IMPLEMENTING MOBILE LEARNING IN SENIOR CHEMISTRY

by

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We accept the Process Paper as conforming to the required standard.

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Abstract

This project explored the need for mobile learning and the practical implementation of mobile learning in a senior secondary chemistry course. The project was focused around two guiding questions: 1) How can teachers leverage mobile technology to enhance lessons and activities? 2) What framework is required to support teachers in the development of resources? The project resulted in the creation of a resource curation site called the BC Chemistry Resource Room located at the domain chembc.weebly.com and mobile-friendly resources (a navigation system, lessons and templates). The findings indicate a need for a collaborative approach to building online resources. The project included the following deliverables:

1) BC Chemistry Resource Room [http://chembc.weebly.com](http://chembc.weebly.com)
4) Developed Lessons [http://chembc.weebly.com/resources.html](http://chembc.weebly.com/resources.html)

*Keywords: mLearning, mobile learning, interface design, chemistry*
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Chapter 1: Introduction

Project Focus and Intent

The complexity of life can make pursuing an education difficult. However, the advent of technology can overcome some of life’s educational barriers. Distributed Learning (DL) utilizes technology to provide students with flexibility in how they can access an education that would not be possible through traditional means. This freedom enabled DL to adopt a well-suited slogan of “any time, any place learning”. However, without any boundaries on space and time, how can educators create a meaningful learning experience where there is no definition to the learning environment?

It is necessary to determine how students access courses before addressing the questions of how to provide a meaningful learning experience, increase engagement and improve success rates. The global trend is that mobile devices are the preferred method in which to access the internet, and according to Morgan Stanley (2010), mobiles will surpass desktop usage in 2015. In Canada, Media Awareness Network (2005) reported that 46% of Canadian youth in Grade 11 said they owned a cell phone compared to 6% of children in Grade 4 (p. 17). It is clear that mobile is becoming the preferred method of accessing the internet and educators need to design for this environment. This leads to the critical question: how can teachers use mobile learning to improve engagement? Student engagement is the interaction between time, effort and other resources invested by both students and institutions intended to optimise the student experience and enhance the learning outcomes (Trowler & Trowler, 2010).

Making the content fit the smaller screen was a superficial attempt at mobile learning. Instead, a teacher truly designing for the additional capabilities that technology brings, leverage
those capabilities to enhance the learning experience. A course design that takes advantage of the touch capabilities to bring in a sense of immersion, uses the built in hardware and apps, and utilizes direct line communication leading to building connections between teacher and students.

Mobile technology is pervasive but very few teachers capitalize upon it. From personal experience, cost and lack of time to experiment are the two greatest limiting factors that prevent the implementation of any educationally sound strategy. Mobile learning is not about replacing the current delivery system but augmenting it to provide a better overall experience. Teachers prioritize imminent issues such as broken links and providing support to students and there is very little time to work on anything new. Effective integration of new strategies on a large scale requires automation and the initial legwork shared among peers.

Online course design requires the implementation of a myriad of tools and theories that are educationally sound. A pedagogical approach ensures that the needs of the learners are a priority and each process reflects their needs. A strategy to increase engagement will be created by connecting Activity Theory (Uden, 2007), Mobile Learning (Quinn, 2011), Message Design (Wang & Shen, 2012) and Universal Design (Elias, 2011) among others with a theme of reducing cognitive load. The next chapter discusses this strategy.

I view course design as two interwoven parts, content interaction and the acquiring and communication of learning. For this project, Message and Universal Design principles will guide content display. Were as mobile learning theories (Quinn, 2011) will determine effective methods to leverage mobile capabilities to promote learning.

**Challenge to Address**

The challenge is to determine a practical method to build quality online resources. A proposed solution is to take a collaborative approach to development to overcome the time
burden required to build resources. This project attempts to address this issue by the creation of mobile-based resources and the development of a resource hub website that will act as a curation site, where teachers can post and gather resources. The intent of the project is to provide original quality materials that teachers have not seen before which will help reduce their development time and act to promote the sharing of their own resources with the resource hub community.

As much as I wanted to focus simply on mobile technology and its potential benefits, I also needed to address the practical issue of development time. Hence, there will be multiple deliverables created to help bridge the gap between development time and the implementation of resources.

**Definition of Terms**

Asynchronous Learning – Learning that occurs when interactions between teacher and students are not constrained by time and place. Students are not restricted to a set schedule and can progress through a course at pace which meets their needs.

Cognitive load - the load related to the control of working memory. The finite working memory can be either under loaded or overloaded during complex learning activities. Meaningful learning requires all elements to be processed.

CSS – Cascade Style Sheet describes the look and format of a webpage. A CSS allows for the separation of content from presentation.

Div – Div tag is container for web page elements and it groups block elements, which a CSS then can format.

DL - Distributed Learning is a method of instruction that relies primarily on indirect communication between students and teachers. Interactions rely on the use of internet, telephone, correspondence or other electronic mediums.
F2F/brick and mortar/Traditional - refers to working with students in a physical facility that is distinct from providing remote online services.

HTML – Hypertext Markup Language is the standard for adding tags to text so that a web browser knows how to display text and graphics.

LMS – Learning management system is an infrastructure for administration, documentation, tracking and reporting. It also has the capabilities of managing instructional content.

Meta tag – Provides information about an HTML document but does not display it on the page. Search engines use Meta tags to show relevant information to a search query.

Mobile Device – any hand held device that is portable and able to access the internet. Mobile devices range from smart phones to laptop computers.

Mobile Learning (mLearning) – Any type of learning that occurs when the learner is not at a fixed location. Mobile learning exploits the functionalities of handheld mobile devices whether it is a smartphone, tablet, laptop or a web enabled phone.

**Brief Overview of Project**

This project intends to create five deliverables (three major and two minor) that will help teachers integrate mobile technology into the classroom. Either the deliverables will provide a resource teachers can use or it will be a method to help reduce development time. The first major deliverable will be a mobile-friendly dashboard navigation that can work within a LMS or as an independent system. The second major deliverable will be Chemistry 12 lessons on Reaction Kinetics and Equilibrium, the lesson development will incorporate mobile compatibility and design with the intent to reduce cognitive. The third major deliverable will be to create a resource hub website that acts as a curation site for resources. Teachers will populate the site by
sharing their resources. Finally, the minor deliverables will consist of mobile-based student activities and a guidebook to help educators place content online.

The intent of this project is to create a viable community focused on creating and sharing resources. It will be difficult to draw conclusions from quantitative measures due to the many uncontrolled variables; hence, this project uses a qualitative approach. Peers will provide feedback in the form of an anonymous survey once the resources are developed. In addition, informal discussions with colleagues will guide development. Furthermore, I will implement the resources into my current teaching practice. Development of the resources will take place August through October 2014 allowing time in November to incorporate feedback and refine the deliverables. If the deliverables receive positive reviews, I plan to continue development beyond the scope of the Master’s in Educational Leadership (MEDL) program.
Chapter 2: Literature Review

Mobile learning or mLearning generally put is any type of learning that occurs when the learner is not at a fixed location. Mobile learning exploits the functionalities of handheld mobile devices whether it is a smartphone, tablet, laptop or a web enabled phone. As a concept, mobile learning is in its infancy and as a result, it has a broad range of definitions. The definitions include a high emphasis on the novelty and functionality of the device itself, an emphasis on the learner being mobile rather than the technology, or a focus on the informal learning environment, which leads to a juxtaposition between mobile learning and formal education. Furthermore, many different theories of learning underpin mobile learning applications. While this breath of perspectives is to be welcomed because it leads to many possibilities for development, it poses problems when trying to develop a theory of mobile learning (Sharples, 2006).

