

DEVELOPMENT OF AN ONLINE LEARNING PLATFORM AND CPD MATERIAL FOR NAVAL ARCHITECTS AND PROJECT MANAGERS WORKING IN OFFSHORE WIND AND OIL AND GAS SECTORS

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SUMMARY

This paper presents the development process behind an e-learning platform and mobile application that is used to transfer design innovation from the interior design and leisure marine industry, as well as Human Factors Integration from the automotive and aerospace sectors, into Wind Farm Support Vessels and associated mothership design. This is achieved through the development of four different modules: Maritime Human Factors; Marine Design; Marine Design of Wind Farm Support Vessels (WFSV); and Marine Design of WFSV Mothership. The main impact of these courses will be understanding and awareness of the needs of the wind farm vessel industry and the market potential for ship builders; better trained commercial marine industry staff with awareness of emerging technologies and techniques; marine industry standardised qualifications for Wind Farm Support Vessels. In attempting to achieve these aims, this paper discusses the benefits of mobile learning for the online provision of these courses.

1. INTRODUCTION

Extrapolating the European Wind Energy Association's (EWEA) growth scenario for the period up till 2030 employment in the installation, operation and maintenance, of offshore wind farms is expected to produce skilled employment of 851,400 and requires specialist marine vessels. Recent research has indicated that current wind farm support vessels will not be appropriate for accessing far shore wind farms. In order to improve operability of WFSV accessing the far shore wind farms, such as Dogger Bank which will have 1800 turbines up to 120 Nautical Miles from the shoreline, mothership vessels will be required.

Interior design principles applied to vessel accommodation will help to reduce the adverse effects of shift work, through creating a low stress appealing living environment. Human Factor Integration (well established in the defence sector) in the design of the bridge will reduce cognitive workload and hence reduce the risk of human error, the most significant cause of marine accidents.

The aim of the work presented in this paper within the main project of EBDIG-WFSV (European Boat Design Innovation Group - Wind Farm Support Vessels) is to provide innovative professional development training through mobile app development of Moodle platform and networking to commercial marine industry employees by transferring embedded practices within interior design and the leisure marine industry which will enable the European commercial marine sector to understand and exploit growing design opportunities in the wind farm support vessel sector to produce more appealing working conditions for this new and growing sector to help recruit new staff and reduce the risk of human error. This project used an e-learning platform www.ebdig.eu (video conference, Moodle etc.) to transfer innovation from the interior design and leisure marine industry in Wind Farm Support Vessel (WFSV Design; WFSV mothership design; Human Factors Integration (HFI) via

4 modules and a networking framework. Mobile learning has been incorporated with the courses, which can transfer existing innovation from interior design and leisure marine design (super yacht and motor yacht) industry and education. The implementation of the mobile app will facilitate both the course providers and the students for course selection and progress.

2. HUMAN FACTOR COURSE CONTENT

Module 1 - Maritime Human Factors: The aim of this module is to comprehend commercial marine vessel types, functions, limitations and solutions. On completion of this module the student should be able to:

- Carry out a comparative analysis of characteristics of the following vessel platform types: displacement monohull; planning monohull; SWATH; catamaran; Surface Effect Ship; hydrofoil
- Identify the relationship between commercial vessel function and platform type
- Appreciate functional vessel limitations and solutions of : accommodations; access; safety; life at sea
- Define the following symptomatic areas of concern relevant to the design and operation of marine vessels: Motion Sickness; Fatigue; Sleep loss; Injury; Human Error
- Appreciate the influence of following Human stressors: Mental workload; airborne noise; whole body vibration; motion; impact; lighting issues; temperature extremes; lack of ventilation
- Appreciate the significance of the following aspects of Human-Machine Interface: automation; controls; instrumentation; seating; General Arrangement (GA); crew size; HVAC; lighting; anthropometrics
- Understand the Ship as a Socio-Technical System and the potential of Human Systems Integration

- Identify the details of the following approaches to Human Factors research and design: simulator testing and field research; computer modelling; questionnaires.

