CLOUD NOTEBOOKS: AN ALTERNATIVE TO A TRADITIONAL LEARNING MANAGEMENT SYSTEM (LMS)

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ABSTRACT

This paper describes the design and implementation of a Learning Management System (LMS) based on cloud notebooks and cloud storage. Cloud notebooks were developed to replace a Google Sites-based course website that previously functioned as an LMS. Prior to using the course website, Moodle was used briefly as the LMS. Compared to these two previous systems, the current notebook based LMS, also referred to as a Learning Management Notebook (LMN), is simpler to use and navigate. It can easily be modified, updated, and maintained by an instructor and lends to rapid development using affordable cloud resources. The paper discusses the user interface design, the mapping of a previously implemented course website onto a set of cloud notebooks, and the integration of the notebooks with cloud storage. It also describes the features that can be added to expand the scope of the LMN. Based on the experience gained with the deployment of the LMN in different courses, the advantages and disadvantages of using the LMN are discussed. The conclusion arrived is that, depending on the degree to which an instructor chooses to use the features of a typical LMS, the cloud-based notebooks can be a viable alternative to a traditional LMS such as Moodle or Canvas. When used in conjunction with cloud storage, a tablet computer and a collaboration platform such as Microsoft Teams, the LMN can offer many of the same features and advantages of a traditional LMS, but with better customizable options and easier navigation and manageability.

Keywords: e-learning, LMS, OneNote, cloud notebooks, LMN

INTRODUCTION

The objective of this paper is to discuss the possibility of using readily available and affordable cloud resources to configure an LMS that is easy to develop, deploy, manage, navigate, and use. Throughout this paper, the proposed LMS is referred to as a Learning Management Notebook or LMN. It incorporates the most frequently used features of a traditional LMS and has the following desirable characteristics to make the LMN an attractive alternative to a mainstream LMS such as Canvas.

- Rapid development with minimum or no coding required to configure the LMN
- Easy deployment and management of the LMN in the cloud
- Real-time updating of contents
- Seamless integration of the LMN across multiple devices
- Automatic backup and restoration of the LMN for high availability and reliability
- Availability to teach offline, if needed, without an Internet connection
- Usability as a whiteboard for in-class teaching

Since the proposed LMM is based on readily available cloud resources, it can be deployed in an institution that does not have a traditional LMS. Others have also discussed the possibility of using cloud resources to create a learning platform that could be substituted for an LMS (Wright, Lopes, Montgomerie, Reju & Chmoller, 2014). These resources can support not only the storage and retrieval of course-related information, but also the deployment of virtual computing laboratories in the cloud thereby enabling a comprehensive e-learning portal to be hosted in the cloud (Stefan, 2014). A discussion on virtual labs is beyond the scope of this paper, leaving the development of the LMN to be presented here, starting with a survey of the literature on potential applications of cloud notebooks in different scenarios.

LITERATURE SURVEY

When cloud notebooks were first introduced, they were designed for simple note-taking applications. Their use in education became widespread as notebook software evolved to take advantage of the collaboration features of cloud computing across multiple devices and users. Numerous scholarly articles have since been published exploring the potential applications of notebook software such OneNote in teaching, including a graduate thesis that evaluated, in detail, the use of OneNote in a secondary school (Patchigalla, 2019).

Among the early adopters of cloud notebooks in higher education were those involved in teaching laboratory classes. A number of articles have highlighted the usefulness of OneNote as an Electronic Laboratory Notebook (ELN) (Bertram, 2019). OneNote as an ELN can be adopted for both scientific and nonscientific applications (Guerrero, López-Cortés, García-Cárdenas, Saa P, Indacochea, Armendáriz-Castillo, Zambrano, Yumiceba, Pérez-Villa, Guevara-Ramírez, Moscoso-Zea, Paredes, Leone Paola & Paz-Y-Miño, 2019). Extensive research and user study on the adoption of ELN has shown that an ELN built upon a pre-existing cloud notebook platform can help overcome the barriers to the adoption of ELN (Kanza, Willoughby, Gibbins, Whitby, Graham, Erjavec, Zupančič, Hren & Kovač, 2017). The barriers cited were the cost of currently available ELNs, their ease of use, and their accessibility across different devices and operating systems.

In a detailed study exploring the effectiveness of OneNote, multimedia course contents were distributed in a OneNote class notebook to be utilized by the students and faculty members for collaboration (Campbell, Wilson & Olson, 2017). In this study, the students were surveyed on the use and acceptability of the OneNote-based learning platform. The results demonstrated that although the students were initially skeptical of using a university mandated electronic resource such as a note-taking tool, many reported increased efficiency and better organization of their studying habits (Campbell et al., 2017).

As the studies confirm, there are many reasons for using cloud notebooks to support teaching and learning. For example, notebooks allow documents to be organized in a structured manner and annotations to be easily added. Links to Web sites can be included and accessed on the fly, and clippings from external programs can be inserted with ease (Tofan, 2018). OneNote, for instance, excels in being able to incorporate multimedia modules in its notebook pages. Embedding the modules in a notebook page is easier than incorporating them in a typical LMS. Multimedia capabilities of notebooks allow for the inclusion of cases, articles, videos, files, and webpage clips

in them that further enhances the learning experience of students (Calle, Bonfante-Mejia1 & Riascos, 2019).

When used in conjunction with other cloud resources such as SharePoint or OneDrive, OneNote can be used to create a fast, flexible and user-friendly collaborative workspace that carries a low training burden (Barber, Haque, & Gardner, 2009). OneNote's collaboration capabilities can be expanded further with Microsoft Teams enabling students working in groups to be assigned specific tasks and due dates, and the lecturer to view the progress of each group to be able to provide feedback online (Wajrak, 2019). According to Wikipedia, Microsoft Teams is defined as a unified communication and collaboration platform that combines persistent workplace chat, video meetings, file storage (including collaboration on files), and application integration (Wikipedia, 2019).

The overall picture that emerged from the survey of the literature was that OneNote, when used in conjunction with other services such Microsoft OneDrive/SharePoint and Microsoft Teams, and a tablet computer can help create a flexible and easy to navigate learning environment that is conducive to teaching, learning, and collaboration. Although the articles surveyed highlighted the many useful features and attributes of OneNote and its varied applications in education, none have presented a systematic approach to developing a OneNote-based learning platform that could be used as a substitute or a replacement for an LMS. As such, this paper and the accompanying discussion on LMN serve a unique purpose.