At its core, mLearning is about augmentation. Mobile learning works in conjunction with learning environments were the mobile technologies provide enhancement to the learning experience. Mobile devices have capabilities such as a camera, microphone, messaging, touch screen interaction and geolocation that form learning affordances that allow students to learn in unique ways. Depending on the needs of the student, learning of content can take on different forms, Appendix A lists how mobile capabilities support different needs.

Examining current practices and different theories allows for the creation of a framework to help guide course development for the K12 system. In specific, the framework will incorporate Transactional Distance Theory (Moore, 1993), Activity Theory (Uden, 2007), Message Design Theory (Wang & Shen, 2012) and Universal Instructional Design principles (Elias, 2011) and their implications on mLearning.
Transactional Distance Theory

Transactional Distance theory is the interplay between teachers and learners in an environment where there is a physical separation between the two (Moore, 1993). The physical distance leads to a communication gap, to reduce the potential misunderstandings between teachers and student requires the application of special teaching techniques. Transactional Distance refers to this physical separation. Kang (2008) states there are three factors (student, teacher, and means of communication) and three variables (structure, dialogue and learner autonomy) which determine the transactional distance.

Unfortunately, Transactional Distance theory cannot solely guide distance education since it neglects the social aspect of learning. Park (2011) built upon the transactional distance theory and included socialized activity, where these theories are not discrete but cover a continuum. The aspect of using a continuum created a pedagogical framework for mobile learning. According to Park (2011), there are four types:

- Type 1 - High transactional distance and high socialized mobile learning activity
- Type 2 - High transactional distance and high individualized mobile learning activity
- Type 3 - Low transactional distance and low socialized mobile learning activity
- Type 4 - Low transactional distance and low individualized mobile learning activity

The framework allows designers to target the audience (type of student) and build courses around the students’ learning environment. Table 1 summarizes the implications of Park (2011) framework.
Table 1

Summary of Park (2011) pedagogical framework for mobile learning

<table>
<thead>
<tr>
<th>Type 1</th>
<th>High transactional distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High socialized mobile learning activity</td>
</tr>
<tr>
<td></td>
<td>• Students communicate and collaborate among themselves</td>
</tr>
<tr>
<td></td>
<td>• Content predetermined</td>
</tr>
<tr>
<td></td>
<td>• Transactions mainly occur among learners</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 2</th>
<th>High transactional distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High individualized mobile learning activity</td>
</tr>
<tr>
<td></td>
<td>• Structured content</td>
</tr>
<tr>
<td></td>
<td>• Individual learners control their learning process</td>
</tr>
<tr>
<td></td>
<td>• Interactions mainly between the individual learner and the content</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 3</th>
<th>Low transactional distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low socialized mobile learning activity</td>
</tr>
<tr>
<td></td>
<td>• Loosely structured instruction</td>
</tr>
<tr>
<td></td>
<td>• Students work in groups to solve problems</td>
</tr>
<tr>
<td></td>
<td>• Frequent communication among students</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 4</th>
<th>Low transactional distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low individualized mobile learning activity</td>
</tr>
<tr>
<td></td>
<td>• Loosely structured content</td>
</tr>
<tr>
<td></td>
<td>• Individual learners interact directly with instructor</td>
</tr>
<tr>
<td></td>
<td>• Instructor leads and controls learning</td>
</tr>
</tbody>
</table>

When designing for an asynchronous distributed learning program it is important to determine the categorization as it can lead to effective design. Teachers should be cautious not to apply the framework as extremes since it represents a continuum.

**Activity Theory**

The cultural-historical theory of activity (CHAT) describes the individual and societal aspects of human behaviour. Vygotsky (1978) claims that instead of a behaviourist model of individual stimulus and response, human development is a series of interactions within one’s social and cultural context, that are mediated by tools and signs. The application of Activity Theory to interactions can identify potential issues and determine the effectiveness of lesson interactions during the design process.
The principle and components of activity theory serve as analytical tools for many different areas, including human-computer interaction, information systems, interface design, communities of practice and education. Uden (2007) suggests it is through the interaction with other learners and the teacher, mediated by mobile technologies, that the ZPD (zone of proximal development) emerges.

According to Uden (2007), there are two main barriers when designing mobile applications: the restricted input techniques associated with mobile devices and the increased cognitive load on users when attempting to multi-task. Uden (2007) applied the principles of activity theory to analyse the learning process and outcomes to create a series of steps to take when designing the learning environment. Uden (2007) suggest the following four-step approach.

Step 1: Clarify the purpose of the activity
Step 2: Analyse the context for learning and use
Step 3: Historical analysis of the activity and its constituent components and actions
Step 4: Search for internal contradictions as the driving forces behind disturbances, innovations and change of activity system (pp. 91-97)

The framework provides a mechanism to analyze the goals of a lesson. Once the goal is set, an educator can review the path that a student will take to reach the goal. During the review process, examination and modification of interactions occur so that they fit the mobile learning environment. Since not all students have access to mobile devices, the desktop environment cannot be ignored either; as mobile functionality tests are performed, the same process also needs to occur for the desktop environment. Development of alternate activities is necessary in situations where the same mechanism is not feasible in both environments.
**Message Design Theory**

On the theme of reducing cognitive load, Message Design Theory fits into the larger picture very well. Message Design Theory’s objective is to understand how people learn and how cognition works to coordinate elements such as images, signs and symbols so that they work together to provide better accessibility, usability and learning (Wang & Shen, 2012). An effective course designer organizes knowledge and learning content into different learning messages to meet cognition needs.

While forming the principles for Message Design Theory for mLearning Wang and Shen (2012) took into consideration three aspects: design for different devices, design for learner mobility and design for better accessibility, usability and learning. Based on these three design aspects Wang and Shen (2012) formulated the following four principles:

**Principle 1: Design for the least common denominator**

- Learning content needs to be chunked and packed so it can work on a variety of mobile devices
- Students prefer video-based mLearning materials, which should be less than 5 minutes

**Principle 2: Design for eLearning, adapt for mLearning**

**Principle 3: Design short and “condensed” materials for smart phones**

- The smart phones’ form factor is a limitation for many users. Designers need to be conscious of screen size and the dexterity issues that may arise when interacting with a small screen and keyboard

**Principle 4: Be creative when designing for mobile devices with 3G and 4G technologies**
• Instructional designers can create a greater variety of learning content for mobile devices, which include video and audio. Learner can also use web browsers in their phones to start e-learning courser via mLearning means. (pp. 567-569)

Universal Instructional Design

When developing a framework for best practice in online development another theory to consider is Universal Instructional Design (UID). This project incorporated UID principles to build flexibility of use into both the instructional design and operating systems of educational materials so that they will be appropriate to the widest range of students. Elias (2011) extracted eight UID principles that are particularly useful in distance education:

1. Equitable use
   • Deliver content in the simplest possible format

2. Use cloud-computing file storage and sharing sites
   • Flexible use
   • Package content in small bits.
   • Consider unconventional assignment options

3. Leave it to learners to illustrate and animate courses
   • Simple and intuitive
   • Keep learners’ interfaces simple
   • Keep code simple
   • Use open sites and software

4. Perceptible information.
   • UID recommendation is to add captions, descriptors and transcriptions

5. Tolerance for error
• Scaffold and support learning.

6. Low physical and technical effort

7. Community of learners and support
    • Encourage multiple methods of communication
    • Group learners according to technological access and/or preference

8. Instructional climate
    • Push regular reminders, requests, quizzes and questions
    • Pull in learner-generated content (pp. 148-149)

The method in which content is structured and displayed affects how a student will interact with the material. Message Design Theory and UID offer practical solutions to designing lesson activities and navigation. In the recommendations of Message Design Theory and UID, phrases such as “least common denominator” and “equitable” appear, that have ramifications on the setting of technical parameters such as display size, video formats and target sizes. The ADL Mobile Learning handbook (Brown & Haag, 2014) provides a basics guide for technical parameters; an overview of the guide is located in Appendix B.