Module 2 - Marine Design: The aims of this module are to introduce the skills, knowledge and understanding involved in Marine Design, as an Industrial Design approach; to demonstrate the relevance of, and application of the Marine Design (Industrial Design) processes for a range of commercial marine vessels; and to develop the ability to analyse and evaluate vessel design and enhance design decisions. On completion of this module the student should be able to:

- Define Marine Design as an Industrial Design approach, its purpose and processes
- Appreciate creative and lateral thinking methods
- Identify the key stages of a number of Industrial Design processes
- Define innovation as a process in the context of Marine Design
- Have familiarity with the User-Centred Design process and emotional design
- Appreciate the relevance and potential of Design-Driven Innovation
- Appreciate basic aesthetic principles and the principles of interior design
- Appreciate the impact of design upon the environment

Module 3 - Marine Design of Wind Farm Support Vessels (WFSV): The aim of this module is to demonstrate the relevance of, and application of Marine Design in the design process of a Wind Farm Support Vessel. On completion of this module the student should be able to:

- Identify the key stages of the User Centred Design process to determine mission requirements and platform design, including task analysis and the consideration of symptomatic areas of concern
- Appreciate the application and potential of Emotional Design methodologies
- Identify the key stages in Design-Driven Innovation scenario development
- Appreciate the application of exterior form development
- Appreciate the application of the principles of interior design and UCD analysis in the development of vessel General Arrangement (GA) and interior development
- Identify the key considerations of the domains of Human Systems Integration for Wind Farm Support Vessels
- Appreciate the application of Digital Human Modelling (DHM) to resolve both anthropometric and cognitive aspects of command and control

- Appreciate the implications and challenges of design regulations for Wind Farm Support Vessels

Module 4 - Marine Design of Wind Farm Support Vessel Mothership: The aim of this module is to demonstrate the relevance of, and application of Marine Design in the design process of a Wind Farm Support Vessel mothership. On completion of this module the student should be able to:

- Identify the key stages of the User Centred Design process to determine mission requirements and platform design, including task analysis and the consideration of symptomatic areas of concern
- Appreciate the application and potential of Emotional Design methodologies
- Identify the key stages in Design-Driven Innovation scenario development
- Appreciate the application of exterior form development
- Appreciate the application of the principles of interior design and UCD analysis in the development of vessel General Arrangement (GA) and interior development
- Identify the key considerations of the domains of Human Systems Integration for Wind Farm Support Vessel mothership
- Appreciate the application of Digital Human Modeling (DHM) to resolve anthropometric aspects of key tasks
- Appreciate the implications and challenges of design regulations for Wind Farm Support Vessels

3. WEB-SITE DEVELOPMENT AND E-LEARNING PLATFORM

One of the largest aspects of the project related to the e-learning platform was the websites that needed to be designed and implemented, as they would be the link to the courses on line. There are two websites which are being implemented, a website about the project and a website about the courses. The aim of these websites is to help train marine industry professionals in interior design techniques so they can provide a better standard of living while being on these ships as well as better capturing the attention of the growing customer base in the expanding wind farm market.

There were a lot of considerations that needed to be made with regards to this part of the project such as the hierarchical structure of the sites, how the sites would look and behave and how the sites would function on mobile devices. The structure of the sites was first major planning point. How the information would be broken down and structured is obviously very important on an educational website. As per the work of Lindgaard et al. [1] users develop opinions on visual appeal of a website based on their first 500ms of exposure to it so the user-friendliness of the site would play a large part in how

satisfied the end users would be. The structure of the site was mapped out using a wireframe in order to give us a clear visualisation of the site's organisation.

The project information was originally only broken down into five topics, only one of which had subtopics however this was revised into seven categories, four of which have subcategories, as shown in Figure 3.1. This increased amount of information is relevant as it meant redesigning the appearance of the site to make it easier to read and digest the information presented.

also offers webhosting, however this was not necessary for this project as we have a dedicated server for the websites. There are several other free services that offer similar features such as Drupal or Blogspot, however Wordpress is the most popular with an extensive documentation and an incredibly active community involved in both product support and modification. The Wordpress setup is relatively straightforward, with an intuitive web-based installer that's used to point your Wordpress installation towards a MySQL database.