EVOLUTION OF THE E-LEARNING PLATFORM

The LMN presented here represents the current stage of an evolving e-learning platform that initially started with the deployment of a stand-alone course website. Table 1 lists the various stages of the development of the learning platform. The earlier stages of development have been chronicled elsewhere (Ganesan, 2013; Ganesan 2012). Prior to the development of the LMN, the instructional materials consisting of PowerPoint slides, Word documents, multimedia modules, and audio reviews were stored in Google Drive and accessed via a course website designed using Google Sites. In the current LMN, the website has been replaced by a set of OneNote notebooks stored in the cloud, and the course materials have been moved from Google Docs to OneDrive. The reasons for choosing OneNote and OneDrive as the development and hosting platforms are discussed in the following section.

Table 1. Evolution of the E-Learning Portal

LMS Hosting Platform	**Software and Services Used**	**Responsibilities**	**Location**
Local webserver	Windows Server, Internet Information Server, FrontPage	Implement and maintain both servers locally, design the course website using FrontPage and store course materials on local servers	On-site

University webserver	Apache Server, FrontPage, FileZilla	Design the course website using FrontPage and upload the site and course materials to Apache using FileZilla	On-site
University LMS	Moodle	Use Moodle to configure the user interface to access course-related information and upload course materials to Moodle	Private Cloud
Cloud-based website and storage	Google Sites, Google Drive, YouTube	Design the course website using Google Sites and store the course materials on Google Drive and YouTube	Public Cloud
Cloud-based notebook and storage	OneNote and OneDrive	Design the user interface using OneNote and store the course materials on OneDrive	Public Cloud
Multiple cloud resources that support extensive collaboration Features (Future)	OneNote, OneDrive, Teams, and Zoom.	Use OneNote as the gateway to course materials, store materials on OneDrive, and develop a platform for collaboration using Teams and Zoom.	Public Cloud

CHOOSING A DEVELOPMENT PLATFORM FOR THE LMN

When cloud notebooks were initially being explored as a possible hosting platform for the LMN, only a few cloud notebooks were available in the market. The three prominent cloud notebooks at that time were Evernote, Google Keep, and Microsoft OneNote. Although other cloud notebooks have since appeared on the scene, all three notebooks remain as leaders in the field of notebook software (Moreau, 2019). Among them, Google Keep was initially considered for the development of the LMN since the course materials were already stored on Google Drive. However, after reviewing Google Keep, OneNote, and Evernote, OneNote was chosen for the following reasons.

First and foremost, OneNote is intuitive to use since it mimics the user interface of a traditional notebook that is familiar to students from the very early days of their schooling. Studies have also shown that OneNote has features that are conducive to traditional notetaking and learning that further enhances its usefulness as a learning tool (Dieck-Assad, 2018). Others have also found OneNote to be the notebook software of choice in an academic environment (Guerrero et al., 2019). Moreover, a special version of OneNote, known as OneNote Class Notebook, is available to expand the functionality and features of the proposed LMN, if needed.

Another reason for preferring OneNote over the other notebook software is that OneNote is tightly integrated with Office 365, the software suite that is widely used for creating documents and presentations. Also, Microsoft OneNote can readily be integrated with a cloud service such as Microsoft Teams for creating effective online classroom space for collaboration. Being able to seamlessly integrate OneNote with other services was yet another compelling reason for choosing OneDrive to complement OneNote as the cloud storage service. Having chosen the development platform, the next step was to configure an appropriate user interface using OneNote.

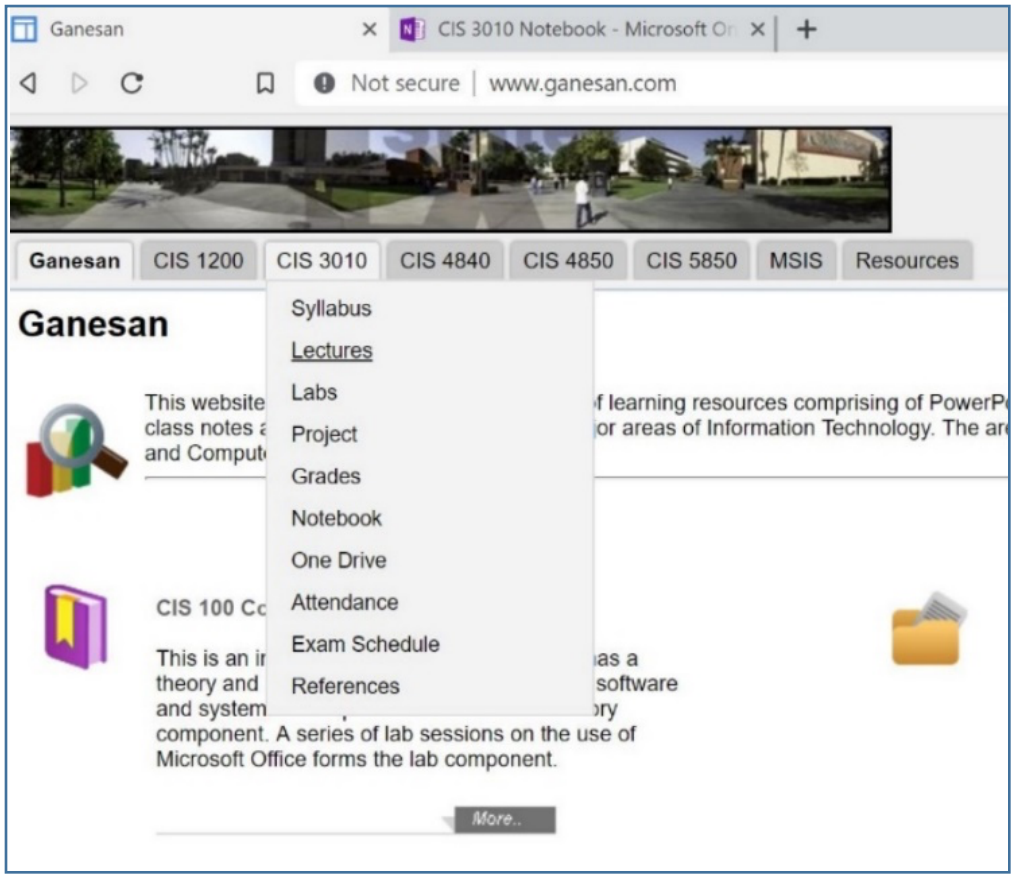
EVOLUTION OF THE USER INTERFACE

The structure of the user interface evolved over time, beginning with the initial development of the course website. It was refined after reviewing the course structure of several popular online courses. In particular, the courses offered by leading MOOCs (Massive Open Online Courses) providers such as Coursera, EdX, and Udemy were examined to arrive at a user interface that was simple to comprehend, but effective at providing easy access to the most frequently retrieved information by the students. For the most part, a common user interface prevailed across the courses offered by the MOOCs providers that constituted the following:

- Course syllabus
- Outline of weekly coverage consisting of Slides, Videos, Reading Assignments, Exercises, and Quizzes applicable to each week
- Course materials stored in the form of PowerPoint slides, Word documents, pdf documents, video modules, and audio modules
- Reference material presented as pdf documents or as links to webpages
- Quizzes and homework assignments
- Project-related information, if projects are assigned as part of the course
- Discussion forums
- Contact and other general information

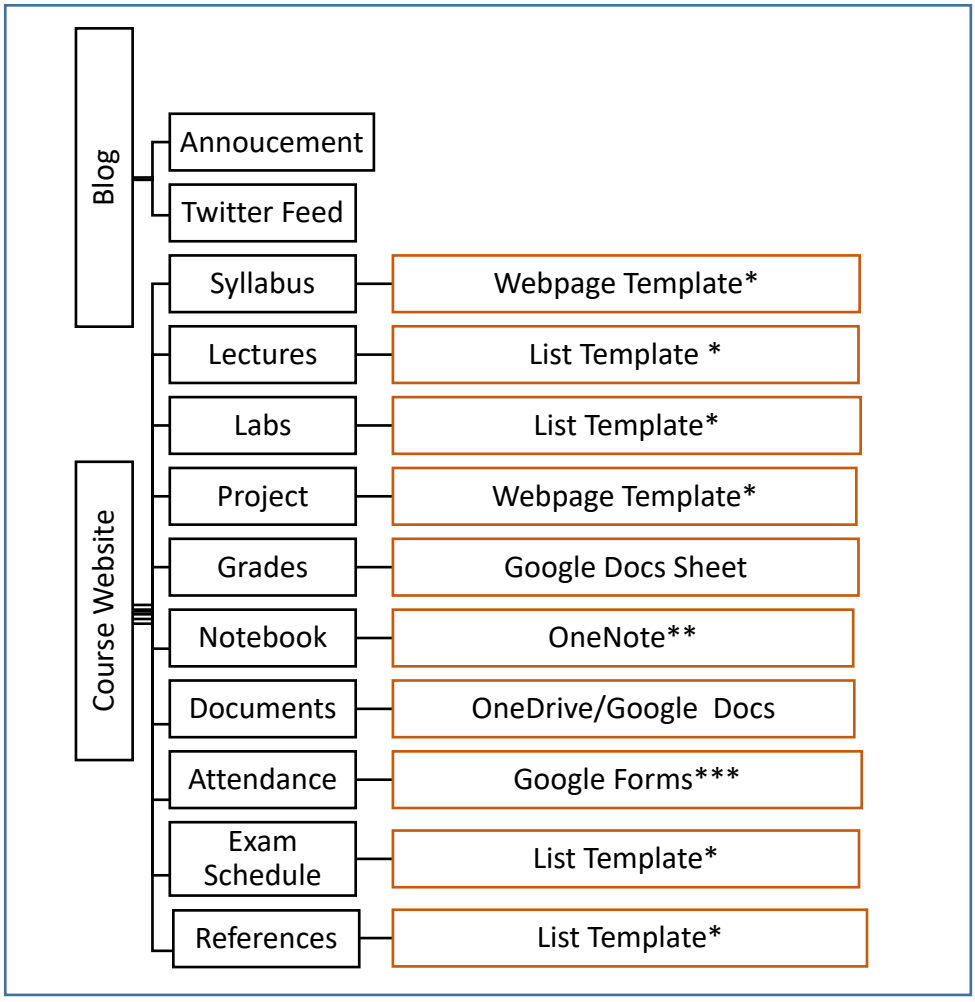
As the course website was primarily intended to support face-to-face and hybrid classes, discussion forums and quizzes were considered to be in-class activities and were not included in the user interface. The rest were incorporated in the user interface of the course website as shown in Figure 1. The interface presented represents the class entitled CIS 3010 Management Information Systems which is one of the five courses originally hosted on the course website. Being a common core course in the Business curriculum, CIS 3010 was chosen as an appropriate example to be used throughout this paper to explain the mapping of the user interface to the LMN.

Figure 1. Website User Interface for CIS 3010



In the earlier course website, webpages corresponding to the different links in the drop-down menu, shown in Figure 1, were created to access the course syllabus, course materials, exam related information, project details, and references. Together, they represented the frequently accessed pages from a typical LMS. Different pages on the website were created using different templates available in Google Sites. Figure 2 summarizes and shows the webpages created, the templates used for creating the webpages, and the links that interconnected the pages on the website. Using these templates, a comprehensive course website was developed and implemented without having to write any code at all.

Figure 2. Site Map for the Course Website



* Google Sites templates used.
** This link was introduced after the development of the notebooks to facilitate access to the notebooks.
*** Google Forms is a separate feature of Google Docs that is not part of the templates in Google Sites.

MAPPING OF THE COURSE WEBSITE ONTO CLOUD NOTEBOOKS

As the next step, the webpages and navigation links shown in Figure 2 were mapped onto the notebook pages and tabs respectively. For each course, a separate notebook was created to map the course contents. Figure 3 shows the structure of the notebook created to map the course contents of CIS 3010. The first tab in the notebook pointed to a page containing the syllabus and the office hours. A screenshot of this page is included in Appendix A. The second tab, shown in Figure 4, pointed to the Weekly Coverage. Under this tab, links were created to access various course materials that included slides and multimedia instructional modules stored on OneDrive (Ganesan, 2009; Ganesan, 2007).