Tool Analysis

To promote learning by leveraging a mobile tool requires an analysis of the mobile device’s competencies. Quinn (2011) breaks down what the mobile capabilities more and refers to them as the four C’s of mobile:

• Content - The delivery of media including documents, audio and video
• Compute - The ability to perform calculations and have programmatic responses
• Capture - Capturing data from the local environment such as photos, videos, audio, or information from sensors such as location or direction
• Communicate - The ability to reach others with text, voice, or even video

Quinn (2011) argues although content, compute and communicate are not unique to mobile, when combined with capture, unique opportunities arise. For example, by capturing location then the content can be customized so it its context-specific. Incorporating capture allows the potential to break out of the traditional design by adding performance capabilities to augment and customize the content and communication.

Privacy Concerns

British Columbia educators are legally responsible for managing student privacy issues as stipulated by The Freedom of Information and Protection of Privacy Act (FIPPA, RSBC 1996, C-165). The use of mobile devices and in particular cloud tools gives rise to privacy concerns. When using web-based tools, teachers need to be aware of what information is collected and how it is stored. Teachers should perform a risk analysis and inform students and parents of the potential dangers.

Conclusion

In course design for mobile access, various approaches are viable each with their own legitimacy. The main themes that resonate throughout the different approaches are reducing cognitive load, the use of social interactions and a pedagogical approach to selecting tools and creating activities. No single approach can meet the diverse needs of the students, teachers and curriculum. In order to create a working model, an educator should select a theme then use discrimination in selecting principles from different approaches that align with the course dynamics.

The K12 environment has inherent obstacles that simply do not exist in the post-secondary system. A major concern when working with adolescents is the protection of privacy.
As a result, there are implications on the types of cloud tools that can be used and the teacher’s ability to promote community building. Using restricted tools is an option but unfortunately, this limits the amount of connections made beyond the “walls” of the classroom. This area requires further exploration; the onus should not lie on the individual teacher to minimize all of the risks. A more efficient tactic on performing a risk analysis would be to take a district or provincial approach.

As with any new method there are many barriers and unknowns, however this should not impede the introduction of mobile learning. The current K12 system may not be ideal for mLearning implementation but there are schools that already have the necessary infrastructure and a support in place where experimentation could begin. By keeping a focus on pedagogy, not on technology, and by leveraging the capabilities when appropriate, mLearning has great potential in enhancing the learning experience for students. “Mobile Technology is not the object of learning but as a tool to support students’ learning activities” (Uden, 2007, p. 88).
Chapter 3: Procedures & Methods

Project Stimulus

I work as an asynchronous distributed learning teacher and the majority of the interactions with students do not occur in a face-to-face environment. This project inspired me to help reduce the transactional distance between the teacher and students. I looked for ways for improve the non-physical interactions that do occur. I asked myself the initial guiding questions of what do I want my courses to look and feel like and what are the experiences that I want my students to have.

As I pondered these questions different aspects of mobile learning from OLTD 508 (Mobile Technologies and Game Based Learning) surfaced. I came to the realization what I truly sought was flexibility and personalization for students and myself. Unfortunately, it is not practical for a teacher to devote the amount of time required to develop quality online content. Knapp and Defelice (2009) provide a conservative estimate of 20 hours to develop one hour of online content. Therefore, I suggest a collaborative approach to development.

Increasing student engagement and success are the driving forces behind all my development. When creating a website, the majority of teachers will be using one of three methods:

1. Raw HTML files
2. LMS provided by their school
3. Website builder site such as Weebly or Wix

However due to the large time investment required, teachers should also consider the portability of developed resources. Before choosing a development method, teachers should
investigate how easily a site can export into a useable format. There are many reasons why a
teacher may want to export a site. For example:

- A teacher receives a better opportunity at a different school or school district and the new
  school does not use the same learning management system.
- The web space provider changes their pricing structure or goes out business.

Keeping flexibility in mind, I have chosen to develop in HTML, since most LMS and
website builders rely on a database structure that can be difficult to export. HTML is the standard
to create internet content and therefore will have the greatest longevity and compatibility.

Coding in HTML does require time and may not be practical for a teacher to reproduce
all of the functionalities of an LMS or website builder site. Therefore, I decided to develop a site
within a site. This method will allow access to all of the features of an LMS but still have a core
HTML structure that is exportable.

My first deliverable for this project was to create a dashboard navigation system that can
act as a standalone unit or work within a LMS. The second deliverable was to create a series of
lessons and templates that reduce the development time and improve student engagement. The
third deliverable was to create a resource hub that acts as curation site where teachers can submit
resources. Within the resource hub, there is a section devoted to providing resources that will
facilitate the creation of online content. The next topics will discuss the pros, cons and
challenges of developing the deliverables.

The target audience is British Columbia Chemistry 12 teachers. It is difficult to find
resources that match the depth and breadth of the curriculum. By narrowing, the audience I in
turn increased the degree of common interests that will help build a sense of community.
Creation of Deliverables

Dashboard Development. Peer feedback showed that the Moodle LMS navigation is utilitarian and not intuitive. The likelihood of success decreases as the amount of barriers increase; analysis of click through rates is essential when designing a website. My intent was to create a navigation system that would allow students to access the major sections of the course within three clicks.

The decision to setup a three click maximum was based on the-three-click rule which is an unofficial web design rule that states users become frustrated if they cannot retrieve information within three mouse clicks. I agree with Porter (2003) where he suggests that “the number of clicks isn’t what is important to users, but whether or not they’re successful at finding what they’re seeking” (p.3). This rule helps focus web designers to create easy to navigate sites. It is not difficult to create a site map were all the pages are just three clicks away, but this criterion alone does not make for an effective website design. The flow between the pages also needs to be logical. In my opinion, if we can minimize the number of clicks and remain logical this will help reduce the cognitive load and increase enjoyment levels.

The design process began with involving the key stakeholders (teachers, counselors and users) and asking them to list the parts of the course they frequently accessed. The stakeholders also provided information on what they would like to see on the homepage. Surprisingly, the responses were very similar among the different stakeholder groups the top requests were:

- Course Outline/Information – such as assessment, timeline
- Quick access to lessons
- Clear indication of what contributes towards marks
- Contact information to get help
• Access to email, grades and resource books

After tabulating the responses, the goal was to create a mobile friendly interface that would integrate the different components of the course. Initial prototypes were created using Adobe Captivate; this software allowed for quick object based designing without having to code. On average, a prototype would take approximately two hours to create and then given to the stakeholders to gather further feedback. The feedback on each prototype consisted of three questions:

1. What do you like?
2. What do you not like?
3. What would you like to see changed?

Over the course of a month, seven prototypes were produced addressing issues around arrangement, sizing by relative importance and mimicking current mobile user interfaces. Appendix C contains images of the different dashboard versions that led to the final design.