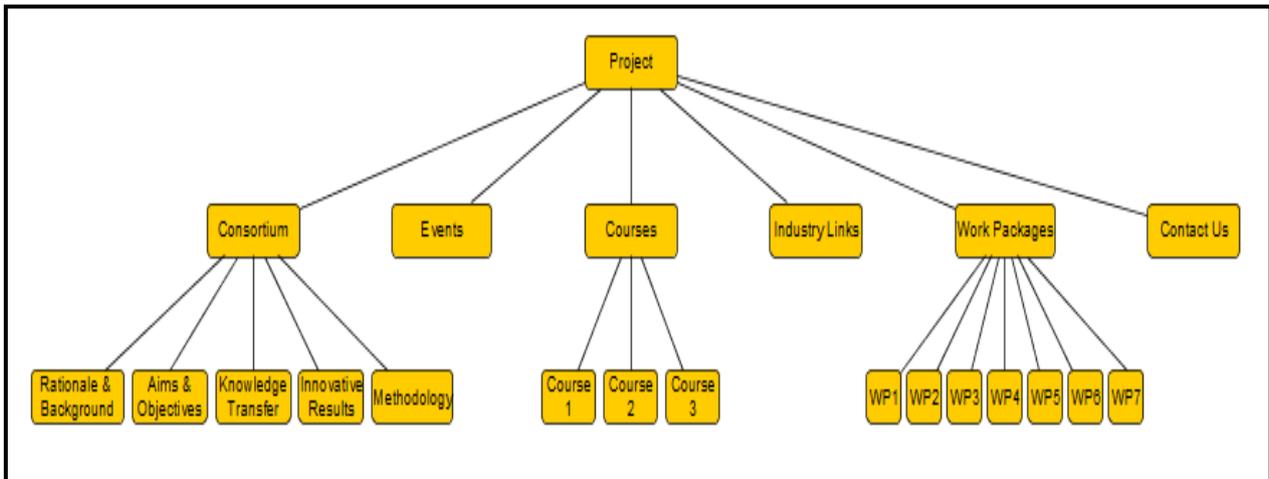


Figure 3.1: A wireframe representation of the website

Many things such as succinct headers, scannable text and an appropriate use of whitespace is very important in order to make the website elegant without compromising the content within. While trying to maintain the look of the current EBDIG website and add in the courses, textual information took a back seat to the layout of the site which inhibited how well the information could be processed.

For this PHPMyAdmin was used in order to create and administer the MySQL databases on the server. A default installation was rather bare, but offered great potential for design and customization. Since integration with a mobile app is one of the core aspects of the project, we used a single column, responsive design to ensure that the website would work well when integrated into the app.