Figure 3. Class Notebook Structure

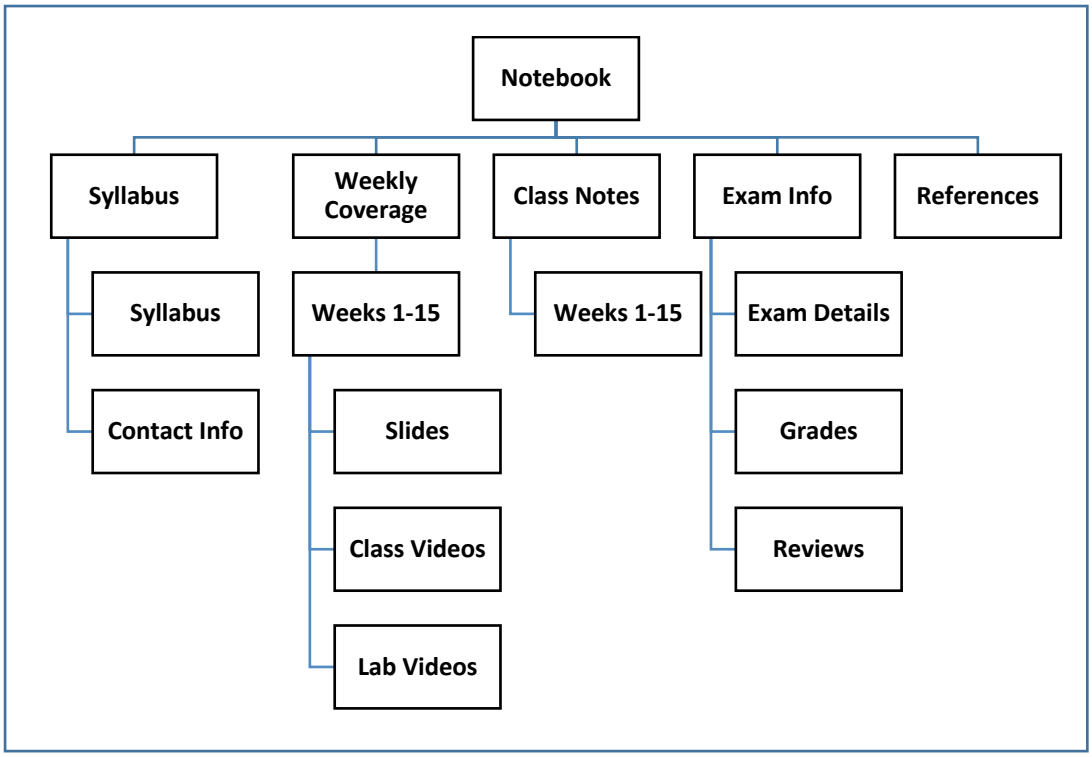
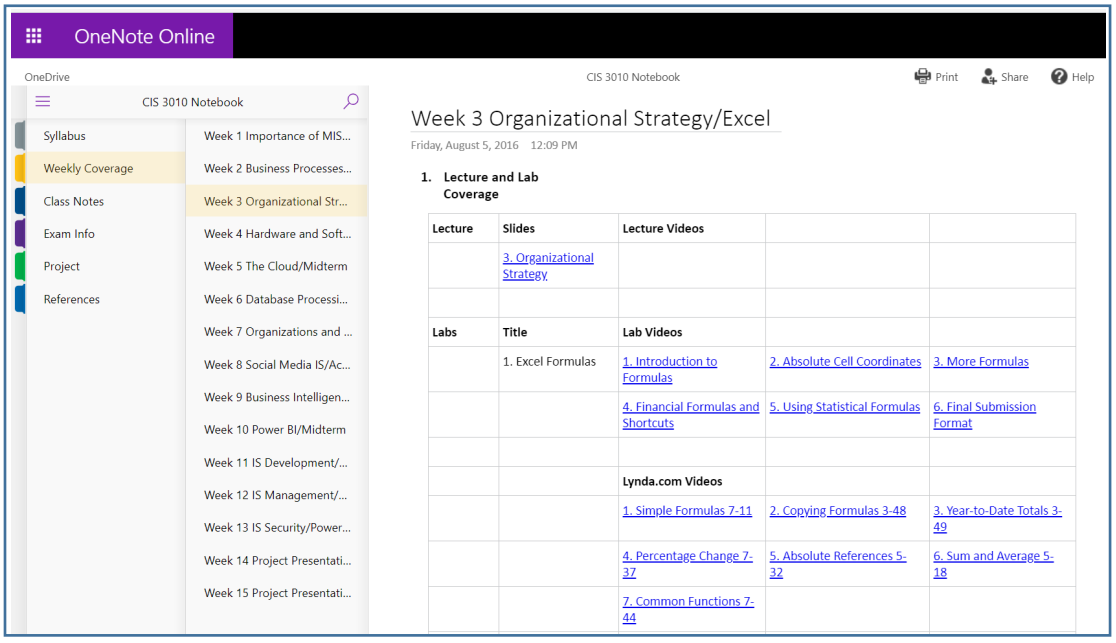


Figure 4. Week 3 Weekly Coverage

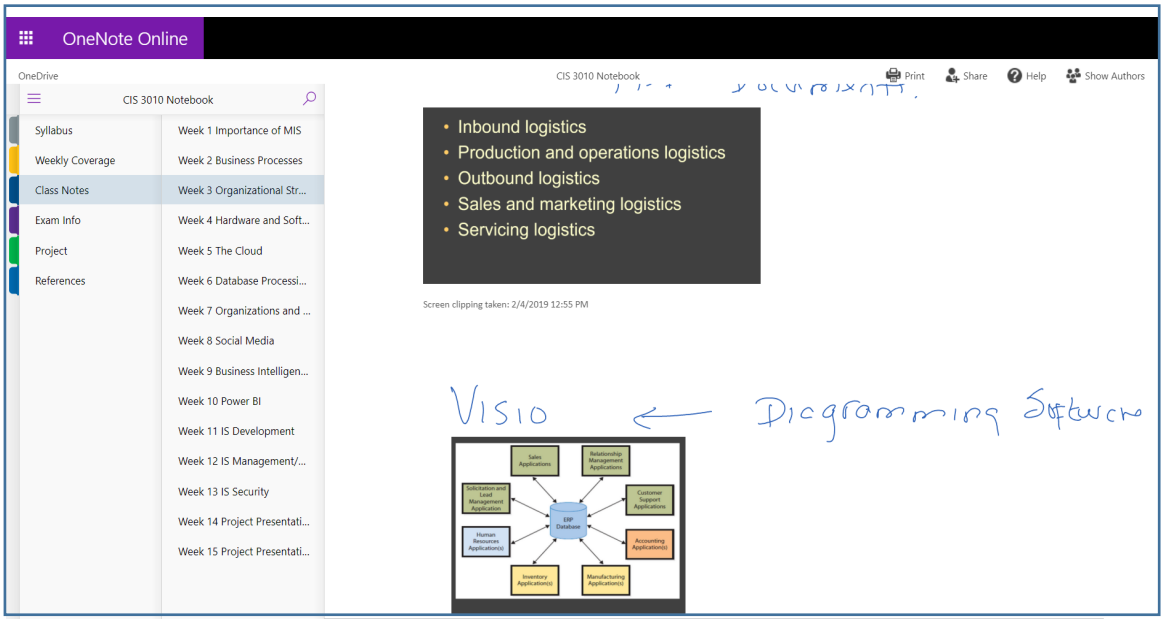


The third tab in the notebook pointed to the page entitled Class Notes that was used for writing notes during a lecture. The Class Notes page served the added purpose of emulating a cost-effective whiteboard for writing, storing, and retrieving handwritten notes when the notes were written on