Captivate has the capabilities to publish in HTML but unfortunately the resulting files are not editable. In order to increase the usability of the dashboard I created the templates from scratch using only HTML coding and a Cascading Style Sheet (CSS). The process of developing in HTML resulted in templates that are mobile friendly and are editable without having to use proprietary software.

Determining the display area was the first decision. I considered two factors:

• What are the screen sizes for mobile devices?
• How much useable space does the LMS provide?

The content design reduces cognitive load by allowing all key information to fit on a screen without the need for scrolling. According to W3Schools (2014) one of the smallest mobile screen
sizes is 640 x 960 pixels however the 99% of people have a 1024 x 768 screen size. These statistics provided the upper and lower limits; the next step was to determine how much usable space the LMS provided. The amount of usable space was calculated by taking a screenshot and using Photoshop to count the number of pixels occupied by the banners, padding margins and white space. A 640 x 480 area was determined to be a dimension that would work in most situations.

The next stage was to allocate the space. During the design process, the left side was chosen as the preferred location for the inter-module navigation. Gutierrez (2014) suggests a minimal button size of 44 x 44 pixels so that the targets are large enough to accommodate a thumb. Considering this size, the smallest buttons were set to be 64 x 52 pixels; the slightly larger button size helped improve the dexterity. The width of the left column was set to 75 pixels to accommodate buttons with room for white space. The remainder 565 x 480 pixels were to be used to display content. This area utilizes four different templates. The intent is to provide teachers with multiple ways of presenting content. The templates are:

- **Targetedframes.html** – allows for user to toggle between 3 different pages all on one screen
- **Module1_menu.html** – divides the display area into two columns (left 330 px, right 235 px)
- **Module2_menu** – **Module4_menu** – uses the same layout as module1 but with varying button sizes
- **Fullpageinstruction.html** – does not divide the space up, it provides a blank canvas for teachers to modify to fit their needs

Appendix D contains images of the dashboard templates.
In addition to the four main templates above, I provided a template called homepage.html. This template is very similar to the fullpageinstruction.html template except for one unique feature. The homepage.html template has a marque that enables the page to be dynamic. By simply uploading new pictures, teachers can push out reminders and messages. This helps improve the instruction climate, one of Elias (2010) principles for Universal Instructional Design.

Div tags were used in place of tables to define spaces. The main advantage of using a div tag is that it can exist in a CSS where its properties can be set and altered, thereby providing a mechanism for executing global changes. All fonts and buttons where also placed into a CSS enabling users to customize the look of the dashboard by only editing a single file.

During the design process there were many comments regarding the use of colour. Attempts were made to follow the design principles listed by Wang (2012), but I lack colour coordination skills. Fortunately, I was directed to an online resource, paletton.com, which applies colour theories and provides the hex codes of complimentary colours.

Wang (2012) suggests the use of high brightness colour with black backgrounds. I decided to use a bright red to contrast the black background, and then relied on the colour wheel tool on paletton.com to find complimentary colours (See Figure 1: Colour wheel tool from paletton.com in tetrad mode). By choosing the triad and tetrad options I was able to find complimentary colours on the opposing side of the colour wheel that are a high contrast to black.
The HTML conversion process occurred over ten days. I did not have any formal training in HTML coding and relied on Google and YouTube to answer questions. Coding is logic driven so as long one can recognize patterns it is relatively easy to make changes. The amount of time to create a final product makes me question the value of starting from scratch to design a navigation system. I would recommend teachers personalize their web space but with the use of templates. All of the template files generated are available on the resource hub and there are many websites that offer templates for sale ranging from $10 to $60.

**Lesson Development.** The next stage of the project focused on the development of lessons for Reaction Kinetics and Equilibrium that represent approximately a third of the Chemistry 12 curriculum. The design of the lessons used the UID and Message Design principles discussed in Chapter 2. Unfortunately, I could not implement all aspects due to time constraints. For example, the execution of closed captioning involved a three-step process: scripting dialogue, recording dialogue, and synchronizing animations to audio and script. The process of adding closed captions is not difficult but it is time consuming to synchronize the three different activities.
The decision of opting for greater quantity of good resources over a few excellent resources was easy to make. Lesson development is a never-ending task; there are always adaptations and modifications to make. In order for the resource hub to succeed, the site needs a substantive amount of materials for others to use; and with time, the community can enhance the resources.

The general progression of a lesson was:

1. Title Screen – lesson title
2. Overview Screen – learning outcomes listed, environment conditions: amount of time needed, the use of audio and video, etc.
3. Intro – narrative introducing the concepts
4. Lesson Activities – questions, videos, fill in the blank, drag and drop activities
5. Summary – a quick recap of the major themes in the lesson

For each finalized lesson, I produced a slideshow presentation and provided the accompanying notes. The rationale for providing the notes was two-fold. Firstly, it is difficult to skim through material if it is auditory based hence when students are reviewing they need a quick method of accessing information. Secondly, listening to audio may be difficult depending on the environment the student is in. Mobile compatibility does offer great access but not all environments are optimal for learning.

I used Adobe Captivate to create the lesson presentations because it is one of the leading companies in e-learning development. Captivate has the capability of publishing projects in both flash and HTML5, which is essential for mobile integration. Unfortunately, it did not take long for issues around mobile compatibility to arise. Even though Captivate has the ability to publish in HTML5, not all of its features are compatible (more information on incompatible features is
provided in Appendix E). In fact, many of its advanced features were not compatible, which was disheartening. Creating engaging and interactive lessons requires going beyond a static webpage. I attempted work-around solutions that resulted in mobile friendly lessons but then issues with desktop compatibility arose. A lesson would only run on select browsers with the use of plugins. Mobile use is on the rise but it is not ubiquitous, hence being able to run on a desktop is vital. I was not about to develop two different lessons or one watered down lesson that did not take advantage of the technology at hand.

The resolution was to publish projects in flash; this would allow for the use of advanced features, desktop compatibility and mobile access with the use of a flash based browser such as Puffin. This issue is technology-based and given a little time, the software developers will have these issues resolved. The minor inconvenience of the addition of a mobile app was worth the gains achieved in interactivity.

As I noticed repetitive actions during development, I created templates to mimic these actions. I was able to speed up the development process considerably with execution of the templates. These templates are available on the resource hub website.

In the interest of providing teachers and students with the ability of personalizing assignments, I made the decision not to create specific mobile-based assessment but alternatively provide ideas of how to use mobile devices to enhance learning. The collection of ideas is located in the resource hub (http://chembc.weebly.com/get-mobile.html).

The amount of time required to develop online content is astonishing. With the advice of my advisor, I scaled down my original intent of developing the entire Chemistry 12 curriculum to focusing on a third of the course. In retrospect, a third of the course was an ambitious goal; I could have achieved proof of concept with a few lessons. A lesson took approximately 30 hours
of development time, over the course of August, September and October ten lessons were
developed. The large development time necessary to produce quality resources reiterates the
need for a collaborative approach. I am passionate about the subject area and enjoy developing;
however, this lone ranger model is neither practical nor sustainable.

**Resource Hub Website Development.** The Chemistry Resource Hub is located at
[www.chembc.weebly.com](http://www.chembc.weebly.com). The decision to use Weebly as the building platform for the resource
hub site was based on three reasons:

1. There was not enough time to design a theme and navigation system. Weebly offers
   themed webpage templates with drag and drop site building tools.
2. This project is about development and I wanted to showcase another tool.
3. Weebly does permit site back-ups.