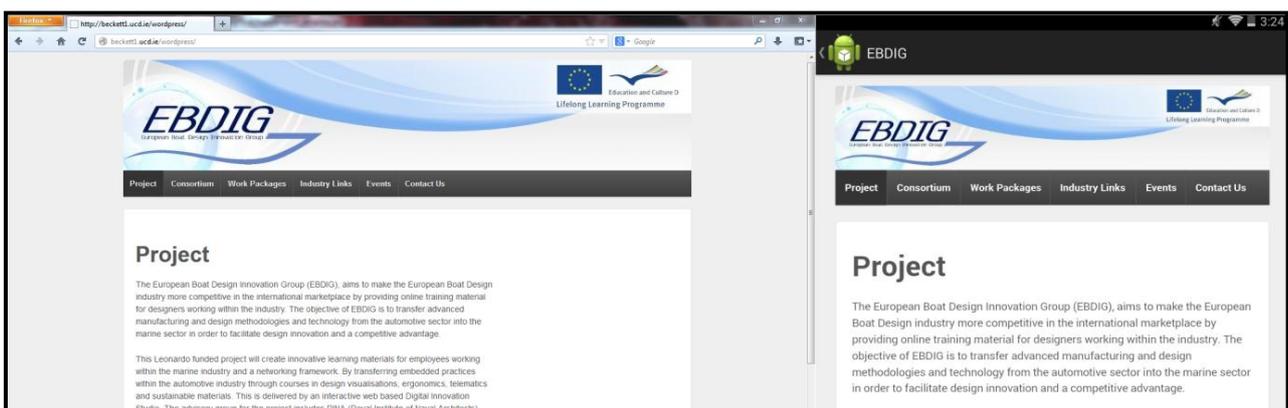


Figure 3.2: Displayed content in different devices

This revised structure, coupled with a need for a redesign of how the content was presented lead to adopting an entirely new approach to this part of the project. Instead of designing the site from scratch using bootstrap, Wordpress was used instead. Wordpress is a free and open source CMS with an emphasis on ease of use. It

As shown in Figure 3.2, the content on the sites is neatly displayed on a range of devices. This is complimented by how easily it is managed through Wordpress' interface and elegant WYSIWYG editor. The sites are currently set up so that anyone who needs to interact with it, be it an end-user or system administrator, will be able to do so with ease. The sites currently are still hosted on a virtual server within UCD's School of Computer Science and

Informatics, however there are plans in place to migrate them to a dedicated server hosted in UCD's Daedalus Building.

3.1 MOODLE

The next large segment of the project was the installation and setting up of the Moodle. Moodle is a free, open source Virtual Learning Environment (VLE) that was first released in 2002 and as of November 2013 has 70,000 registered sites and over 65 million users worldwide [2]. Moodle is the basis for many academic institutions' e-learning platforms, including the UCD's School of Computer Science and Applied Language Centre. One of the main reasons for choosing Moodle over other e-learning environments such as Blackboard or Canvas was that Moodle is free whereas many other platforms require paying an annual license fee which may increase if there is a rise in the number of students using it.

Moodle's central aim is to provide educators with a basis for creating online courses and by default offers many useful features such as online assignment submission, quizzes and student forums. Moodle's base design is very modular in order to make it as customizable as possible. Elements known as blocks can easily be added to courses to add additional functionality. There is also a wide range of plugins available online that can add even more functionality to your site. With regards to students and learning, it is broken down into three main elements - individual elements, collaborative elements and feedback/communication. These three elements combine to provide a rich learning environment for participating students who are eager to learn.

Moodle has various different methods for deployment. Users can either download the installer from the Moodle site, or pull the code from the Moodle git repo. The files are then moved to where you intend to host the Moodle. A data directory is also required by Moodle, but it is bad practise to have this in an area on the disk that is accessible from the internet. Moodle is based on MySQL and PHP, so these must be installed as well. For this installation, I used PHPMyAdmin in order to create and administer the MySQL databases on the server. Moodle only requires one database, which it is granted access to during the installation. Once the files, data directory and database have been set up correctly, installation is initialised by pointing your web browser where the Moodle is hosted on the server. The web based installer ensures that you have everything set up correctly and makes it simple to set up an administrator account for your VLE. After the installation, the system administrator will need to set up cron. Cron is a standard program on most Unix based systems that allows the user to run commands or scripts at specified intervals. Moodle uses cron for a number of different maintenance tasks including deleting broken question links, deleting unverified user accounts and sending out forum emails. The last task is incredibly important as it provides a simple means for teachers and students to communicate

with each other. On Unix based systems, Moodle Postfix and SMTP in order to send mail[3] when cron runs, so having it run at regular intervals is very important to ensure that students receive emails in a timely manner. Cron runs based off settings specified in the crontab file. This is what must be altered in order to set cron to run at regular intervals. In order to do this on a Debian based system, the following commands can be used [4]:

```
//Opens the crontab a text editor.  
$ crontab -u www-data -e  
  
//When added to the crontab, makes cron run every 15 mins  
*15 * * * * /usr/bin/php /path/to/moodle/admin/cli/cron.php >/dev/null
```

This mechanism forms the basis of the online assistant that can notify the administrator of a course when a student completes the course. Originally a custom block which performed a MySQL query on the Moodle database to determine how much each student had completed, was planned to be developed. However Moodle already has similar functionality in its Participation Report plugin [5]. This is implemented through modifying the teacher's permissions to allow mod/quiz:emailnotifysubmission. This works on a Moodle-wide basis, but it is also possible to enable it on a quiz-by-quiz basis if you do not wish for your teachers to be inundated with emails about quiz submissions. This is run when cron runs, so there may be a slight delay in the sending of emails depending on your settings. The content of the emails can be modified using the settings found under Site administration > Language > Language Customization [6].

