UNSW
AUSTRALIA

School of Computer Science and Engineering

Faculty of Engineering

The University of New South Wales

Requirements to theses submitted in the Faculty of Engineering

Thesis submitted as a requirement for the degree of

Bachelor of Engineering

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Abstract

More and more educational institutions depend on online learning management systems for distributing resources to students, which has been accelerated by the coronavirus pandemic, and so there are a huge number of learning management systems available. These systems have a wide variety of features such as quizzes, blogs, assessment management, integrations with third party platforms such as Zoom and TurnItIn, and more.

However, many of these systems do not have an efficient or useful way to reuse content and resources used in other courses. Time is wasted organising and uploading content for students. Many of these learning management systems are also difficult to use for both teachers and students and are missing key features such as forums and teachers may look to other platforms such as Piazza for these features in conjunction with the learning management system.

Therefore, we will implement a learning management system with an improved UI that is more accessible and easier to use for both teachers and students, and adopts a system where teachers can upload content to a specific topic. This topic then can be reused for other courses, allowing for easier course creation and management.

Acknowledgements

The authors of this thesis would like to extend their deepest gratitude to Professor Maurice Pagnucco for supervision, support and assistance to this thesis, and Dr John Shepherd for his feedback and suggestions as well.

(Expand acknowledgements in the future)

Abbreviations

BE Bachelor of Engineering

UNSW University of New South Wales

LMS Learning Management System

Contents

Chapter 1

Introduction

Having a set of clear requirements to their thesis is important to student finalising their BE, or other, degree. Such requirements are both in relation to the physical appearance of the thesis, as well as the writing style and organisation. The present document tries to concisely state the theses requirements while appearing in layout and structure as a thesis itself.

Chapter 2 explains the background for this document. Chapter 3 states the style and submission related requirements to theses submitted at the school. Chapter **??** explains content related requirements to theses. Chapter **??** evaluates the thesis requirements template. Finally, Chapter 4 draws up conclusions and suggest ways to further improve the thesis requirements template.

Chapter 2

Background

2.1 Comparison table

Categories	Canvas	WebCMS	Moodle	D2L Brightspace	OpenLearning	Edmodo	Google Classroom
Topic Tree			No		No	No	Yes
Account			Yes		Yes	Yes	Yes
Course Pages			Yes		Yes	No	Yes
Assignments			Yes		Yes	Yes	Yes
Dashboard			Yes		No	Yes	Yes
Quizzes/Exams/Tests/Polls			Yes		Yes	Yes	Yes
Forums			Yes		No (comments system only)	No	No
Multiplatform Access			Yes (Has separate mobile application)		Yes	Yes	Yes
Accessibility			Yes		Yes	No	Yes
Grading			Yes		Yes	Yes	Yes
Attendance			Yes (Requires a plugin)		No	Yes	No
Calendar			Yes		Yes	Yes	Yes (Provided by Google Calendar)
Enrolment			Yes		Yes	Yes	Yes
Blogs/Wikis/Discussions			Yes		Yes	Yes (Discussion only)	No
Notifications			Yes		Yes	Yes	Yes
Lectures and Tutorials			Yes		Yes	No	No
Third Party Integration			Yes		No (API is provided)	Yes	Yes
Inbox/Messaging			Yes		Yes	Yes	No
Gamification/Karma System			No		Yes	Yes	No
High Quality User Interface			Yes		No	Yes	Yes
Open Source			Yes		No	No	No
Data Migration			Yes		No	No	Yes
Performance (out of 10)			6		1		8

2.2 Google Classroom

Google Classroom is an online learning management tool provided by Google which offers a free and easy tool for helping educators manage and assess progress of students. It has become one of the most popular learning management platforms adopted in schools across Australia. The main selling points of this platform are:

- The ability to easily manage students learning
  - Allowing students join classes directly or by sharing a code or link
  - Setup a class quickly and create class work that is displayed on students' calendars
  - Providing communication with students' guardians and automatically send them updates

- The ability to easily measure students progress
  - Storing frequently used feedback to be used for fast and personalised responses
  - Allowing teachers to grade consistently and transparently with rubric integrated student work
  - Providing students with a plagiarism checker to help them produce their own original work
- The ability to provide collaboration between students and teachers
  - Connecting students and teachers online in virtual classes
  - Allowing communication of announcements on the Stream page
  - Enabling face to face connections with students using Google Meet
- Keeping data secured
  - Authenticating users through a login feature
  - Restricting classroom activities to members
  - Assuring data is never used for advertising purposes
- Allowing for third party apps to be integrated in learning for example:
  - Schoolytics: Gives educators and teachers generate insights on student learning
  - Hapara: Help students build executive functioning skills

2.2.1 Features

Google classroom provides the all of the basic functionalities and some unique features of a learning management system.

- Allows teachers to create classes/groups which students can join through a link or code
- Allows users to create announcements in which others can comment within the class
- Allows teachers to create classwork by creating questions, assignments, quizzes or class material
- Classwork can be scheduled and the due dates of the classwork will show up on students' calendars
- Classwork, posts and announcements can be reused
- Other Google applications are integrated within Google Classroom, offering more utility for all users
- Allows teachers to input grades which are viewable by students

2.2.2 Review

In terms of the aspect of ease of use, flexibility and usability Google Classroom offers teachers to reuse questions or sets of questions for classwork. Figure 2.1 highlights the functionality that allows teachers to reuse classwork. While reusing classwork teachers are able to then set separate parameters such as set the due date, add more questions, change the topic and change mark allocation.

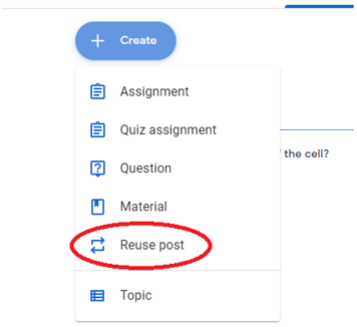

Figure 2.1: Teachers can reuse posts

Topics can also be created in Google Classroom. Topics allow for categorisation of class work. An example of the topics is shown in figure 2.2. The example displays 2 topics, each with 1 question. One functionality that is not implemented is the use of prerequisites for topics. For example, if topic1 was a prerequisite for topic2, then students who have not completed topic1 cannot access topic2. This design does not show how each topic is linked with each other which could be improved on.

