they must be coordinated with deadlines and detailed deliverables. Outputs of these tasks must be shared, combined, reviewed and approved.

The sequence of activities and tasks, with their inputs and outputs, can be defined as workflow.
Workflow systems require the definition of different roles, each with specific rights and responsibilities. Examples of roles would be browsers (who can only view information), authors (who can contribute information), and administrators (who manage the system). It is also useful to be able to categorize the status of a digital document, and to change its status based on actions associated with different roles. For example, we could categorize status as preliminary, in review, and approved. Only team members having a role including approval rights can approve a document to change its status.

Workflow processes can take several forms. Common ones include sequential processes where a document is passed from one person to the next in sequence, and parallel processes where a document is distributed to several people in parallel. Work rules define the actions required at each step (e.g. review, approve, etc.) before the document is released to the next step.

**Collaborative knowledge building**

The process of authoring and sharing digital information can be considered to be an aspect of collaborative knowledge building. For design teams, this is the digital equivalent of the traditional paper-based product development file. Several requirements can be identified.

**Shared document repository.** A shared repository is a network workspace where all team documents and files are located. The repository must provide access control so that only authorized team members can access it. Automatic version and revision control maintain a record of previous versions when changes are made. Check-in/check-out facilities ensure document integrity by allowing only one user to make changes at a time.

**Group editing and markup.** Group editing and markup of documents is a very widespread activity with paper documents. Digital tools allow users to edit and markup the file itself by inserting comments, annotations, suggested revisions, and so on. Input and feedback from many people can be compiled and reconciled to generate the final document.

**Group negotiation and decision support**

Negotiation and decision-making are core activities in collaborative work. Many decisions are made by the group, using discussion followed by voting or consensus. Software tools allow team members views to be surveyed, and support voting. Some systems incorporate more elaborate group decision support methods.

**Selection of collaboration tools**

Many tools exist to support one or several of the requirements described above, but the author is aware of no single system that provides best-of-class support for all of the requirements. An appropriate approach is to carefully select a few complementary tools to provide the necessary breadth of capabilities without unnecessarily sacrificing ease of use and integration.

A good collaboration toolbox might be comprised of the following complementary tools:
Each of these complementary tools is discussed in the following sections.

Email
We can assume that all students have email accounts, provided by the university or through some other service provider. Email is sufficiently ubiquitous and well understood that no further discussion is required here.

Email list server
Email list servers allow messages to be sent to a common mailing list for one-to-many communication. Lyris ListManager\textsuperscript{19} is an excellent email list server with many useful and advanced capabilities, including:

\begin{itemize}
  \item web-based administration
  \item powerful access control
  \item accessible through a browser or via email
  \item messages archived in threaded, searchable form
\end{itemize}

Synchronous conferencing
Synchronous conferencing, sometimes known as desktop conferencing, permits users to communicate and collaborate in real time using a variety of useful tools. Microsoft NetMeeting\textsuperscript{20}, available free from Microsoft, is a leading product for desktop conferencing. NetMeeting’s capabilities include:

\begin{itemize}
  \item video and audio conferencing over a standard internet connection
  \item real-time shared whiteboard with multiple remote participants
  \item real-time text-based chat
  \item file transfer
  \item program sharing to allow multiple remote participants to view and control a program running on one participant’s computer.
\end{itemize}