3.2 LEARNING OBJECTS

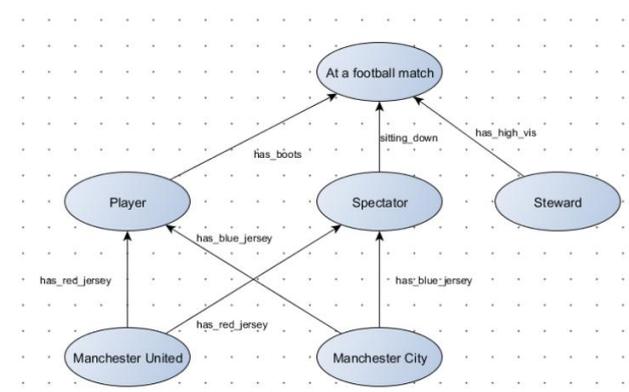
Ontologies are models, which are used for formally representing knowledge. People use ontologies every day without realising it because of the information that ontologies infer, a basic example of which would be a football match. Assuming everyone in a stadium is a player, spectator or steward, people observing the game would be able to discern the differences between the groups by using an informal ontology which is intuitive to them based off the characteristics displayed such as whether or not someone is wearing boots or a high visibility jacket. Difficulties can arise when groups (henceforth referred to as classes as per ontology nomenclature) share similar characteristics. Describing someone at the game as wearing a red jersey lets you know that they are affiliated with Manchester United, but not if they are a player or a spectator. This is avoided by being specific about the attributes which each class contains, so in this example Manchester United players are the people in the stadium who have boots and are wearing red jerseys.

One method for representing this information is by using an ontology language, as shown in Figure 3.3. This project is going to focus on using Web Ontology Language (OWL) which is a collection of languages endorsed by the World Wide Web Consortium [7] which are used for knowledge representation. The most

prominent of these languages are OWL Lite, OWL DL, and OWL Full. A 2006 study by Wang et al. found that over half of the ontologies in a sample taken from various different well regarded repositories were OWL ontologies [8]. OWL allows users to define a set of known facts about an object. It does this by extending Resource Description Framework (RDF) which is another model recommended by W3C [9].

The three main building blocks in RDF and OWL are classes, individuals and properties. In the previous example, player and Manchester United represents classes and subclasses, while has_red_jersey and has_boots are the properties that make someone a Manchester United player. An individual is a unique member of a class, for example Wayne Rooney for Manchester United however this isn't shown in the previous example for the sake of keeping the diagram as simplistic as possible. RDF and OWL allow to structure this information in a manner similar to XML metadata.

Within this project, OWL is going to be used in relation to two pieces of software, Protégé[10] and Pellet[11]. Protégé is a platform which allows users to create and develop ontologies. It is java based and open source which allows users to create their own tools for expanding the program. It was by the Stanford Center for Biomedical Informatics Research and is used by various large agencies such as the National Cancer Institute, National Library of Medicine and eBay. It offers two main ways of modelling ontologies, its Frames editor and its OWL editor. Frames are another method for modelling ontologies but does not concern this project because of Pellet. Pellet is an OWL based reasoner. A reasoner is software able to infer logical consequences from a set of asserted facts. Reasoners are able to perform a series of tasks with ontologies, such as checking whether or not a the description of a concept is contradictory, checking if a concept is a subsumption of another concept and finding all of the concepts to which an individual belongs. For this project, Protégé and Pellet



are going to be used in order to develop ontologies for the creation of learning objects for the courses offered.