a tablet computer and projected on to a screen. Others have also noted that, when used with a tablet PC and a stylus, OneNote can be effective in eliminating the need for blackboards, whiteboards, or other presentation software for writing and displaying hand-written notes (Tofan, 2018). Moreover, the notes stored on the Class Notes pages can be accessed by the students for later reference.

If required, the handwritten notes can be converted to typed notes by the ink-to-text conversion feature supported in OneNote. Also, images, audio clips, and video modules can be embedded in a notebook page thus enabling the page to effectively serve as a repository for multimedia learning resources. Other than multimedia modules, real-time screen images can be captured with ease and stored on a notebook page using the screen capture option provided in OneNote. Figure 5 shows a Class Notes page containing handwritten notes and a diagram captured during a lecture. The on-the-fly screen capture feature of OneNote was found to be very helpful in capturing and storing screen images such as, for example, the screenshot of a webpage referenced during a lecture.

Figure 5. Class Notes Captured and Stored in Class Notes Page



Another advantage of using the notebook as a whiteboard is that the students seated at the back of a classroom can view the projected screen by opening the notebook page on a computer in front of them since the notebook page is shared over the Internet and displayed in real-time. The option to view the Class Notes page in real-time could be beneficial if the course is to be streamed online using Zoom, for example, to the students who are unable to attend the class. In this case, a microphone and a camera are the only additional hardware required to turn the LMN into a platform for delivering synchronous online instruction (Ganesan, 2007).

Finally, in addition to the tabs discussed in this section, a few other tabs were created to present exam related information, project details, and an expanded list of references. Screenshots of notebook pages corresponding to the tabs that provide information on the exam and project are included in Appendix B and Appendix C respectively. These pages shown in the appendices along

with the other pages discussed in this section constitute the overall design of the LMN with the exception of the pages required for managing attendance and administering examinations.

ATTENDANCE MANAGEMENT AND ADMINISTRATION OF EXAMINATIONS

Both attendance management and the administration of exams or quizzes can be implemented and managed using the Forms software that is part of the Office 365 suite of software. A screenshot of a form created to manage attendance is included in Appendix D. The data on student attendance obtained through this form is stored in a spreadsheet enabling the data to be analyzed later. As for the exams and quizzes, Google Form that was used in the previous course website to create online quizzes can still be used to create and administer the quizzes. In this case, an add-on known as Flubaroo can be employed to grade the quizzes automatically.

On the other hand, the quizzes can also be created and managed using the Forms software which is a component of Office 365. If more advanced features are needed, there are several online quiz-making software available for creating and administering the quizzes and linking them to the notebook (Winsted, 2020). Since the LMN discussed here is intended for in-class and hybrid courses, paper-based quizzes and examinations were reinstated to ensure proper monitoring of the tests. As such, the quizzes and exams were neither conducted online nor included in the LMN.

CLOUD STORAGE AND SYNCHRONIZATION

One of the important advantages of the LMN discussed in the previous sections is the synchronization of notebooks across multiple devices such as tablets, desktops, laptops, and smartphones. When an LMN is created, the master copy of the LMN is stored in the cloud with a local copy stored on the local device. Both copies remain synchronized at all times. If desired, the notebooks can be copied and synchronized across multiple devices such as a home computer, an office computer, and a laptop computer.

The synchronization of notebooks automatically updates all the copies of a notebook stored on different devices thus providing an additional layer of protection against the loss of data. Another advantage of synchronization is that, by using the local copy of an LMN, a course can be taught even when there is an interruption in the Internet connection. In this case, as soon as the Internet connection is reestablished, the edited notebook on the local computer is automatically synchronized across all the devices through the master copy of the notebook stored in the cloud. This will ensure that the copies of notebooks stored on different devices remain updated in a timely manner.

Also, when the single sign-on option is used to log into a local device, the user is authenticated to access not only the local storage space but also the cloud storage space that is mapped to the local computer. As a result, the LMN can be opened directly from the local drive of a device without having to additionally log into a cloud service. The same applies to the course materials as well. As such, the notebook and the courser materials stored in the cloud appear to the instructor as files stored natively on the local computer. Moreover, a fringe benefit of synchronizing the files and notebooks across all devices is that, when an old computer is replaced with a new computer, the

notebooks and the course materials are automatically copied to the new computer, provided the single sign-on option is adopted and chosen to log into the computer.

OTHER ADVANTAGES

In addition to the advantages of synchronization and the single sign-on feature discussed, there are also other advantages of using a cloud notebook to design and implement an LMN. Notebook pages, for example, can easily be updated in real-time similar to updating a page in a word processor. A separate web server or a streaming server is not required to stream the multimedia modules embedded in the notebook pages since OneDrive, by default, will stream the modules. Notebook pages stored on OneNote can also be selectively shared among and with students for such purposes as starting a discussion forum. Announcements, on the other hand, are easier to post on a notebook page compared to creating a separate blog for that purpose.

Equally important is the fact that OneDrive and OneNote are available free-of-charge by registering for a personal account with Microsoft. For most applications, the free and private account offered by Microsoft is adequate to implement the notebook based LMS. Many colleges subscribe to Office 365 thus making OneNote and OneDrive with additional features freely available to faculty members and students. The caveat on using the account provided by a school is that the students will lose access to the LMN and course materials once they graduate from the school or complete a particular course.