Microsoft SharePoint Team Services
Microsoft SharePoint Team Services is a set of collaboration services that run as an extension of Microsoft Internet Information Server 5.0 with Microsoft FrontPage server extensions. These services are included or are free with Microsoft Windows 2000 Server. Once installed, all user and administrative interaction is through a standard browser, although some capabilities require the Microsoft Internet Explorer browser.
Microsoft provides a good summary of the capabilities of SharePoint, reproduced in Table 1:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Web Site Template</td>
<td>Out of the box, SharePoint Team Services creates user-designed, customized and user-configured team Web sites.</td>
</tr>
<tr>
<td>Browser-based Authoring</td>
<td>Team members with appropriate permissions can author to the Web site using their 4.0 level or higher browser.</td>
</tr>
<tr>
<td>Pre-Formatted Team Lists</td>
<td>Share team information in a structured and uniform way using built-in lists such as events, announcements, discussions, and tasks.</td>
</tr>
<tr>
<td>Document Libraries</td>
<td>Document libraries allow users to upload documents, assign templates to libraries, and custom properties to documents within libraries.</td>
</tr>
<tr>
<td>Subscriptions and Notifications</td>
<td>Subscribe to lists and document libraries and receive notification when changes meet the criteria you set.</td>
</tr>
<tr>
<td>Document Discussions</td>
<td>Team members can use the discussions feature to conduct inline discussions on documents and other Web pages without affecting the source document.</td>
</tr>
<tr>
<td>Delegated Administration</td>
<td>Site owners and those with administrative privileges can set up user accounts for team Web sites through the browser.</td>
</tr>
<tr>
<td>Three-Click Installation</td>
<td>SharePoint Team Services automatically sets up the software required to search (Index Server) team Web sites and store data (MSDE).</td>
</tr>
<tr>
<td>Browser-based Customization</td>
<td>Members can customize existing lists using the browser to add new properties to lists and document libraries, specify custom views, or create entirely new lists and document libraries with unique properties.</td>
</tr>
</tbody>
</table>

One of SharePoint’s most impressive features is support for group discussions of HTML-based documents, including any website. The necessary “discuss” button has been included as part of Internet Explorer for some time. To enable the “discuss” tools, an account on a SharePoint server is required. These tools allow team members to add text annotations and conduct threaded discussions in the context of a document. Figure 1 shows a sample discussion of a web page on the Microsoft website. The discussion tools appear at the bottom of the browser window. Comments can be inserted, edited and deleted by clicking on the “sticky note” icons on the page.
Figure 1. Sample group discussion of document.

Evaluation and discussion of selected collaboration tools

These four tools are evaluated against the requirements in Table 2. For requirements not adequately addressed, additional tools are suggested. The comparison shows that no single tool supports all the requirements, and that the tools complement each other. There is also overlap in functionality, with multiple tools supporting the same function.

All of the tools provide some form of access control for security. Lyris ListManager, NetMeeting and SharePoint all have some notion of roles as well. This is typically implemented as different levels of user rights or permissions.

Email is the best tool for one-to-one asynchronous communication, while Lyris ListManager provides additional advantages for one-to-many communication. SharePoint also offers communication support through its message boards, but these are not as powerful as email or mailing lists. SharePoint can provide notification of changes (i.e., new messages), but the user must explicitly subscribe to them. SharePoint Team Services has no provision for global change
notification, where a message would be sent for any change to the web. This would be a useful addition.

NetMeeting is the only tool that supports synchronous collaboration. Its strengths are synchronous multimedia messaging and synchronous group editing. NetMeeting is not required for collocated teams who can meet face-to-face, but would be very important for distributed teams.

SharePoint Team Services is very strong in document sharing and asynchronous group editing. It lacks check-in/check-out and version control functions, but these are available in the more powerful SharePoint Portal Server.

The tools provide limited support for scheduling and calendaring, workflow and negotiation. Other tools exist for these functions, and future work will investigate further complementary tools to fill these gaps.
<table>
<thead>
<tr>
<th>Requirements</th>
<th>Tool</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>email</td>
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<tr>
<td>Access control</td>
<td></td>
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<tr>
<td>Login accounts</td>
<td>*</td>
</tr>
<tr>
<td>Roles</td>
<td></td>
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<td></td>
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<tr>
<td>Messaging and conferencing</td>
<td></td>
</tr>
<tr>
<td>Asynchronous</td>
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<tr>
<td>One-to-one</td>
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<tr>
<td>One-to-many</td>
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<tr>
<td>Threaded by topic</td>
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<tr>
<td>Archived and searchable</td>
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<tr>
<td>Notification of new messages</td>
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<tr>
<td>Multimedia</td>
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<tr>
<td>Synchronous</td>
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<tr>
<td>One-to-one</td>
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<td>Notification of new messages</td>
<td></td>
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<tr>
<td>Multimedia</td>
<td></td>
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<tr>
<td>Information sharing and</td>
<td></td>
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<tr>
<td>exchange</td>
<td></td>
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<tr>
<td>Document distribution</td>
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<tr>
<td>Document publishing</td>
<td></td>
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<tr>
<td>Collaborative knowledge</td>
<td></td>
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<tr>
<td>building</td>
<td></td>
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<tr>
<td>Check-in/check-out</td>
<td></td>
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<tr>
<td>Version management</td>
<td></td>
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<tr>
<td>Shared document repository</td>
<td></td>
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<tr>
<td>Group editing</td>
<td></td>
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<tr>
<td>Scheduling and calendaring</td>
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<tr>
<td>Gantt charts</td>
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<tr>
<td>Group calendars</td>
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<tr>
<td>Workflow and task management</td>
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<tr>
<td>Task assignments</td>
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<tr>
<td>Workflow modeling</td>
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<tr>
<td>Workflow support</td>
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<tr>
<td>Group negotiation and</td>
<td></td>
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<tr>
<td>decision support</td>
<td></td>
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<tr>
<td>surveys</td>
<td></td>
</tr>
</tbody>
</table>
* - some support  ** - strong support
Notes:

1. Subscription and notification service.
2. NetMeeting announces incoming calls.
3. These capabilities are available with the more powerful SharePoint Portal Server.
4. Synchronous group editing is possible using a shared program like a wordprocessor in NetMeeting.
5. Microsoft Project has many task scheduling and tracking capabilities.
6. Group calendars can be implemented using a variety of tools. Microsoft Exchange includes group calendars.
7. Microsoft Office combined with Microsoft Exchange provides some basic workflow support.

Case study
The author implemented and piloted Microsoft SharePoint Team Services in the fall 2001 term at the University of Western Ontario. This required the acquisition and installation of a new server running Windows 2000 Server with Internet Information Server (IIS) 5.0 and FrontPage 2002 extensions. SharePoint Team Services is bundled with Microsoft FrontPage 2002.

Installation was straightforward, with no unexpected difficulties. Total server software installation, including operating system, took a couple of hours, and consisted mostly of inserting necessary CDs and clicking “OK”.

Due to delays in delivery of the server hardware, SharePoint was not available until a month or so into the term. After brief orientation with regard to SharePoint administration, the author created pilot SharePoint webs for student teams in two courses: MME473a – Computer Integrated Manufacturing, and MME 419/499 – Capstone Design Project. Student use of these webs was optional, and no training was provided.

**MME473- Computer Integrated Manufacturing**
MME473a involves a significant team project, with 38 students working in 11 teams. SharePoint webs were implemented for all teams, and students were encouraged to make use of them. Six teams made use of their SharePoint webs.

**MME 419/499 – Capstone Design Projects**
MME 419/499 is a capstone design course involving over 90 students working in 34 design teams. SharePoint webs were offered to teams who requested them. By early January 2002, eight teams were using SharePoint actively. In particular, three teams of 3 were working together to design a robot for a “robot wars” competition, and 10 students divided into 3 subteams were working on a spacecraft systems design project.

Figure 2 shows a screen shot of several SharePoint document libraries created by the UWO
Spacecraft Systems Design team. The overall navigation and look of a SharePoint web can be seen from this figure as well. Figure 3 shows a sample listing of documents in a SharePoint document library. Documents can be uploaded, opened, edited, searched and sorted by clicking on the appropriate command in the browser.

Figure 2. SharePoint document libraries for spacecraft design team.
Observations

Despite the late start and lack of training in the use of SharePoint, a significant number of student teams made good use of it. All teams used document libraries for sharing files. Other SharePoint tools were used less frequently, and many features were not used at all. This observation suggests that document sharing is the key requirement for collocated teams. Students were particularly happy that team documents could be accessed from home over the Internet.

Tools and features that were used by at least one team included:

- document libraries
- announcement lists
- discussion boards
- web links lists
- event lists
- task lists
- contact lists
Relative usage of these tools in nine project webs is broken down in Figure 4.

Figure 4. Usage of SharePoint Tools

Student use tended to focus on a few key tools, and many useful and important capabilities were overlooked. In almost all cases, students were unaware of useful capabilities like subscriptions and notifications, and document discussions.