Figure 3.3: Learning Objects

4. PEDAGOGICAL ISSUES RELATED TO E-LEARNING PLATFORMS

By definition, e-learning platform conditions differ greatly from the face-to-face scenarios in which the teaching of design skills (including ergonomics and human factors) traditionally takes place. E-learning platforms often primarily function through the creation of asynchronous communication between tutors and students [12]. Learners can have negative experiences of e-learning platforms and issues include isolation from a community of practice as well as technical problems [13]. Students have suggested that the time taken for tutors to disseminate feedback is also a factor in creating a less than optimal experience of e-learning platforms [14].

The administration of design education traditionally takes place via the master-apprentice system [15]. The master-apprentice system is a top-down (tutor → student) approach and originates in face-to-face settings. The master-apprentice system still dominates in design education [16]. Research has suggested in E-learning environments, the demonstration of practical skills can be performed effectively using the master-apprentice system [17]. However, literature argues that E-learning platforms may not be optimally configured for tutors to deliver their evaluation of students' designs [17]. This may be because issues with communication via asynchronous e-learning platforms are exacerbated through participants' reliance on text to construct dialogue [18]. Research has argued that the above positive and negative attributes of e-learning environments may revolve around inherent differences between *demonstration* and *evaluation* in design [17]. Arguably, 'demonstration' of skills of techniques may be a more 'objective' practice than the 'evaluation' of students' work [17]. The above research should be taken into consideration when constructing the e-learning environment discussed in this paper.

Because of potential issues related to isolation, this paper suggests that peer-learning is a valuable strategy in helping to facilitate the operation of this e-learning platform. Topping [19] defines peer tutoring as teaching which is facilitated by individuals who are not professional tutors. Peer learning enables students to take a leading role in learning and to develop autonomy and independence [20]. Furthermore, Wong, Chan, Chou, Heh, and Tung [21: 417] propose that students "interacting with a more knowledgeable peer can learn to become as knowledgeable as the peer". The practice of peer tutoring originates in face-to-face environments [22]. De Wever, van Keer, Schellens, and Valcke [22: 355] argue peer tutoring can also be seen to occur in an online environment where it improves students' "knowledge construction." Research has demonstrated that peer-learning can help improve students' experiences of e-learning platforms in design teaching environments [23]. Peer learning can be incorporated into e-learning platforms either through using asynchronous or synchronous communication means.

5. ANDROID APPLICATION

The purpose of the mobile app is to host the courses' information which should facilitate both users and teachers. The design of the app is going to resemble the courses website which was discussed in section 3, in order to establish a distinct visual e-presence. The content within the app reflects course material, and the option for teachers to easily modify content within the app is a future possibility.

The design of the app, as shown in Figure 5.1, was something that a lot of thought and effort was put into during the background research stage, and this design was refined upon during the implementation. The original implementation of the application contained a login screen, however this was later decided against as only people with an interest in the application would have access to it; however this would be easy to add later on if it is required. The other large difference from the original prototype of the application was the addition of a main menu, which contains all the apps features in one centralised area, as shown in Figure 5.2. In order to implement this design, a custom adapter defined in MainListAdapter.java was used. It extends BaseAdapter and specifies all of the characteristics of the menu such as the colour, the text contained within the menu entries and the icons.

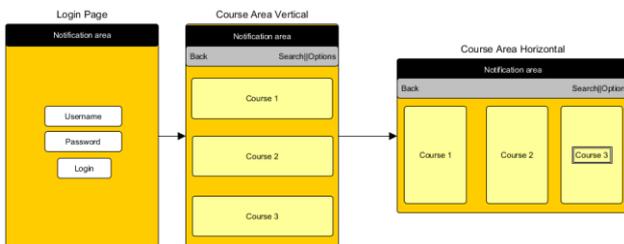


Figure 5.1: A wireframe representation of the app's design

In order to do this, it uses a layout for each menu entry as defined in main_list_row.xml that retrieves the appropriate information from two arrays used for storing menu text and icon references. Padding is added to the list to give greater emphasis to each element. The stylization of the text in the menu (and used later on in the Calendar activity) is defined in styles.xml. The entire activities' layout, including the menu, is then created in activity_main.xml and then called upon in MainActivity.java. It was done using a RelativeLayout for easier positioning of each of the elements. If a hardcoded pixel value had been used instead, the elements would not position correctly on screens of different sizes. ActivityMain.java is where the functionality of the menu is implemented using a series of switch statements. Originally this was done using if statements however switch statements lead to cleaner, more clearly defined code. An argb value is also added here to give a colour change on press to indicate to the user that their input has been received by the application.