Overall, a cloud-based LMS such as the proposed LMN offers many advantages that include low implementation cost, instant updating of cloud software, improved compatibility with different document formats, and better information security (Ghazal, 2015). Moreover, the ease of use and the usefulness of cloud-based file hosting services are perceived to be higher by students when compared to traditional LMS tools and services (Stantchev, Colomo-Palacious, Soto-Acosta & Misra, 2014).

EXPANDING THE SCOPE OF THE LMN

Given the advantages discussed in the previous section, the LMN can be a viable choice as a learning platform, especially when only the most frequently used features of a typical LMS are needed and used by an instructor. If advanced features are required, the scope of the LMN can be extended further by using a special type of notebook known as the Class Notebook. It is a free add-on module available for OneNote.

A Class Notebook has three components, a Content Library, a Student Notebook, and a Collaboration Space (Microsoft, 2019). Each one is a notebook by itself, but with different features and functionalities to serve different purposes. The Content Library could be considered as a sub-notebook, created within the parent notebook, for sharing course materials such as syllabi, Word documents, PowerPoint slides, etc. with the students. This notebook can be viewed and edited by the instructor. The students can only view the notebook.

A Student Notebook, on the other hand, is created for each student in the class to be shared between an individual student and the instructor. Only the student concerned and the instructor are allowed

to view and edit this personal notebook. A student can use this notebook to submit assignments while the instructor can access the notebook to correct the assignments and provide feedback. The third and last sub-notebook, known as Collaboration Space, is created to facilitate collaboration among all the constituents of a class that include the students and the instructor. A typical use of this space would be to host a discussion board. Both the students and the instructor can view and edit the contents of this notebook.

Since the LMN presented in this paper is intended for face-to-face and hybrid classes, the Class Notebook add-on was not used. The decision for not upgrading to a Class Notebook, at this time, was partly influenced by the need to keep the LMN simple to use, navigate, and manage. The Class Notebook that has its own applications, strengths, and advantages is nevertheless mentioned in this paper simply to highlight the possibility of expanding the scope and functionality of the proposed LMN.

SHORTCOMINGS OF THE LMN

While the proposed LMN with all the basic and extended features discussed can serve a multitude of purposes, there are still certain limitations associated with the LMN when compared to a traditional LMS such as Canvas. The three main limitations are as follows:

- Course Analytics: This is a useful feature supported by an LMS such as Canvas that is not available in the proposed LMN. Course analytics is intended to provide the instructor with useful student related statistics such as page views, student participation, assignment submission rates, etc.

- Integration with SIS: The integration of an LMS with a Student Information System (SIS) for importing student data into an LMS is a very useful feature supported in most traditional LMSs. Importing student information is probably easier with a traditional LMS than with an LMN. However, student data can still be imported into the LMN if it is used in conjunction with a cloud service such as Teams. In this case, Teams must be linked to the directory system and the SIS of the institution to be able to transfer the data.

- Integration with External Apps: There are certain learning-related applications such as WebAssign, iClicker, and Examity that can easily be integrated with a traditional LMS such as Canvas. This is not the case with OneNote. Although the number of applications that can be integrated with OneNote continues to grow at the time of this article being written, only a few popular third-party applications such as Turnitin can be easily integrated with OneNote. Applications such as Respondus, a popular lockdown browser used for securing online quiz-taking, are yet to be integrated with OneNote.

CONCLUSION

Finally, it is reasonable to conclude that only a few of the numerous features listed in the 3847-page Canvas user manual (Canvas, 2019) is likely to be used by most instructors. An LMN developed with readily available and affordable cloud resources can easily support these frequently used features of a traditional LMS without the added complexity and learning curve associated

with most LMSs. The proposed LMN, therefore, can be an attractive alternative to a traditional LMS since the former is capable of supporting the following LMS features that are considered to be the mainstay of mainstream LMSs such as Canvas (Middlebury, 2019).

- Conduct online, asynchronous discussions with your students
- Collect assignments, provide feedback, and post grades
- Post web links
- Upload documents, videos, audio files, and more
- Post deadlines and reminders through calendar and announcements
- Manage group work assignments
- Integrate video conferencing with individual students, a whole class, or guest speakers
- Communicate easily with the whole class, specific groups, or individual students.

Although some of the above features may require the implementation of the Class Notebook mentioned, the LMN that was developed and deployed has provided a flexible and cost-effective learning environment to a diverse body of students. It has also helped transcend the temporal and spatial limitations of a traditional classroom. Equally important is the fact that the LMN introduced the students to several cloud technologies including the ones used for collaboration. These are most likely the same technologies the students may encounter at their future place of employment.

In conclusion, it is compelling to note that, with the increasing number of cloud apps and services, one can design, develop and host a fully functional and customizable LMS with minimum programming experience and inexpensive resources. For those of us who are constrained by the structure of a traditional LMS and not inclined to use all of its features, there is now a real choice between a traditional LMS such as Canvas or Moodle, and a personalized and customizable LMS/e-portal such as the LMN discussed in this paper. The choice probably applies to many instructors in most colleges.