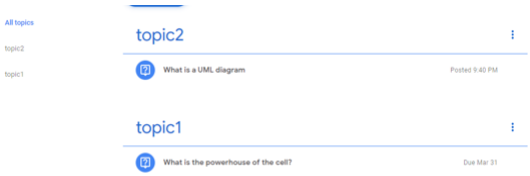

Figure 2.2: List of topics

One interesting feature within Google Classroom is the integration of other first party applications such as Google Calendar and Google Drive. Google Calendar is a very popular task reminder and calendar application and would benefit greatly with the incorporation of displaying due dates for classwork from Google Classroom. Google Calendar allows for the easy visualisation of important dates and thus is suitable for Google classroom. Google Drive is also a very popular file hosting server where files can be easily shared with other people. For the case of Google Classroom, it can be utilised to share classwork with students.

Due to Google Classroom being affiliated with Google many of the other platforms

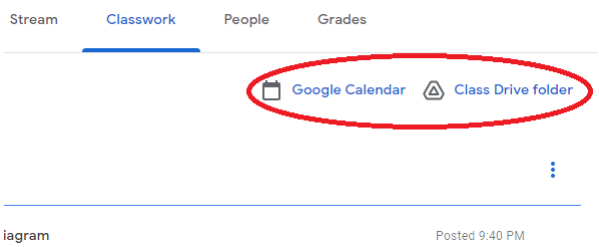

Figure 2.3: Google Drive and Google Calendars are integrated

related to Google are integrated very well. Announcements can be created which have Google Drives and YouTube videos attached which further improve the usability of Google Classroom.

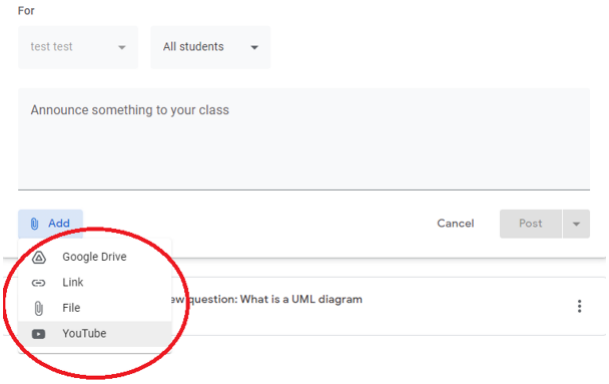

Figure 2.4: Google Drive and Youtube are integrated

Overall Google Classroom does not have many unique features that make it an outstanding learning management platform; however, it does provide the integration of other Google platforms such as Google Drive, Google Calendars and YouTube.

2.3 OpenLearning

2.3.1 Overview

OpenLearning is a ASX listed company that provides an LMS for educational providers. It was founded by Adam Brino, Richard Buckland (COMP6441 lecturer) and David Collien and is used in security courses at UNSW.
It works with universities such as UNSW and Taylor's University (based in Malaysia) to deliver MOOCs (massive open online courses). It also features an LMS that educational institutions can use. Some courses at UNSW currently use it such as COMP6441 (Security), and many universities such as UNSW, UTS, ACU, Charles Sturt University and more also use the platform.
Unlike other content management systems such as Moodle, OpenLearning is not free

or open source and can be quite costly.

2.3.2 Home

When logged in, the home page of OpenLearning is quite confusing.

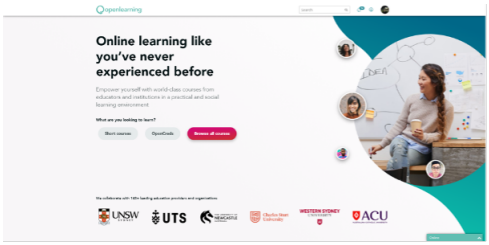

Figure 2.5: OpenLearning Homepage

For students, it can be quite confusing how to reach their courses. The home page clearly directs you to search for a new course offered by OpenLearning, not a course you are already enrolled in.

The balloon icon in the top right should be clicked to reach my courses.

Figure 2.6: This icon is confusing and it is not clear how to get to my educational resources.

2.3.3 Course Home Page

The course home page UI is good, with clear links to information and important announcements being easily viewable.

2.3.4 Performance

The overall performance of OpenLearning is poor, with pages feeling slow and sluggish with Google Lighthouse, a performance testing tool, giving 14/100 for performance. However, accessibility seems otherwise quite good, with a 90/100 score.

Figure 2.7: OpenLearning Course Home

Figure 2.8: Google Lighthouse Result

2.3.5 Forum and Commenting

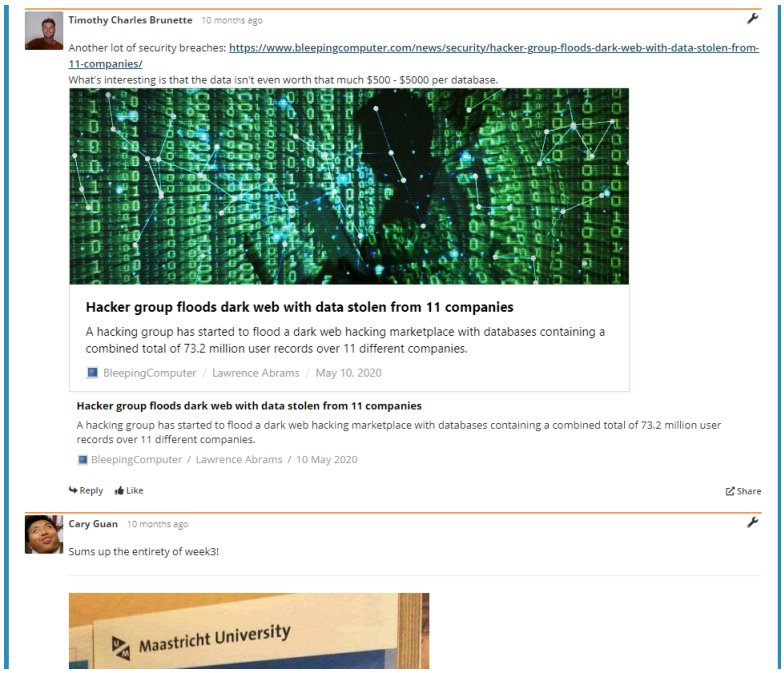

Figure 2.9: OpenLearning comments system

OpenLearning makes it quite difficult to communicate with other students, with a com-

ment feature available but not searchable or sortable at all. There does not seem to be a forum feature either, and so in courses such as COMP6441, it can be very difficult to collaborate and communicate with classmates.