As per Google Android design guidelines, this is important as it provides the user with sprinkles of encouragement that gives the user a greater sense of interactivity with the application as they are using it [24].

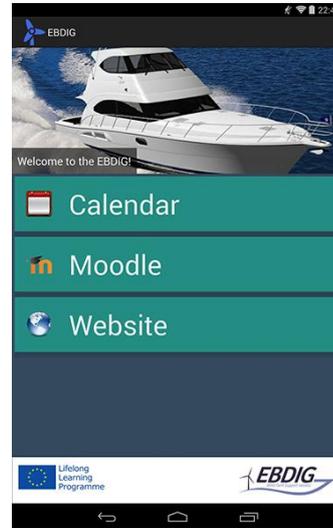


Figure 5.2: A screenshot of the mobile app

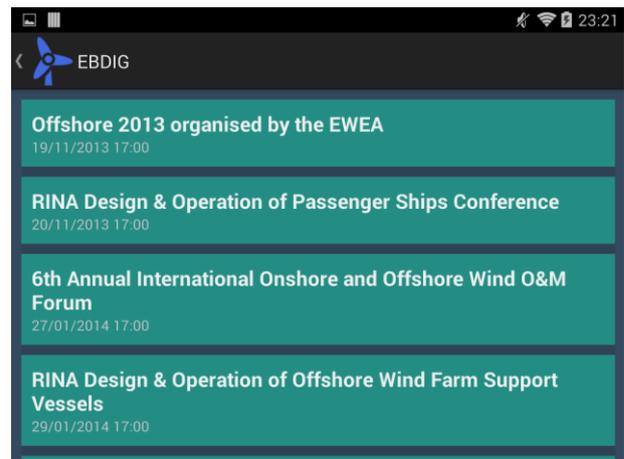


Figure 5.3: A screenshot of calendar menu

The first option of the menu is the calendar as shown in Figure 5.3. The calendar provides a list of events and their start times, and can be easily changed to include any other information that might be necessary such as locations or event information. Currently the calendar works by taking information from calendars synced with the device. This is done in CalendarActivity.java, where ContentResolver items are used to query specified URIs for information that is defined by calProjection and eventsProjection arrays. There are two URIs used here, one for the calendars that are synced on the device and one for the events associated with those calendars. The selectionArgs array is also used to ensure that the correct calendars are being queried. Each of these queries return cursor items, which are then iterated through using

nested “for loops” to ensure that all events from all calendars are returned. The information derived from iterating through the cursors is used to create simple EventDescription items which are then added to a list. This list is used to populate a list view, which is what users see when they open the calendar activity. Much like the main menu, the calendar is styled using a custom adapter. Each entry in the calendar's list is its own entity as defined by the calendar_list_entry.xml. The style of the text is once again defined within styles.xml, leading to a consistent feel to the text as used throughout the app, as recommended by the Google design guidelines for Android. The writing style for the calendar is also influenced by these guidelines, as it is purposefully elegant and succinct. The calendar entries contain only relevant information meaning that the user is not bogged down by useless information.

