

Open Device Labs as a strategy to enhance the undergraduate and postgraduate student learning experience of software quality assurance and usability for mobile devices

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ARTÍCULO

Open Device Lab como una estrategia para mejorar la experiencia de aprendizaje de estudiantes de pregrado / posgrado en relación a la garantía de calidad de software y usabilidad para dispositivos móviles.



Claire Horgan

Department of Computing at the Institute of Technology Tralee

Lecturer in computing at the Institute of Technology Tralee. Research areas include software quality management and software quality assurance. She is co-founder and manager of the open device lab in Tralee. Claire obtained her bachelor degree in computing from Cork Institute of Technology and a Master in computing focusing on software quality metrics from the Institute of Technology Tralee in 2003.

claire.horgan@staff.ittralee.ie
ORCID ID: 0000-0002-6767-5104

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Abstract

Open Device Labs (ODL) are a resource where users can test their applications on a growing range of internet-connected devices. Quality assurance across real devices is vital to ensure a pleasant user experience. From an educational perspective the Tralee Institute of Technology goal is to provide students with the skills they need to become competent software de-

velopers. They should have an appreciation of the end users' experience. This papers looks at using an ODL to enhance student learning of quality assurance and usability.

KEYWORDS

Open Device Lab, web, applications, test, quality assurance, usability, education.

Resumen

Los laboratorios de dispositivos abiertos son un recurso en el que los usuarios pueden probar sus aplicaciones en una gama cada vez mayor de dispositivos conectados a Internet. La garantía de calidad en dispositivos reales es una necesidad para garantizar una experiencia de usuario agradable. Desde una perspectiva educativa, el objetivo del Instituto de tecnología Tralee es proporcionar a sus estudiantes las habilidades necesarias para

convertirse en desarrolladores de software competentes. Esto requiere que aprecien la experiencia de los usuarios finales. Este documento analiza el uso de un ODL para mejorar el aprendizaje de los estudiantes a partir del aseguramiento de la calidad y las perspectivas de usabilidad.

PALABRAS CLAVE

Open Device Lab, web, aplicaciones, prueba, garantía de calidad, usabilidad.

1. INTRODUCTION

The Institute of Technology Tralee, a university level institution located in the south west corner of Ireland, set out

“within the framework of national and international developments in higher education, to provide... easily accessible, multilevel, programmes of quality, of teaching, research and development work which: develop a deep understanding of the chosen field of study; develop a capacity for independent critical thinking and foster academic scholarship” ITT (2017)

The Department of Computing within the institute delivers a variety of programmes across a range of computing disciplines. The Department lists amongst its main goals, the production of graduates who can develop software products across multiple platforms to the highest international standards (IEEE, 2016). In order to achieve this, the students need a clear understanding and appreciation of quality assurance requirements across multiple devices (Jehl, 2015). With the ever-growing number of devices, browsers, screen sizes and resolutions this is not an easy task.

An appreciation of software quality assurance is an essential skill for any computing graduate today. Users expect the highest quality experience (Nicol, 2013). IT Tralee strives to give students an intensive practical application of the relevant theories to simulate this real-world experience. This facilitates the student to experience any application they develop from the users perspective. Thus the student will be in a position to evaluate and reflect on their work and research ideas to enhance the overall usability of the product. This process helps guide the student to make critical design and implementation decisions. According to Keith (Keith, 2012) testing on multiple devices prevents the developer from creating device specific solutions but guides them to thinking about removing the problem from all devices.

In approaching this area the Department of Computing asked itself a number of pertinent questions:

- How could it instil in the student an understanding and appreciation of the need for multi device testing?
- How could it facilitate the student to focus on end user usability in the design and coding of web and app applications?

The Department decided the best way to enable a developer to understand the usability issues in the project being developed was to approach testing from a user perspective. Due to the multi connected, multi device world which their developments would inhabit, this would need to be done on a myriad of different platforms and devices. Smartphones and especially the Iphone have dramatically changed the mobile technology scene (Knot, 2015) and therefore the development of mobile applications has also dramatically changed. This lead the Department to further question how it could prevail upon the student to develop and test their applications to allow them enhance the end user experience they would deliver and thus improve the coding and testing skills of the student.

One possible solution considered was the use of emulators. However, the Department considered that emulators often fail to reflect the real device and may not take into account different operating system, browsers, device setting like fonts etc. To test these issues properly the student needed access to multiple devices.

“Whether you develop websites or apps, you face several problems in ensuring that a product runs correctly on as many devices as possible. Emulators for iOS, Android, Opera and the rest can help with that, but they differ from the software that runs on real devices. One of the things you just can’t simulate properly is touch interaction. Without being able to test gestures, there is no way to find out whether your users will understand how to use your interface. Because this is unlikely to change anytime soon, there is no way around testing on real devices.” (Hannemann, 2013).