2.3.6 Data Migration

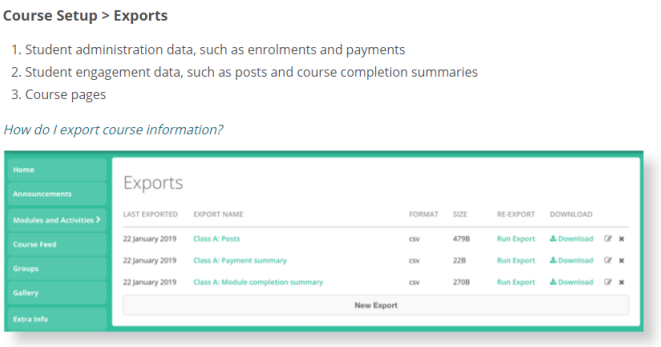

Figure 2.10: Exporting data in OpenLearning

Data migration seems quite poor in OpenLearning. There are no support articles available on how to import data from another course, and so it seems quite difficult to create a new course. There is a basic system to export data into a csv file, but there does not seem to be a way to import data either.

2.3.7 Conclusion

OpenLearning is a good platform for instructors and students, with a huge feature set with blogs, commenting, and a very flexible course setup. However, the UI, performance and stability can be significantly improved to be more competitive with other CMS platforms. A searchable forum can also be implemented, and little data migration features can hinder courses that use the platform, as time is wasted uploading and curating content for courses.

2.4 Moodle

2.4.1 Overview

Modular Object-Oriented Dynamic Learning Environment, more commonly known as Moodle, is a learning management system founded in 2002 by Martin Dougiamas. Supporting over 60% of higher education institutions around the world, including UNSW,

Moodle provides an open-source, personalised learning platform aimed at supporting both students and educators. Moodle's modular design is centered around providing a personalised experience, giving users' the flexibility to build and access courses in a way that suits them. With a vast library of plugins, and the ability for developers to design their own, Moodle really provides users with unlimited functionality.

2.4.2 Dashboard

When a logged-in user first accesses Moodle, they are directed to the Dashboard which consists of content blocks for each of the user's courses. User's are provided with numerous ways to customise the dashboard, including:

- Hiding and showing individual courses
- Filtering courses by past, present and future
- Sorting courses alphabetically or by date
- Displaying courses as cards or in a list

Users can use these customisation tools to organise the dashboard based on their needs and as a result, easily find a desired course.

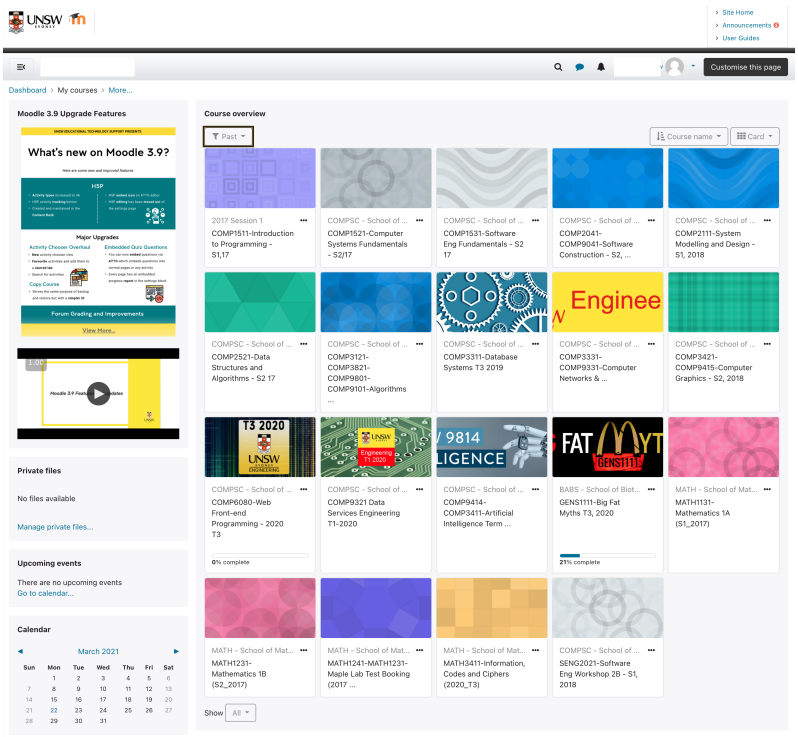

Figure 2.11: Moodle's Student Dashboard

2.4.3 Course Pages

A course page consists of various links to resources. These links can be separated into collapsible subsections which help with the organisation of a course. Course admins can customise the subsections based on how they would like to structure a course. Course admins can also customise the way in which students work through course content by blocking access to resources until certain criteria have been met.

The course page sidebar can also be edited to include different sections like course contacts, calendars, announcements and useful links.

Within a course page, students can access announcements, discussions, forums, quizzes, polls and course resources like lecture notes and assessment notifications. Course admins can open assignment submissions and provide students with assessment feedback and grades.

2.4.4 Forums

Moodle provides course admins with the ability to create one or more forums attached to a course page. Students and admins are able to post to the forum, reply to others, star posts and subscribe to conversations. There is no easy way to search through