Student feedback
A student survey was conducted using the SharePoint survey tool. A total of 7 students responded. While this is a small sample size, feedback was very positive as shown in Table 3.
Table 3. Summary of Student Feedback.

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses Percent (number)</th>
<th>Median</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>How useful did you find SharePoint in supporting your team project?</td>
<td>0 0 0 71 (5) 29 (2)</td>
<td>4</td>
<td>4.3</td>
</tr>
<tr>
<td>How much did you use SharePoint?</td>
<td>0 0 43 (3) 43 (3) 14 (1)</td>
<td>4</td>
<td>3.7</td>
</tr>
<tr>
<td>Based on what you have seen of it, how useful do you think SharePoint could potentially be if you were more familiar with it?</td>
<td>0 0 14 (1) 43 (3) 43 (3)</td>
<td>4</td>
<td>4.3</td>
</tr>
<tr>
<td>Do you think SharePoint should be available to all student project teams?</td>
<td>0 0 0 100 (7)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Compared with other software you've used, how easy was SharePoint to learn and use?</td>
<td>0 0 14 (1) 29 (2) 57 (4)</td>
<td>5</td>
<td>4.4</td>
</tr>
</tbody>
</table>

The survey results suggest that while students did not fully utilize SharePoint, they recognized its potential usefulness. They found it easy to use, and most significantly, they were unanimous in strongly agreeing that SharePoint should be available to all student project teams.

Sample comments

Student comments about SharePoint suggest that notification of changes is an important requirement for a shared workspace. Otherwise, the comments were very positive as shown below.

“Sharepoint worked well for our team. One feature that I would like to see is e-mail sent to team members when something new is posted. You can't always trust that the other team members are frequently visiting the site. Another similar program that I used for a project with Ivey is Community Zero. This program had the e-mail notification feature that was very useful.”

“Sharepoint is an excellent communication tool for engineers and other students alike working on deadline oriented projects. I hope that in the future more course instructors make Sharepoint part of their teaching strategy.”

“Needs more awareness, when members of the group check sharepoint once or twice per day and respond then the sharepoints acts like a information node...that works. When group members hardly read it, except to upload documents and download others, it no better than email. I like the convenience of no disks and not relying on email, the work is where ever the internet is.”

“I wish that I started using it earlier in the semester. Maybe if you made it an assignment worth a couple of marks early in the year more people would use it for the first time, and then like me get hooked and use it all the time. It would also be nice if the students could set up there own sharepoints as they require, instead of having to go through you. I also feel that I could make use...
of my own personal sharepoint for accessing my own files from where ever I may be. I think it would be great if each student was given their own space the moment they register in first year.”

“Sharepoint is useful system, especially in maintaining report documentation. It was easy to use, and documentation was immediately available upon submission to the site. Sharepoint should remain an essential part of the MME 473 course, as the documentation is kept organized and accessible to all members at any time.”

Discussion and conclusions
Preliminary experience with SharePoint Team Services suggests that this tool is a useful component of a shared team workspace, satisfying many of the requirements of collaborative work if combined with complementary tools. It is easy to install and administer, and students find it easy to use. It is web-based, with a browser interface, making it accessible from anywhere.

SharePoint has many more advanced features like document discussions and subscription-based notifications that were not much used by students despite their value. To some extent, this is due to lack of familiarity and training. Further experience is required to assess the value of these tools.

SharePoint Team Services lacks some important capabilities found in the more powerful SharePoint Portal Server, particularly check-in/check-out document control, and automatic version management. Administration of SharePoint webs was a bit tedious as the administration tools are quite elementary. Also, SharePoint Team Services does not allow a user to subscribe to an entire web for notifications. This requires subscriptions to each part of the web, which is cumbersome when many webs are being monitored for changes.

Despite its limitations, SharePoint Team Services provides important collaboration capabilities not otherwise available at the University of Western Ontario, or at universities in general. Students using SharePoint were unanimous in their strong agreement that this capability should be available to all student teams. This supports the argument that effective tools to support collaborative learning are of strategic importance, and that more effort is required to make them available to students.

References


Hanna, Donald E., and associates; *Higher Education in an era of Digital Competition*, Attwood Publishing, 2000, p.60


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