Time was a major driving factor for using an easy to use site builder; however, there are
limitations with these types of providers where advanced features typically come at an additional
cost. Weebly does permit users to backup sites; this function can act as an export function when
attempting to move the site to another provider. A word of caution: not all features are
exportable. When developing the resource hub site, features such as blogs and slide shows were
not used since they rely on coding hosted on the Weebly main server and cannot be exported.

When determining the name for the website I wanted something that was easy to remember,
simple and to the point. Since this site is dedicated to providing chemistry resources for British
Columbia teachers, chembc seemed fitting, where chem is shortened form for chemistry and bc
for British Columbia. To make the site easier to find by search engines I added the following
Meta tags: chemistry, British Columbia, Chemistry 12 and bc chem.
I used a scaffolding approach to dictate the order of the webpages. The goal of the site was to have chemistry teachers actively contributing to the community: however before someone becomes a contributor, they are a consumer of content. I organized the webpages to help facilitate the transition. The website has a three-stage hierarchy.

- **Stage 1: Consuming Content**
  
  This stage contains the Home, Resource and the Mobile Integration webpages. The Homepage contains a welcome message and relays the intent of the website. The Resources page houses all of the curated material and finally the Mobile Integration Page provides ideas of how to utilize and leverage mobile technology.

- **Stage 2: Creating Content**
  
  This stage contains the Get Online, Lesson Templates and Dashboard webpages. The Get Online page provides instructions and tips on how to get resources online. The Lesson Template page provides Adobe Captivate template files that I created in an attempt to speed up the development process for others. Finally, the Dashboard page provides instruction on how to create your own navigation system and all of my raw files.

- **Stage 3: Sharing Content**
  
  This stage contains the Join the PLN and Contact webpages. The Join the PLN page provides instruction how to become a member and how to share resources with the Chemistry Resource Room. The Contact page contains all of my contact information.

The crux of the resource hub is its ability to manage data. In order for the website to become effective, the process of inserting and retrieving data needs to be effortless. I chose Google Drive to be the repository system. The rationales for choosing Google over other cloud storage services are:
Google is a large and well-established company hence is not likely to discontinue its services. Many people have Google accounts and are familiar with their products. The ability to set permission levels and restrict access to files. The ability to embed the Google Drive file structure into a website.

The initial logistics of determining the layout and the process of integrating Google Drive occurred over two days and it took one week to insert the content. In the interest of keeping the resources open, all of the resources are licenced under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International Licence. I felt it was important that the original authors receive attribution and to allow users to remix and transform the resources to fit their needs. The addition of the non-commercial term prevents profiteering from occurring. If a company wants to use a teacher’s resource, there is nothing stopping them from asking the author directly for permission or buying the rights.

Implementation of Deliverables

Dashboard template. The dashboard consists of three zones (See Figure 2: Zones of the Dashboard) and the content is projected into these areas with the use of inline frames. Any given dashboard screen is the combination three html files (one representing each zone) working together to display one cohesive page. I chose to break apart one large file into three subsections in an attempt to simplify the editing process. Users can work independently in a zone without having to sort through the unrelated code of the other zones; thereby avoiding potential errors and confusion. Users can edit a zone at a time and any file that references that zone automatically updates. Podcasts outlining how to use the template files are located in the resource hub. In
addition to HTML files, the customizable Photoshop files for all icons and buttons have also been provided.

![Diagram of Dashboard]

**Figure 2:** Zones of the Dashboard.

**Lesson templates.** I categorized all lessons and one can find them on the resource hub. The related embed codes have also been provided so other teachers can insert lessons directly into their own websites. The process of creating the lessons resulted in production of seven Captivate templates that can potentially reduce development time. The templates are freely available under the Lesson Templates section of the resource hub.

**Resources hub.** I shared all resources at chembc.weebly.com. The resources can be downloaded or run off the resource hub website with the use of embed codes. In order to contribute to the site, a teacher must register by providing their email, name, and the name of the school at which they work.

Once an account meets approval, a teacher receives access to the shared Google Drive folder. The process of sharing is simple; all users need to do is drag resources from their desktop into the shared folder. Teachers can easily check if they have successfully uploaded their resources by viewing the contents of the pending folder on the resource hub website.
As a safety precaution, uploaded resources do not automatically update to the community resources. The site administration first scans resources for viruses and checks for spam. Also, by limiting edit access to community files the accidental deletion of resources is avoided.

To help the community grow the Get Online section of the resource hub is dedicated to providing teachers with material that will support the creation of online content. In this section, teachers can find information such as tips to convert existing resources to an online friendly format and advice on how to create screen casts. A copy of the Get Online guide is available in the resource hub (http://chembc.weebly.com/get-online.html).

**Distribution of Deliverables**

The project development occurred over five months and concluded in November 2014. All of the deliverables are available for use at chembc.weebly.ca. Feedback for the deliverables occurred after the completion of each milestone. The next chapter discusses the findings of the beta testing.
Chapter 4: Field & Beta Testing

Methods and Process

During the course of the project, there were three major deliverables and two minor deliverables created, all of which are interconnected. A mobile friendly dashboard navigation system was created as the first deliverable which works with a LMS system or as a stand-alone unit. This navigation system links to the second deliverable, a series of lessons that take advantage of mobile technology and reduce cognitive load. The original project outlined integration of a few mobile-based student-driven activities as the first minor deliverable, but I opted to provide a series on ideas of how integrate mobile technology instead. This way, users could personalize the technology to fit individual needs. The third major deliverable was to create a resource hub website that acts as a curation site to provide British Columbian Chemistry 12 teachers an easy, intuitive way of sharing resources. Also, within this resource hub the final minor deliverable can be found, a guidebook that provides advice on how to generate online content.

I originally planned to release beta testing to the global community through all available communication channels. The goal was to get as much feedback as possible from different users. The initial plan was to use Twitter, Facebook groups, Google+ communities and peers. As the resources evolved, there became a stronger emphasis on the Chemistry curriculum. Ultimately, the review was not to be simply technology-based but was to focus on the effectiveness of the content for Chemistry students. Additionally there was some concern raised about global sharing of the resource hub. For these reasons, the beta testers were limited to counsellors and teachers that have a science background and/or DL experience. Also, I asked users for some informal feedback regarding the new format of the dashboard and navigation.
Since a formal review was not required, the majority of feedback was in the form of email and in-person correspondence. When possible I preferred to have informal conversations as this permitted instantaneous feedback and dialogue could occur with more in depth insights.

As this project is vast in scope, feedback did not occur at the conclusion of the project but rather immediately following the completion of a development stage. To improve the quality of feedback I decided to serve the project up in stages in order to promote detailed responses versus generalizations. The beta testing process began in September 2014 and is currently on going; since the resource hub is dynamic, it continues to evolve. There will always be changes to make and I value the input and opinions my peers have to offer.

**Findings of the Beta Testers**

I requested the beta testers to perform various tasks for each of the deliverables. Table 2 outlines the questions asked.