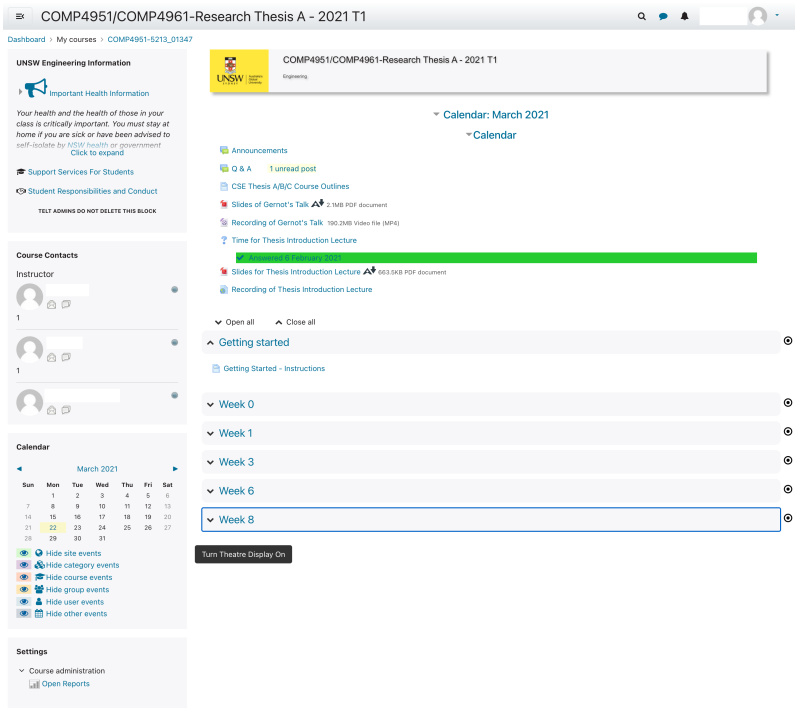

Figure 2.12: Moodle's Student Course Page

forum posts which can make it difficult to find information, especially when the post list is long. There is also no functionality for filtering or sorting posts. Overall, the forum functionality in Moodle is pretty basic and could use a lot of improvement when it comes to the organisation of information and the overall experience.

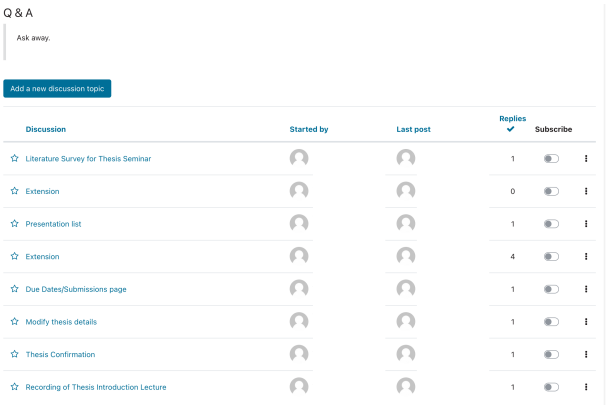

Figure 2.13: Moodle's Forums

2.4.5 Performance and Accessibility

The performance of Moodle is average, with Google's Lighthouse performance tool giving it a score between 60% - 70%, depending on the amount of content on the page. A similar score was achieved for the accessibility of the website, with the biggest issues being lack of contrast between background and foreground colours, as well as HTML elements missing the appropriate attributes required for assistive technology.

2.4.6 Data Migration

Moodle provides users with the option to backup and restore data associated with a course. Automated backups for courses can be set up to reduce the risk of losing data. These backups can also be used to migrate data to a different platform. Admins are able to easily select which parts of the course they would like to backup in the backup settings. The backup files can then be easily saved and restored at any time.

2.4.7 Conclusion

While the user interface, performance and accessibility could use some improvements, Moodle successfully delivers all the required functionality need to support students and educators.

2.5 Edmodo

2.5.1 Overview

Edmodo is a learning management system founded by Nick Borg, Jeff O'Hara and Crystal Hutter in 2008. Edmodo offers an "all-in-one LMS" which includes essential management tools for teachers and a platform for which teachers and their students can collaborate and communicate outside of class. The learning management system serves as a complementary tool catered towards primary and secondary education with a focus on classes rather than stand-alone courses (such as those in tertiary education). Edmodo offers the following features:

- Assessment tracking: ability for teachers to see remaining submitted assessments to review, reviewed assessments, scheduled assessments to release
- Grading and recording attendance: ability for teachers to set grades for a student's assessment and fill in attendance for a class

- Collaboration and communication: ability to create a post, discussion, poll and direct messaging
- Assessment options and interactive activities: ability to create assignments, quizzes and gamified activities
- Unlimited storage space: ability to create files in a single click (Word Document, PowerPoint Presentation and Excel Worksheet) and also upload any files
- Social media platform: students and teachers can interact and view others' posts and shared resources, allowing them to learn more about specific topics or develop skills
- Calendar: shows due dates of upcoming assessments, quizzes and events created by the teacher

2.5.2 Dashboard

The dashboard is similar to dashboard of social media platforms, encouraging discussions amongst the students and their teachers as well as keeping students informed of homework and assessments assigned by the teacher.