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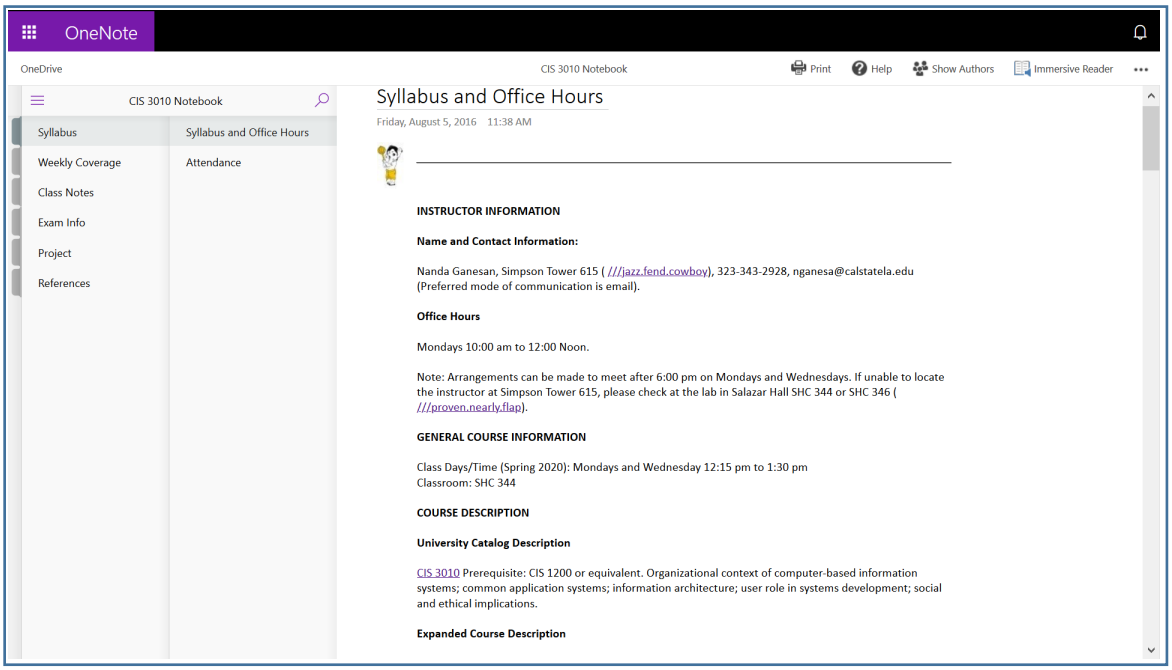
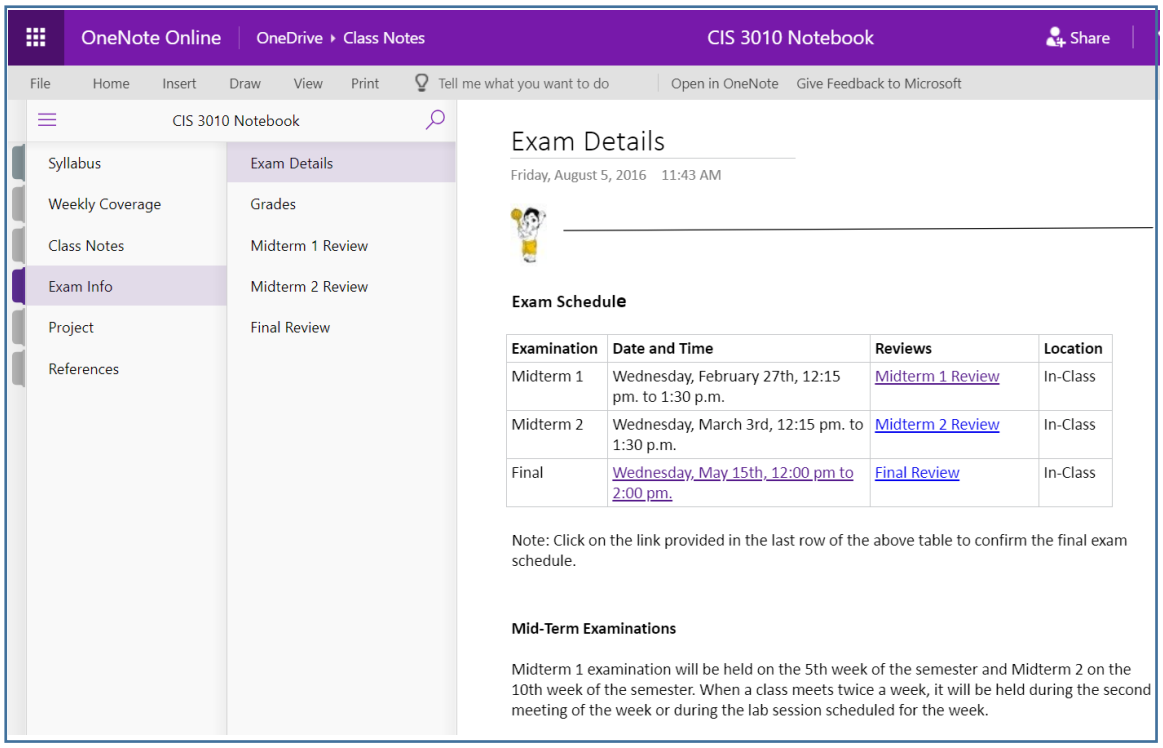
APPENDIX A: TAB 1 SYLLABUS AND OFFICE HOURS