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
</table>

*Beta tester guiding questions*

<table>
<thead>
<tr>
<th>Dashboard</th>
<th>Stage 1: Using the Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Use a mobile device to access the website and compare the ease of use of the Dashboard to that of the LMS</td>
</tr>
<tr>
<td></td>
<td>• Use a desktop computer to access the website and compare the ease of use of the Dashboard to that of the LMS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Stage 2: Using HTML source files</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Examine the source code files and determine the realistic ability to be able to use the template files</td>
</tr>
<tr>
<td></td>
<td>• Determine how easily you can export your current website and get it going by another means (LMS, website builder site or host your own site using HTML)</td>
</tr>
</tbody>
</table>

*table continues*
Lesson

- Review all of the lessons
  - Would you use the lessons with your students?
  - Would you use the templates provided to develop resources?
- Compare the mobile influenced lessons to the previous webpage lessons
  - Is there a worthwhile improvement?

Mobile

- Review the mobile activities
  - Would you use mobile-based activities in your teaching practice?
  - Did you find the resources helpful?

Resource Hub

- Review the resource hub website
  - Comment on the ease of finding material and the layout
  - Would you use any of the resources provided?
  - Would you contribute to the BC Chemistry Resource Room community?
  - What are your overall impressions?

Get Online

- Review the Get Online guidebook
  - Did you learn anything new?
  - Did you find the advice and tips useful?

Dashboard navigation system. The reviews of the dashboard were overwhelmingly positive. The testers stated that the interface was intuitive and for the majority it was the preferred choice to navigate. When reviewing the site on a mobile device the users considered the dashboard far superior. The testers found the LMS frustrating because of the small target areas; it would take multiple attempts or required zooming in to select appropriate links. Users seemed to appreciate the to-do list; they found it an easy way to find the assignments versus having to read through lessons to obtain them. Not all of the reviews were positive; however, one tester mentioned that the new look would be more appropriate for primary courses and another tester mentioned that they favoured the blog-like environment of the LMS.

Although the dashboard was preferred over LMS, the same positive response did not carry over to implementation of the dashboard into instructors’ own websites. Most found the instructions straightforward but were hesitant to play with the files without having someone available to answers questions. One person saw the need for the dashboard but felt it was a
luxury feature for which he did not have time. His priority was developing resources not focusing on how students would access them. The teachers with some past HTML experience were optimistic about the ability to use the dashboard template files. Most beta testers stated that they liked portions of the dashboard and would be tempted to take sections of it for use in their own websites.

The question regarding the portability of their own website caught most teachers by surprise. Many mentioned that they have been busy developing and never thought of what the process of moving a site would involve. Most of the testers are in established positions and are unlikely to move in the near future but said this will require further investigation, likely influencing how they develop in the future.

The beta testers suggested that the dashboard could be improved by providing students with the ability to cross off tasks from the to-do list as they are completed. This is an interesting proposition and perhaps with the integration of SQRM or Tin Can API it will be possible; further development would be required for this request.

**Lesson development.** Across the board, beta testers viewed the lessons favourably. Chemistry teachers plan to share the lessons with their students in varying capacities. Some educators have begun designing flipped classroom activities while others will be using the lessons simply as an additional resource towards which to direct students. The quality of the materials impressed the teachers but they had concerns regarding the amount of development time required. All of the testers took a copy of the templates even though not everyone had access to the software. After receiving the positive reviews, I embedded the lessons into my own course; Anecdotally, I had few questions regarding course navigation and more questions involving critical thinking. I did have one user say he prefers reading to listening to audio. He
could see how the new slide show style would help others but for him reading was his first choice. However, he said for his purposes the accompanying note sheet would be sufficient.

The beta testers provided two suggestions to help enhance this section of the project:

- The tester emphasized the need for the lessons to be broken into smaller chunks, which would facilitate the ability to customize lessons. The smaller chunks would allow teachers to easily delete sections, add new sections and rearrange lessons so that they align with the order that concepts are presented in their own classrooms.
- The testers would like to have a how-to guide to using the software.

**Mobile activities.** All of the beta testers commented that at this stage they are not willing to institute class wide projects using mobile technologies. The main cause of concern was that not all students have access to mobile devices and therefore mobile projects would be reliant on a Bring Your Own Device (BYOD) model. Despite the infrastructure concerns, there was considerable enthusiasm towards the potential uses. Teachers particularly liked the ability to use a tool such as Class Dojo to communicate with parents and students. The beta testers also liked that they could use the built-in functions to create presentations. However, the teachers with a DL background mentioned due to the asynchronous nature of their programs that the peer-to-peer collaboration would be difficult to execute unless there was a cohort that progressed through course at the same pace.

**Resource hub.** Despite some of the grammatical errors on the resource hub website the overall opinion was that the site looked professional, it is well organized and easy to navigate. All of the chemistry teachers indicated that they would be using and contributing to the site. In fact, I have already received resources from four teachers (three from the beta test group, and one teacher who had come across the website on his own). The testers found the process of sharing
resources easy and thought it was a clever new way of utilizing tools that they were already using.

The beta tester made a few recommendations for changes:

- The beta testers stated they could see this website growing and it would need some type of search capability to sort through all of the resources.
- They would also like to see a resource ranking system put in place. Suggestions were to have something similar to the “like” function in Facebook and YouTube put in place.
- Many of the testers saw value of the community approach to resource curating however would like to see a tiered access structure to the website where users that contribute would be provided with full access otherwise only limited access would be granted. The testers felt this technique would prevent people from abusing the site and ensure continual contributions.
- Beta testers raised two concerns, which advocated for the need of a secure password protected site. Teachers wanted to prevent students from accessing assessment information and worried about the possibility of accidently sharing copyright material on a public site.

**Get online guidebook.** The guidebook was considered a valuable resource by testers that were classroom teachers. The majority of the DL teachers stated there were a few tidbits that they found interesting but overall they have been through various stages of producing online content and said this section of the website was not for them.

**Conclusion**

I am very proud of what I produced and of the positive responses received from peers. I had to scale back parts of this project due to time constraints. The suggestions that my peers have
made are goals of my own that I have yet to achieve. Teaching is a practice and it is always evolving; we learn from what we do today to improve tomorrow. We cannot get stuck at one point, because there are always more ideas, more what-ifs, but we do not have the luxury of time to do it all. As B. Jeasonsone said, “When is good, good enough?” (personal communication, November 14, 2014) This statement made me think that as long as I am meeting the needs of my students, I am happy. There is always room for improvement and that is what we use as a driving force.
Chapter 5- Conclusions and Recommendations

Project Overview

The project’s intent was to develop resources and techniques that concentrated on mobile learning which teachers could use in a senior secondary science course and would reduce the time burden of course development. During the course of the project, I created five deliverables that addressed this goal:

- A Dashboard navigation system was developed that is mobile-friendly and has the ability to work in conjunction with a LMS
- Mobile friendly lessons were created that cover the Reaction Kinetic and Equilibrium concepts of the British Columbia Chemistry 12 curriculum
- A BC Chemistry Resource Room website was produced that acts as a curation site of resources that align with the British Columbia Chemistry curriculum
- A Get Online guidebook was published that helps educators transition their current resources to an online friendly format
- Activities were generated that take advantage of mobile technology to complement the learning process

Development Process

I created the dashboard navigation system by applying the principles of Universal Instructional Design and Message Design Theory. I coded the dashboard in HTML to ensure equitable use over all platforms. In order to make the content simple and intuitive to use all of the content was chunked and minimized. Templates to send out push reminders improved the instructional climate.
The lesson development continued with the incorporation of UID and Message Design Theory, but also incorporating Uden’s (2007) framework for analysing mobile learning with the use of activity theory. Activity goals were set; I examined the process in which students would achieve these goals and I made modifications to align the lessons to the mobile environment.