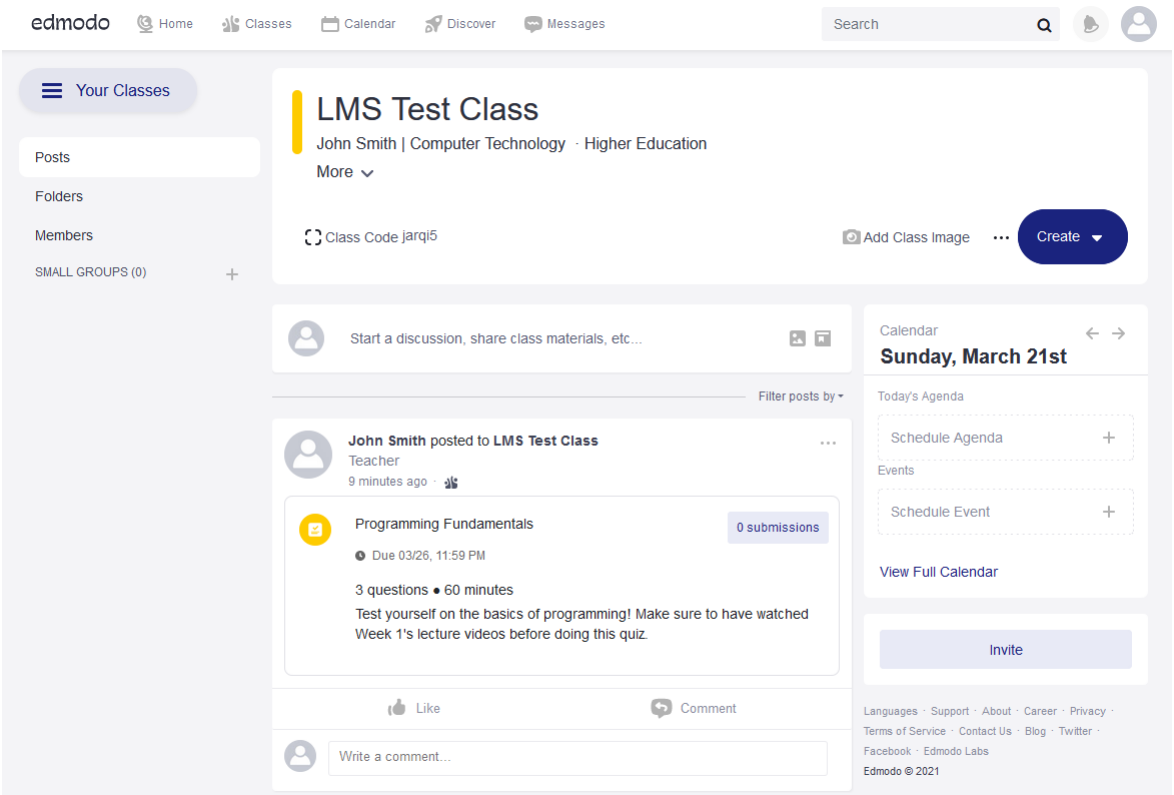

Figure 2.14: Teacher's view of the dashboard on Edmodo

2.5.3 Assignments and quizzes

The creation of assignments and quizzes in Edmodo is very simplistic, however provides limited options and features in which the teacher can use. There is no ability to customise the assessment and teachers are forced to provide extra details in the attachment section in the form of a file.

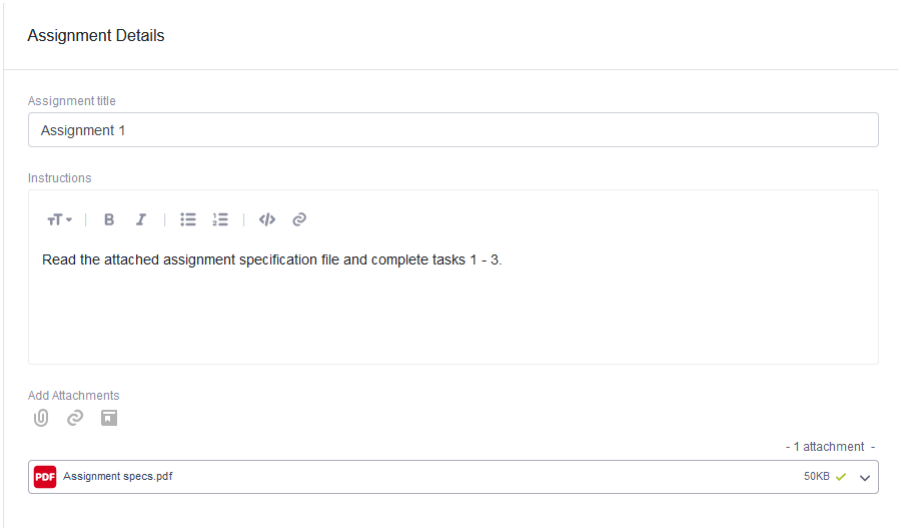

Figure 2.15: Creating an assignment on Edmodo

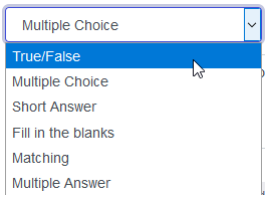

Figure 2.16: Options offered for a quiz question on Edmodo

2.5.4 Data migration

Edmodo does not provide any features to import packages or courses from other learning management systems and is not SCORM compliant. This is due to its nature of class content and assessments being in a fixed structure. Teachers are only offered the ability to copy from existing assignments and quizzes made on the Edmodo platform. New teachers transitioning from another learning management system to Edmodo will have no option to reuse their past course content or assignments.

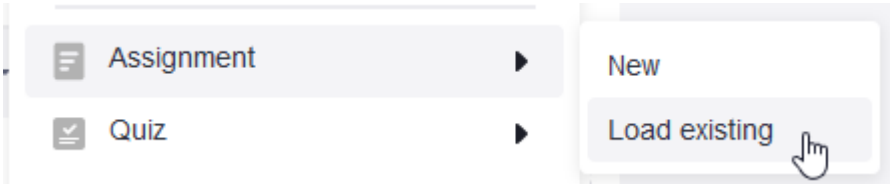

Figure 2.17: Loading an existing assignment on Edmodo

2.5.5 Conclusion

Edmodo offers a clean, social-media style user interface familiar with younger users and provides the essential management tools for teachers, however is one of the weakest learning management systems in terms of re-usability and flexibility for its features.

2.6 WebCMS

WebCMS is a LMS designed and used internally for UNSW CSE courses. WebCMS is a browser based LMS that allows unauthenticated users to only see course announcement page and other pages require an authenticated user with correct enrolment access to the course.

2.6.1 Enrolments

WebCMS has a robust enrolment system that is managed by lecturers and course admins. Course Staff creates a course for a specific term and enrols students from enrolment list. Students can be enrolled into multiple courses for each term.

- WebCMS has multiple roles that can be assigned to individuals for specific courses (Lecturers, Students, Tutors, Course Admin). Each page in the course can be customised to be accessible by users with specific roles.
- Users enrolled into multiple courses will be able to navigate through the courses via the nav bar at top of page. Users can have different roles for each course. (Student in course A and Tutor in course B)

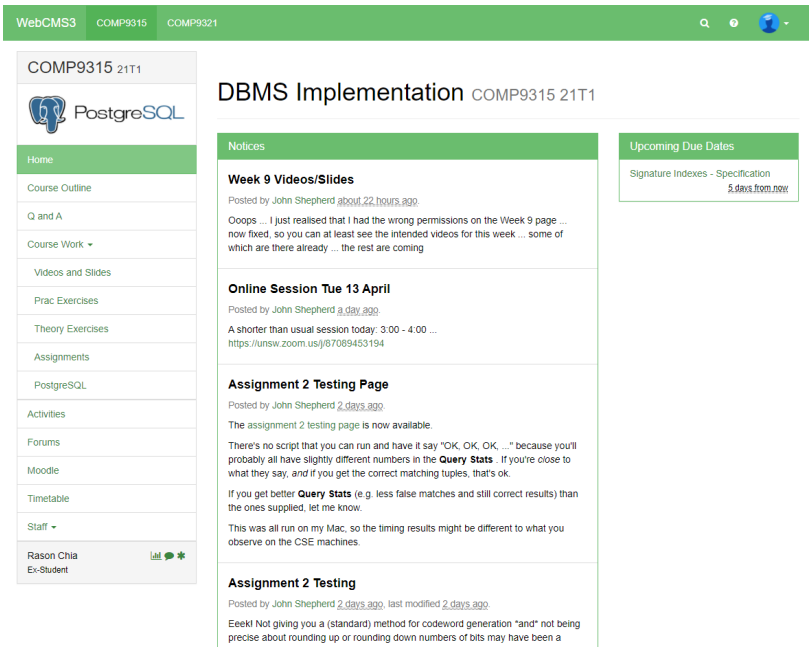

Figure 2.18: WebCMS's Student Course Page

2.6.2 Course Page Feed

Each Course has a homepage that users will land on when navigating to the course. This main page consists of 3 main components, a static navbar to navigate course content, Course Notices / Announcements and due dates for deliverables.