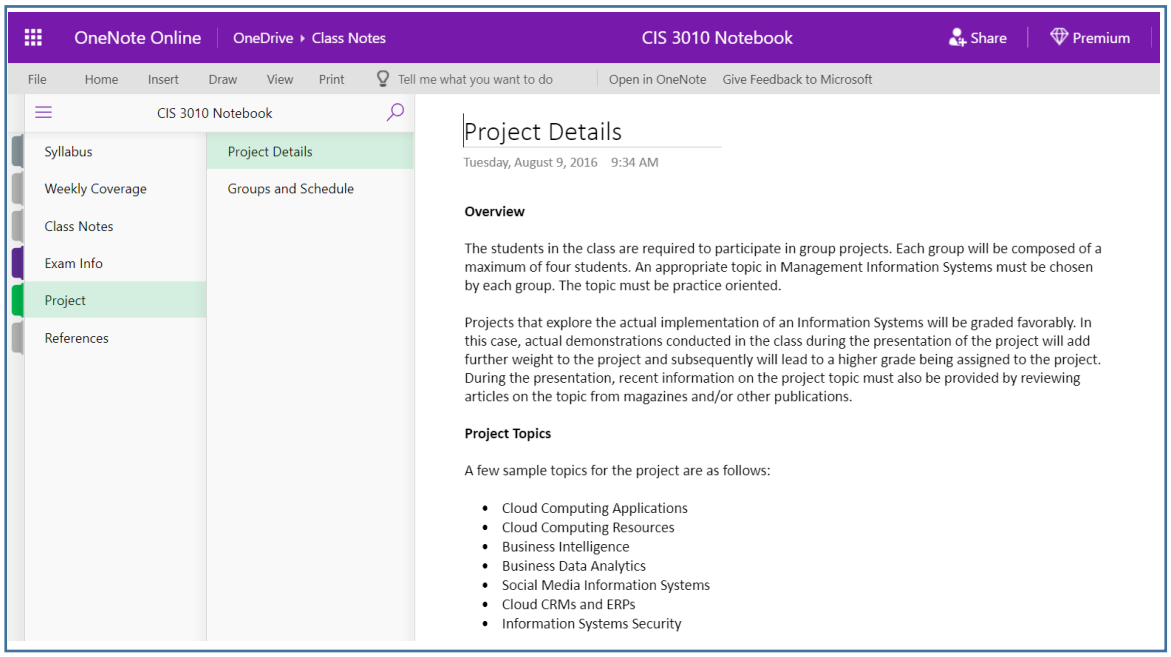


APPENDIX B TAB 4 EXAMINATION DETAILS



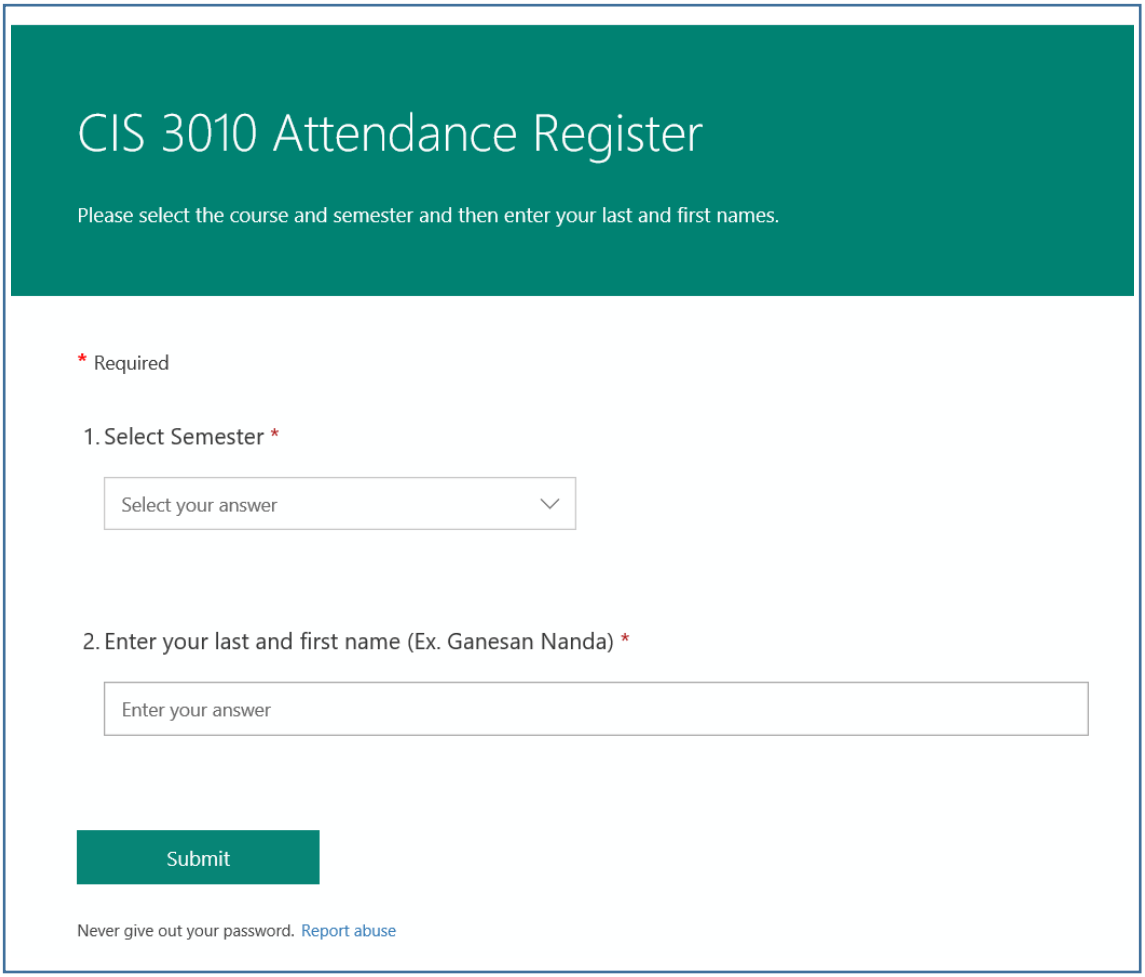
Tab 4 - Exam Info: Examination being one of the topics of keen interest to the students, a separate tab was created for providing exam-related information. Under this tab, multiple notebook pages were created to provide an overview of the exam, a list of topics covered in each exam, audio and written reviews for the exams, and graphs showing the distribution of the grades among the students. The students found the detailed instructions provided under this tab, especially the reviews, exam schedules, and grade distributions to be helpful in preparing for the examinations and assessing their progress in the class.

APPENDIX C: TAB 5 PROJECT DETAILS



Tab 5 - Project: Yet another frequently discussed topic in the class is the class Project. The above page was created to provide detailed information on the requirements for the class project. A description of the project, sample project topics, references to help choose an appropriate topic for the project, the format of the project report, a template for the project presentation slides, and a table with group assignments and presentation dates are displayed under this tab. The students were requested to create their own OneDrive accounts to store their presentations and share them with the instructor and their group members. By requesting the students to store and manage their presentations on a cloud-platform designed for collaboration, the students were invariably being exposed to the use of cloud services for real-time collaboration.

APPENDIX D: ATTENDANCE FORM DESIGNED USING FORMS



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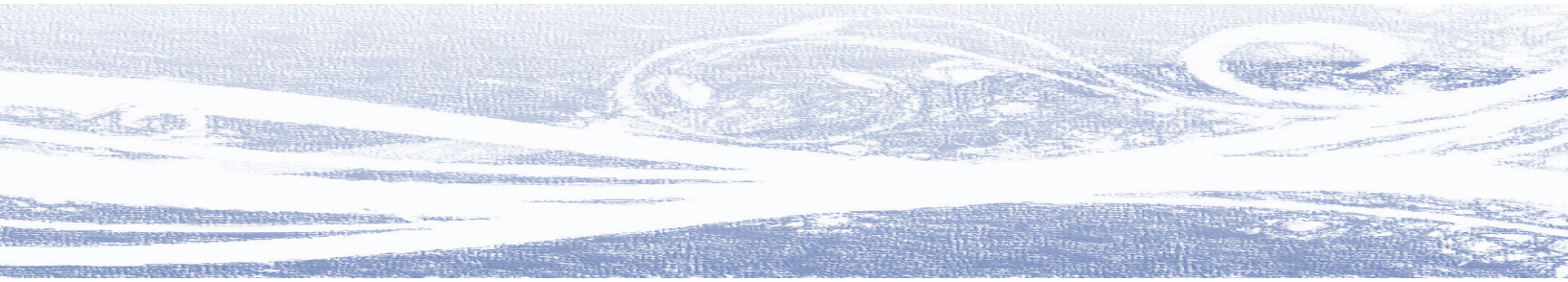

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