I created the resource hub to promote sharing of chemistry-based resources. The resource hub was named the BC Chemistry Resource Room and can be found at the domain www.chembc.weebly.ca. The site was structured to support the transformation of users from being consumers of content to contributors of content. The methodology for the transformation process was adapted from the teaching of OLTD 505 Open Education Resources, where users need support before they can become active members of the community. I designed the site such that teachers can share resources without technical expertise. Also within the site, I provide information on how to make online compatible resources and methods in which they can share them with the community.

My personal experience in producing online content directed the Get Online guidebook development. The guidebook provides advice for educators with varying expertise. Information ranges from tips on how to place Word and PowerPoint files online to creating screencasts and interactive activities.

Finally, I shared various mobile activities on the resource hub that capitalize on the compute, capture and communicate functions of mobile devices. I designed these suggested activities to extend the use of the mobile device beyond being a simple viewing portal.

**Beta Testing Results and Implications**

The project received overwhelmingly positive reviews from the beta testers. The execution of the dashboard worked seamlessly within a LMS system and for the majority it was the preferred
navigation method. I attribute success of design to the involvement of key stakeholders in the development process; this helped combine the real world needs with the theory. Unfortunately, some of the educators were hesitant to deploy the dashboard into their own websites. Beta testers rationalized reluctance to adopt the model citing insecurities around coding. The users saw value in the navigation system and with time, I feel educators will start to take risks and begin to experiment. The adoption process could be accelerated by providing greater support. The current dashboard design may not be ideal for everyone’s site however; the coding and structure are relevant; I feel it is worth the time investment to build extra support.

The lessons and resulting templates were highly sought after by educators. Beta testers commented that many of the resources found online skim over concepts; however, the correlation of lessons to the BC curriculum allow for deeper investigations. The users also liked that the lessons went beyond being a podcast; the interactivity elements took the screencast presentation to the next level. The enthusiasm of educators to use the lessons in varying formats reconfirms my belief in the value of mobile learning concepts. Good teaching practice is to provide students with options to personalize their learning; mobile learning is simply another pathway. The popularity of mobile devices enhances the appeal of incorporating mLearning. In the short time that I have implemented the lessons in my asynchronous course, I have observed the rate at which students’ progress has increased.

The resource hub received the most attention from the beta testers. The quality of resources that were freely available surprised educators. The ease of retrieving and sharing resources are the website’s key success factors. The beta testers were very optimistic for the potential of the site and offered many suggestions for improvement, which included:

- Adding search capabilities
• Adding a method to rank the quality of resources
• Adding password protection to the site

Of all the motions put forward, the need for password protecting the site was reiterated by many of the beta testers. There were several rationales provided which include:
• Students may access assessment information and answer keys
• The need for an additional a layer of protection if someone accidently shares copy written material on a public site
• A password would protect the site from abuse, with full access only provided to members that share resources.

However, I am wary about the potential implications of password protecting the site. At these early stages of the site’s existence, I am hesitant of adding barriers that would deter members from joining the group or reducing its exposure. There are benefits of a two-tiered membership but determining criteria to discriminate between the two groups could be problematic. Initial questions that arise are: How do we judge resources? Do we want quality or quantity?

The Get Online Guidebook received mixed reviews as to be expected. The value of this resource is dependent on the degree of development experience the user has. Educators with minimal development experience found the advice and tips insightful whereas experienced developers were already aware of most the information presented.

Beta tester received mobile activities with optimism in the potential but with hesitation in the execution. They liked the possibility of project development and the ease of communicating with students and parents. However since not all students have access to devices the teachers indicated that class-wide projects would not be feasible. The benefits of mobile devices are evident; unfortunately, this is a situation where the costs do not make it practical at this moment
in time. Nevertheless, there is no need to implement class-wide projects, as there is the possibility of individual students utilizing the technology. Educators simply need to provide enough leeway in project design that allows students to personalize the manner in which they create and present projects.

**Recommendations and Next Steps**

The initial beta testing reviews indicate there is a real need to have resources focused to match the depth and breadth of the British Columbia curriculum. The project will continue to grow and evolve beyond the scope of the MEDL program. The intent is not to create a one-stop shop, but a reliable place where educators can easily access teacher vetted resources and connect with other like-minded educators.

There is no shortage of ideas of how to improve the resource hub. The quality of material housed and the ease of retrieving the resources correlates to the viability of the site. I plan to continue contributing to the community by developing lessons for the Chemistry 12 curriculum. However as the site grows and gains membership the infrastructure will also need to be improved.

Currently the site relies on a file system hierarchy for organization; eventually the system will require a database to overcome its limitations. A database base will allow for queries and tagging of the resources. The tagging of contributions with specific learning outcomes, difficulty levels and media type would increase the usefulness of the site. In addition to the database, a notification system also needs development to keep members connected. To help foster membership involvement I recommend two strategies:

- The implementation of an RSS feed would provide a mechanism to make members aware of new contributions.
• Allow educators to post and respond to questions through the deployment of a members’ only portal.

As the BC Chemistry Resource Room gains popularity, additional supports will be required to meet the needs of the growing community. The site administration will require a team of educators to take on the role of directing the growth and development. In addition, there will be cost items such as server space and technical expertise needed to advance the site. A capital source will need to be established and perhaps Ministry of Education or British Columbia Science Teacher Association could allocate funding.

Leadership Role

As educators, we attempt to personalize the learning environment so that students take onus over their learning and have a meaningful experience. The process of course development should apply the same logic between the teacher’s role and content design. The creation of a quality learning experience requires teachers to take ownership of courses. As a DL teacher, I experienced the process of inheriting courses and not until I started making changes did I feel that the course was truly my own. In my opinion, teachers need to be a part of the development process; this allows for a reflection of their personality within a course, which in turn acts as motivational factor to further improve the learning environment. For teacher directed development to occur, it is essential to provide time, flexibility and support. The leadership component of this project was to facilitate teacher directed development by the means of these three factors. Templates reduce development time, HTML coding makes courses portable and flexible and the resource hub website provides support. The key is to have educators emotionally invested in a course and that can only occur through a supportive work environment.
Limitations and Issues

The benefit of dealing with technology is that it is always changing; what is not possible today maybe possible tomorrow. Unfortunately managing this rapid change is a difficult task. The site will need constant updating: There will always be broken links that require removal or fixing. Furthermore, as the next iteration of programs becomes available new templates will need generating which will require additional time for development.

As we begin to integrate cloud-based technologies, it is crucial to perform a risk analysis of all the tools. Educators are responsible to do their due diligence in order to protect student’s privacy and ensure students and parents are aware of potential risks. From my experience, it is a time onerous process to create a backgrounder and a permission slip. Since tools are being continually developed a collaborative approach will be needed to perform the risk analysis. I would recommend a provincial approach to creating the analysis and not leaving the onus on individual teachers. The ability of successfully using new techniques such as mobile learning is dependent on providing a safe environment for students.

To transition mobile learning from being an extra activity to a common occurrence in classrooms will require a financial commitment from the Ministry of Education. Since not all families can afford the downloaded costs of buying devices, software and data a BYOD model cannot achieve equitable use among students. Until funding is in place mobile learning adoption will be a slow process and there will be pockets of early adopters in areas where socioeconomic issues do not exist.