- Course Notices / Announcements can be posted by lecturers or staff member. These posts will automatically generate an email notification to all enrolled users of the course. Posts are visible to all users and provide course wide information like release of assignments and exam information.
- Due dates of deliverables are retrieved from quizes and assignments that have a due date set. The panel will show the number of days remaining as well as a link to the specific deliverable.
- The static sidebar provides an indexed view of course content. Content links can be grouped under a heading. This allows users to quickly navigate through to the content they are looking for. This sidebar also display the authenticated user's name, role in the course, shortcut links to user's gradebook, wiki and blog.
- Course Admins can set course theme color which is propagated through all the above elements as well as throughout all pages for the specific course. Each course can have a different theme color and this helps users differentiate which course they are looking at.

2.6.3 Email Notifications

WebCMS has a email notification feature which can be triggered automatically on various conditions. By default, any course wide notices always striggers email notifications.

- Users have the eability to subscribe to their posts (comments, replies, forum posts) which will automatically triggger notifications if there has been a new update to their posts. This can be toggled in the settings menu.

2.6.4 Quiz and Assignment System

WebCMS allows multiple quizes and assignments to be created for each course. These deliverables have a due date and can be fully customised, automarked and results displayed directly into the user's gradebook.

- Quizes can comprise of only multiple choice answers or have a mix with short & long response answers. Correct answers can be set for each quiz, once quiz is due, users are not allowed to make anymore submissions and quizes can be automatically marked by WebCMS.
- Assignments can be created with multiple tabs (Specification, Make Submission, Check Submission, Collect Submission). Specification can be formatted or displayed through embedded pdf. Make, Check and Collect Submission functionalities interacts with CSE give command line tools for specific assignment.

2.6.5 Display Content

WebCMS has a robust page formatting toolset which allows the user to format content with headers, create lists and embed content (videos, images).

- Course Setting can restrict that only lecturers or staff members can create or edit the page.
- Pages created can be pinned into the static navbar on the platform for easy access
- Pages can be access by direct link to its content resource number that is unique to each page. e.g.https://webcms3.cse.unsw.edu.au/COMP9321/21T1/resources/59281
- Pages can be embedded with pdf files which provides a basic pdf viewer component so users can view pdfs while remaining on the platform

2.6.6 Gradebook and Profile

WebCMS gradebook stores marks from deliverables like quizes, labs, assignments. User Profiles also has a blog and wiki feature where users can document notes as well as store a blurb about themselves which is visible to other users.

- Quizes which are set to automark can record their scores automatically into the gradebook.
- Marks for Quizes, Labs and Assignments can be manually inputted into the gradebook for each user. This feature can be restricted to be used by staff members only.
- Gradebook allows for total of specfic marks to be displayed on the gradebook. This is done to provide a summary view of a student's score over all the deliverables.

2.6.7 Admin Functionalities

WebCMS administrative functionalities can be restricted to certain user groups like staff members. Admin Functions allow staff members to create and manage course content & structures.

- Course Creation Tools: Creating Brand New Courses and Stetup, Cloning previous courses, Link Course to myunsw enrolment course student lists
- Course Management Tools: Setup deliverables for the course (Quizes, Assignments, Labs), Setup Course Content (Lecture Slides, Labs, Assignment Pages, Quiz Questions),
- Student Interaction Tools: Setup pages to have commenting functionality, Setup forums, Setup Notification Settings

2.6.8 Conclusion

WebCMS is a comprehensive and robust Learning Management System, however it does fall short of some other LMS in the market. WebCMS is not an open source platform that can easily recieve external data or export its own data, it is built as a platform to store / share content but it does not engage students directly with any self serve content like gamification features or self serve modules.

Chapter 3

Project Plan

3.1 Topic Tree

3.1.1 Overview

Most learning management systems do not have a simple and easy method to import course material and resources from other courses. Some LMS platforms such as OpenLearning have no method of importing any data at all, and other platforms such as Canvas allows you to import crowd sourced material into your own course, however still does not allow you to import topics of resources.

This new LMS will have a new topic tree feature, which will allow teachers and academics to add course material under a specific topic instead.
Each topic will have prequisites of other topics, for example the topic Graphs will be a prequisite for the topic Depth first Search.

Topics A topic is a collection of course material that is related to a particular subject. For example, in UNSW's Introduction to Programming course (COMP1511), one of the topics in the course is "Pointers", which contains all course material related to pointers. Instructors can choose what constitutes as a topic, but a topic in this case is part of the course material of an entire course - it does not constitute all the course material of a single course. For example, there is no topic called "Introduction to Programming" or "COMP1511" as that is virtually unusable as not all of this content would be imported into another course.

In the above example, pointers, structs and discrete mathematics must be learned in order to learn graphs. Likewise, graphs and recursion is required to learn depth first search.

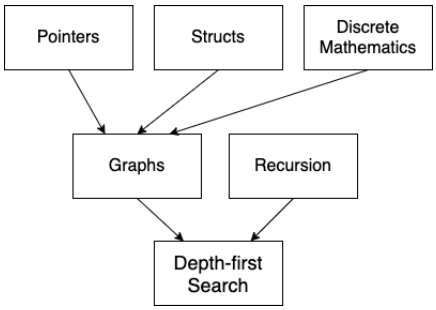

Figure 3.1: Example of a topic tree with Depth first search

Specific courses in this new LMS would be created by choosing the topics this new course has, and all course materials under each topic would be imported into the respective topic. This allows for faster creation of courses, and course materials can be reused more easily.

3.1.2 UI/UX

Instead of only a graph view, we opted for a more traditional UI for the topic tree as well. This is because a graph based UI may be unstable and difficult to use compared to a more traditional UI.

The following is a mockup of a possible UI, and will be changed in the future.

Each group of topics is listed in card format. The topics in each group can be viewed by clicking on the topic.