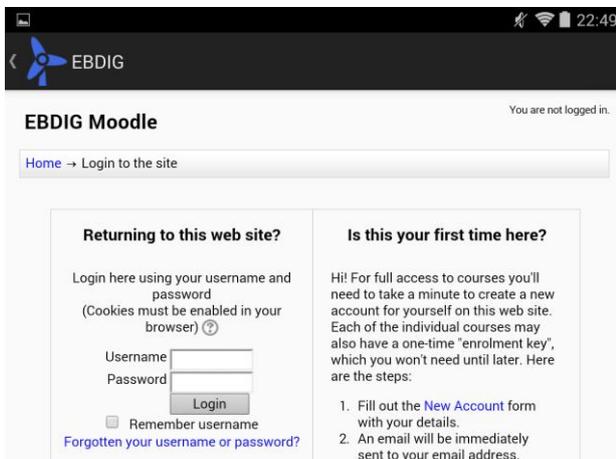


Figure 5.4: A screenshot of EBDIG Moodle mobile app

The remaining two menu entries, the Moodle (as shown in Figure 5.4) and Project Website options, are actually handled using the same method. Both use the WebViewActivity.java class, which extends the Activity to render their content. In MainActivity.java, when an option is selected, the intent with extras containing the appropriate URL is generated and then passed on to WebViewActivity. WebViewActivity then checks the extras to see if they contain the predefined Moodle or website addresses, and if they do, load those sites. As outlined before, both the Moodle and website were designed using reflexively so they will adapt to different screen sizes. In order to maintain the simplicity of the application, WebView only has pinch-to-zoom enabled. As per Android Lint's recommendation, Javascript within the WebView is disabled however both sites should function properly without it. Moodle itself is designed to be usable without excessive amounts of Javascript[25]. Both the website and Moodle were designed around the idea of being as cross platform as possible. Testing this implementation involved using the sites on a variety of different machines such as laptops, tablets and phones to ensure that they render properly. Browserstack.com[26]

was used to test how well both of the sites would work on a variety of different browsers, with the sites loading correctly in IE7+/Firefox 3.0+/Chrome 14.0+/Opera 10.6+/Safari 6.1+ on a variety of different resolutions ranging from 1024x768 up to 1920x1080. The sites were also tested on a 2013 Nexus 7 and a Samsung Galaxy S4 and were working smoothly. The application was tested as it was developed in order to ensure that it had correct functionality. Each element of the app was tested to ensure that it was working properly under a variety of different conditions, and to give feedback if something does not work. For example, a toast appears informing you that there is not an internet connection if you try to use something that requires it. As many cases as possible where the app might not function as expected were anticipated, and were accounted for during the design stage. Android Lint was also used in order to eliminate many common errors found during development. Android's best practices were followed for the project and many common pitfalls, such as hardcoding string values, missing contentDescriptions and not targeting the most recent version were avoided.

6. FUTURE WORK

With regards to the project website, there isn't much work that needs to be done outside of transferring it from the virtual server to the dedicated machine. All of the required information is currently already hosted on it, and should not require revising before September 2014. The courses website will need to be updated when information about the four modules is made available. It was also proposed that a chat room feature could be added to make communication between relevant parties easier and more centralised, especially during events. As above, the Moodle will have to be updated with relevant information regarding the courses that will be running from September onwards. This includes both course information and the creation and setting up of teacher and staff accounts. The reason it is not currently up to date is that this content has yet to be provided. A training manual could also be made for people who are unfamiliar with Moodle's back end. This manual could use screenshots and examples from the EBDIG Moodle in order to help people familiarise themselves with the concepts being presented more quickly, as the themes used on the site makes it look quite different from those presented in examples on Moodle's forums. The Moodle will also have to be moved from the virtual server to the dedicated machine once it becomes available. The application itself has some work that could be added to it in future. The most pressing matter will be better support for a horizontal layout on different screen sizes. Currently the application works well on tablets with large screen sizes in a vertical orientation, but it is not currently optimized for phones or rotating screens. This can be done using different layouts depending on the target screen's pixel density. As well as this, the calendar could be updated to take information from public Gmail calendars. Currently it can only take events from

calendars that are already synched with the device; however it is possible to query online calendars using the Google Calendar API. Further calendar work could include adding fragments containing additional information about each event that would open when pressed. The final piece of future work related to the app is to have users evaluate the application in order to provide feedback so it can be improved in the future. This can be used as a means of improving the UI, bug fixing or adding additional feature that users may feel the app is missing. This could be done through surveys or through a feedback activity built in to the application.

7. ACKNOWLEDGEMENTS

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