The largest issue confronting the resource hub site and possibly terminating its existence is the potential of sharing copyrighted material without the proper permissions. The viability of the site is reliant on an open sharing platform; however, the openness could be its downfall. It
IMPLEMENTING MOBILE LEARNING IN SENIOR CHEMISTRY

will be impossible to monitor every resource published for infringement of copyright. A legalese is a possibility to protect the site, but it is uncertain if that would truly absolve the site from any potential legal action. This issues was the reasoning for restricting the size of the beta group, the larger the group becomes more difficult it will be to control the information on the site. Making the site truly open will require further investigations of the legalities around copyright.

Conclusion

The positive reviews from peers were reassuring as they indicated that mLearning is pedagogically sound. The original plan for the project was simply to utilize mobile technology to create lessons and connect with students. As the development began, the project also started to evolve. Even before receiving feedback, it was evident that the newly created mobile-based lessons were superior to the previous instance. However, it became apparent that the amount of time to develop was not sustainable. It would take an educator several years to complete a course off the side of their desk. I felt it was necessary to address this unsustainable practice. The resolution was simple; to share was the key, something educators have been doing for a long time. A secondary goal of the project formed, to determine a method to facilitate sharing in a digital space. I was very proud of my lessons, but surprisingly I am more proud of the accomplishment of creating the resource hub. The final prototype works effortlessly and from reviews, I can see it catching on with British Columbian Chemistry teachers.

Once the issues regarding password protection have been resolved, I will be contacting the BC Science Teachers Association and asking for the resource to be shared with their members. My hope is that this project extends beyond the chemistry teacher audience. The resource hub structure and functions are transferrable to other disciplines. It would be interesting to see if other teachers would be willing to take on the challenge and create a similar site for their
communities. All aspects of this project are registered under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. I would be willing to share the techniques used in the BC Chemistry Resource Room with any interested party wanting to pursue a similar venture.
References


## Appendix A: Mobile Capabilities

This table lists how mobile capabilities can be used to support different needs.

<table>
<thead>
<tr>
<th>Learning Modules</th>
<th>Performance Support</th>
<th>Access to Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just-in-Time Learning</td>
<td>On-the-Job Support</td>
<td>Field Guides</td>
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<tr>
<td>Microlearning</td>
<td>Alerts</td>
<td>Presentations</td>
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<td>Reach-back/Review</td>
<td>Reminders</td>
<td>Podcasts</td>
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<td>Vodcasts</td>
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<td>Updates</td>
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<td>Forms and Checklists</td>
<td>Audio Recordings</td>
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<td>Decision Support</td>
<td>Video Recordings</td>
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<td>Infobases/Knowledge bases</td>
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<th>Assessment</th>
<th>Innovation Approaches</th>
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<td>Quizzes</td>
<td>Games and Simulations</td>
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<td>Conferencing</td>
<td>Evaluations</td>
<td>Location-Specific Content</td>
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<td>Feedback</td>
<td>Tests</td>
<td>Augmented Reality</td>
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<td>Mentoring</td>
<td>Surveys or Polls</td>
<td>Contextualized Learning</td>
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<td>Social Networking</td>
<td>Reporting</td>
<td>Spaced Learning</td>
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<td>Certification</td>
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<th>E-books</th>
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<td>Text Books</td>
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<tr>
<td>Transcription</td>
<td>Papers</td>
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<td>Translation</td>
<td>Manuals or Reference Guides</td>
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<td>Photos</td>
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<td>Videos</td>
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<td>Audio Capture</td>
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<td>Blogs and microblogs</td>
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<td>Wikis</td>
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<td>Learning journals</td>
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<td>Portfolios</td>
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Appendix B: Design Basics

The following are design basics suggested by the ADL Mobile Learning Handbook

Video format
The most common video formats supported across most devices are MP4 and 3GP. However, video content packaged with a native mobile app may require a specific encoding type for each platform and playback may or may not be supported. The following reference gives an overview of video formats for mobile: http://www.videomaker.com/article/14520-video-formats-for-cell-phones

Screen Resolution
How many pixels (width x height) are available on your target audience's device(s)? This is important to consider when creating graphics for mobile screens. If the image is too big for the device, it will be resized, which results in poor image quality. If the image isn't big enough for the device's display, it may look awkward with blank space around it, which may interfere with your overall design.

The most popular screen resolutions are:

<table>
<thead>
<tr>
<th>Laptops</th>
<th>iPhone</th>
<th>iPad</th>
<th>iPad mini</th>
<th>Android Devices</th>
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<tbody>
<tr>
<td>1024×768 and higher</td>
<td>5: 1136×640</td>
<td>First &amp; second generations: 1024×768</td>
<td>1024×768</td>
<td>Small screens: 426 x 320px</td>
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<tr>
<td></td>
<td>4S: 640×960</td>
<td>3rd generation: 2048×1536</td>
<td></td>
<td>Normal screens: 470 x 320</td>
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<tr>
<td></td>
<td>3GS: 320×480</td>
<td></td>
<td></td>
<td>Large screens: 640 x 480</td>
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Target Sizes
Make it easy for people to interact with content and controls by giving each interactive element ample spacing. Give tappable controls a hit target of about 44 x 44 points.

Touch Areas
Avoid buttons. Use bars instead. This keeps navigation controls within reach of user’s thumbs.
Space items out so users don’t hit the wrong target.
In general, touch areas should be positioned and sized so that fingers do not obscure important information where they are clicking.
Do not tell users to “click” to interact with a button. Use "push" or "tap".
Arrangement

Make it easy to focus on the main task by elevating important content or functionality. Some good ways to do this are to place principal items in the upper half of the screen and—in left-to-right cultures—near the left side of the screen.

Use visual weight and balance to show users the relative importance of onscreen elements. Large items catch the eye and tend to appear more important than smaller ones. Larger items are also easier for users to tap, which makes them especially useful in apps—such as Phone and Clock—that users often use in distracting surroundings.
Appendix C: History of Dashboard Prototypes

The following images represent the different prototype designs that lead to the creation of the dashboard navigation system.
Appendix D: Dashboard Content Templates

The following images represent the different templates created for the dashboard navigating system:

- **Full Page Instruction**
  - **1.** lets get started
  - **2.** how to navigate the course
  - **3.** meet the teacher
  - **4.** course outline
  - **5.** activation assignment

- **Targeted Frames (3 pages on 1 screen)**
  - **1.** outline
  - **2.** assessment
  - **3.** timeline
  - This course consists of five modules:
    - Reaction Kinetics
    - Equilibrium
    - Solubility Equilibrium
    - Acids, Bases, and Salts
    - Electrochemistry: Oxidation and Reduction
  - This course’s learning outcomes can be found here:
    - insert url link

- **Large Button**
  - **1.** Equilibrium
  - **2.** module 2
  - **3.** lessons
  - **4.** notes
  - **5.** tasks
    - Module 2 Practice
    - Module 2 Quiz
    - Module 2 Test

- **Small Buttons**
  - **1.** Acids and Bases
  - **2.** module 4
  - **3.** section 1
  - **4.** lessons
  - **5.** notes
Appendix E: Captivate HTML conflicts

The following Adobe Captivate 7 features were not able to published into HTML format:

- Text caption
- Click box
- Highlight box
- Zoom Areas
- Smart Shapes
- Rollover Slidelets
- Rollover Captions
- Any effects that are added by using a right click
- Advance Action Scripts
- Audio Objects attached to invisible objects
- Non Adobe Widgets
- Scaling Project Feature

The following Questioning formats were not compatible:
- No Likert, fill in the blank, short answer, matching
- No question pools, random questions