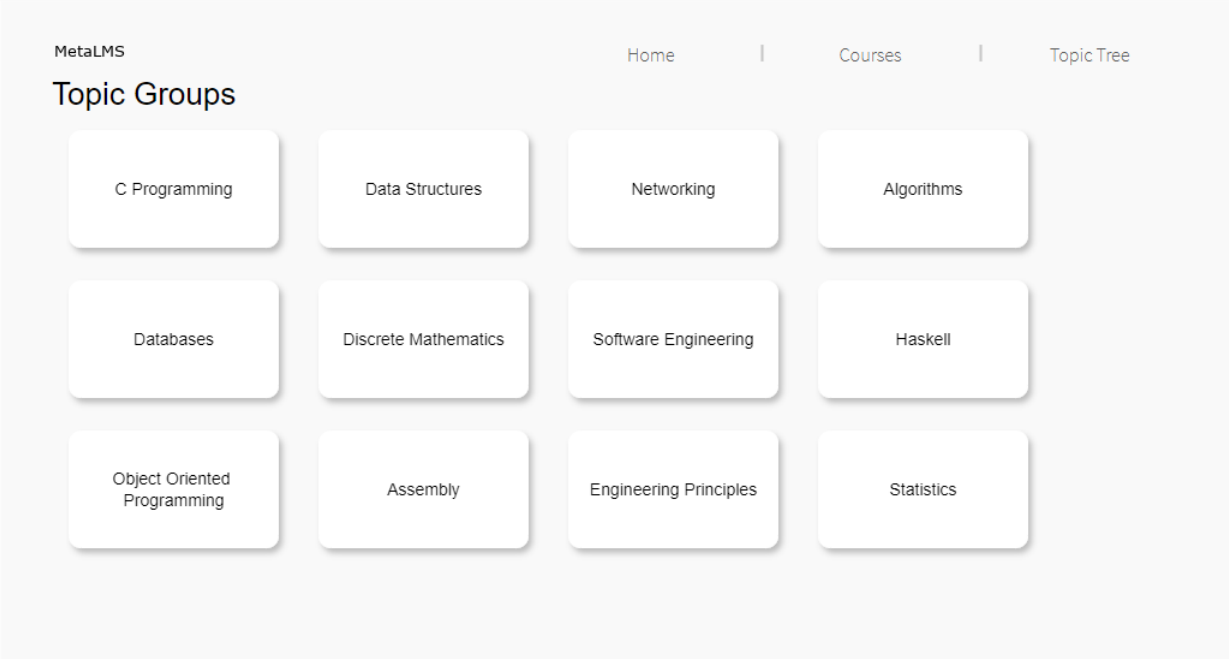

Figure 3.2: Topic Groups UI

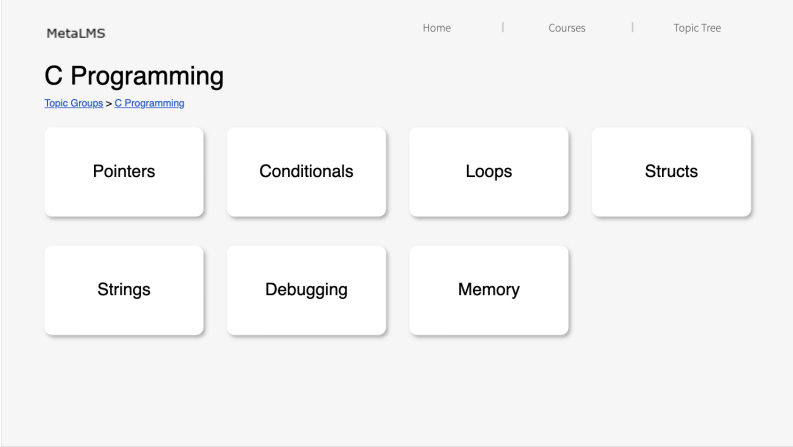

Figure 3.3: Topic Group - C Programming Example

Inside a topic group, the full list of topics inside this group is listed. Prerequisites are NOT shown here.

All resources for this topic are listed, and prerequisites are also listed on this page. This view is modelled after the UNSW handbook, where course prerequisites are listed as links. This topic can then be imported into a course with the import button at the bottom.

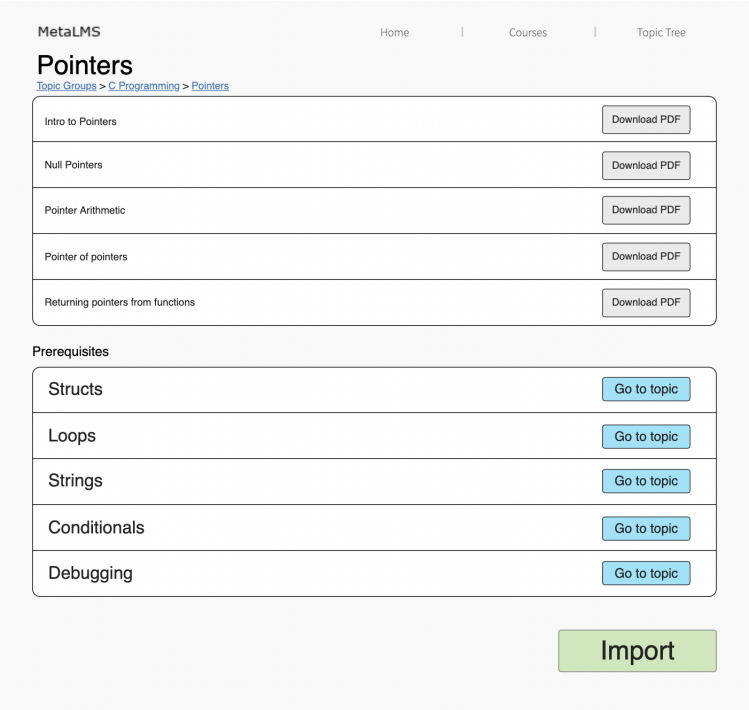

Figure 3.4: Topic - Pointers Example

3.1.3 Requirements

The requirements below are draft requirements, and will become more specific throughout the next stages of the thesis.
Each requirement will have a priority: High, Medium or Low. High priority requirements will be completed first, and then medium and low priority requirements respectively.

3.1.4 Functional Requirements

Viewing Topics

1. Users can view groups of topics Medium
2. Users can view topics within each group High
3. Users can search for a topic High
4. Users can search for specific resources High
5. Users can view topic prerequisites Medium

6. Users can view a graph of topics and their prerequisites Low

Adding Topics and resources

1. Users can add a new topic High
2. Users can upload course material High
3. Users can add a new topic group Medium

Deleting Topics

1. Users can delete a topic that they've created High
2. Users can delete a topic group that they've created Medium
3. Users can remove course material from a topic High

Topic Prequisites

1. Users can add a topic prerequisite Medium
2. Users can delete a topic prerequisite Medium

Integration

1. Users can import course material by selecting topics for a course High
2. Users can remove topics from a course High

Exporting

1. Users can export data from topics and course material Low

3.1.5 Timeline

This timeline details what is planned over the course of the year to achieve a working topic tree feature in the meta learning management system. Milestones are featured throughout this timeline.

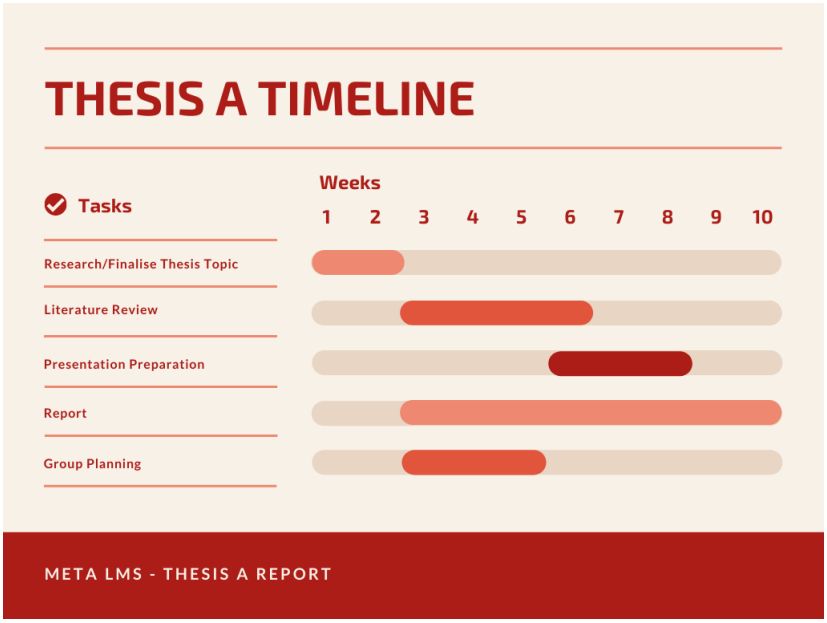

Figure 3.5: Thesis A Timeline

This term, the focus is literature review and planning features for implementation in Thesis B and C.

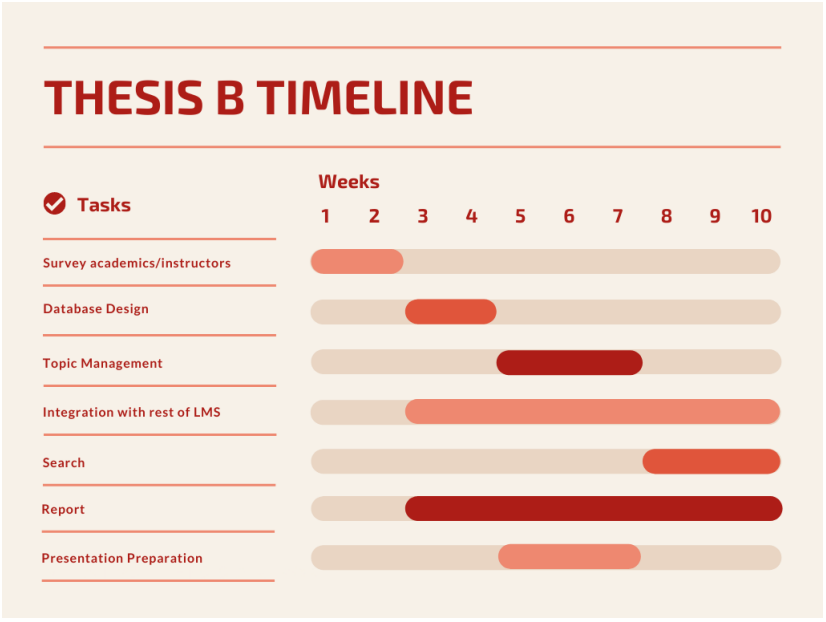

Figure 3.6: Thesis B Timeline

In Thesis B, the focus is to start implementing the topic tree feature, with core features implemented and mostly usable, and a working database design.

Database Design will involve designing a schema for the database to store topics and their dependencies. This will most likely involve a graph relationship between topics.
Topic Management involves designing the interface for adding, removing and managing topics and helping develop a backend for this.
Integration with the rest of the system involves using the topic tree to import content into a course, and export content into the topic tree, etc.
Search involves searching for content, and is not as important as developing the topic management feature.

Figure 3.7: Thesis C Timeline

In Thesis C, the main focus is to finalise features, fix any bugs that arise, test the feature and its integration with the rest of the system, implement a graph interface and allow topics to be grouped with each other.

A graph interface would make it much easier to visualise dependencies between topics, but is not a high priority so the plan is to implement this during Term 3 2021.

3.1.6 Milestones

Major milestones for the topic tree feature include:

1. Week 6 Term 2 2021 - Implement a database schema for storing topics and their prerequisites, and set up an interface for topic management.
2. Week 11 Term 2 2021 - Adding and deleting topic prerequisites/dependencies, a search function and proper integration with the rest of the learning management system
3. Week 6 Term 3 2021 - Graph interface to easily view prerequisites between topics and topic groups
4. Week 11 Term 4 2021 - Final Testing and Analysis of the learning management system

3.1.7 Evaluation

In order to evaluate how well the feature has met its requirements and achieved its purpose, a criteria will be proposed. In addition to meeting its requirements, the feature will also be assessed in several areas:

1. Performance - Whether the topic tree feature is fast and responsive
2. Accessibility - Can a wide array of users use the topic tree easily (including people with disabilities, etc.)
3. UI/UX - Is the feature easy to use and attractive
4. Errors - Is the feature bug and error free

Chapter 4

Conclusion

A thesis requirements/template document has been created. This serves the dual purposes of giving students specific requirements to their theses — both style and content related — while providing a typical thesis structure in a LaTeX template.

4.1 Future Work

Extract the requirements from the template in order to have very concise requirements.