The fragmentation of operating systems and browsers as well as the diversity of internet-enabled devices makes it impossible for the vast majority of developers to personally own a representative pool of test devices. It was impractical, and cost prohibitive, to expect students to source or own a number of devices. As the Department had a pool of some devices already available a location was needed to set them up in which the students could easily access and use them for testing.

The Open Device Lab (ODL) provided the ideal solution. Web and mobile applications could be quickly deployed to multiple devices allowing the student to focus on the testing and quality assurance of the product. Students can be guided to executing real world testing on their products including factors such as screen resolution, operating system, cross browser and usability testing. The ODL makes the teaching and learning of such topics easier and more practical and enhances the students learning experience.

2. SETTING UP THE LAB

2.1. OPEN DEVICE LAB MOVEMENT

In researching this topic the author became aware of the ODLs. The Open device lab movement is a gross roots community lead movement. They recognised that

“The fragmentation of operating systems and browsers as well as the diversity of internet-enabled devices makes it impossible for the vast majority of developers to personally own a representative pool of test devices. Nevertheless, quality assurance across real devices is a must to ensure a pleasant

user experience, sufficient stability and security." (Open Device Lab, 2014)

The OpenDeviceLab.com (Figure 1) contains most of the information about the ODLs worldwide and has three main goals:

- Help people to locate the right Open Device Lab for the job;
- Explain and promote the Open Device Lab movement; and,
- Attract Contributors and Sponsors to help and donate to ODLs

The aim of the open device movement is to provide pools of shared internet-enabled devices that can be used for testing websites and apps. It is impractical and costly to expect a web developer to have a large up to date pool of devices. Then shared pools of such devices seems like the ideal solution. This movement has been spear headed by Andre Jay Meissner (Meissner, 2017).

The organization defines itself as a voluntary and community movement that, through laboratories, share community pools of devices connected to the Internet, allowing developers to test their projects. Thus, the purpose is to improve the experience of using the web and apps for developers, as well as for consumers. (Open Device Lab, 2014).

The Open device lab website provides a directory of all the registered ODLs labs worldwide. This makes it easy for users to locate and request access to a lab. Andre Jay Meissner also set up the Labup.org (Non-profit organization). This site provides supporting information to those wishing to set up a lab or share their experiences of running a lab. A website to help people interested in opening their own ODL with information, papers and the opening application form (Meissner, 2012). When we

investigated the movement, it was found that there was no open device lab in Ireland.

2.2. HARDWARE REQUIREMENTS

ODL seemed like an ideal solution for what the computing department were trying to achieve. However, there was a body of work and research to be done on setting up the lab. It was thought that this was an ideal project for third year computing students on work placement as it contained good research and implementation practice. Two students were taken on for their work placement module. This was a 12-week placement. Their task was to research the hardware and software requirements to set up the lab. Once these requirements were met their next task was to get the lab up and run for testing responsive web sites and interfaces.

The department needed to locate a room that could be easily but securely accessed by students. If students were going to be allowed access to a lab containing valuable equipment then it had to be located in a monitored secure area. A room near the staff offices and next to the department admin office was decided upon. Surveillance cameras were discussed but this was not acceptable to management. The decision was taken to add a key pad lock to the door. All devices would have to be secured inside the lab also.

Access to the student network was required in the lab and lots of electrical points were also required. The department worked with the building maintenance team and computer technicians to put these in place.

The students were tasked with identifying the hardware and software requirements for the lab. This was done by liaising with the ODL founders on the labup.org site and other labs such as the ODL in Frankfurt. A very useful re-

source was an article published by Viljami Salminen which guided the setting up of the ITT open device lab (Salminen, 2012).

The figure 2.0 shows the initial hardware requirements for the lab. With the help of the College computer services team it was possible to source all the hardware from the colleges existing equipment.

The first step was to set up a wireless network. Kasch, I (2013) give a detailed account of how the Nuremberg ODL network has been set up. The ODL in Frankfurt also reviewed this set up and made their findings available, Odlffm (2015a). This was a starting point for setting up our routers. The ODL has a separate Local Area Network (SSID), ITT_ODL. This LAN is setup on the ITT College Network using an Eircom Access Point. For security reasons the ITT_ODL network connects to the internet through the college Network and Firewall.

2.3 SOFTWARE REQUIREMENTS

A number of web testing tools were researched. Salminen (2012) highlights a number of software testing tools to help get a lab started. Odlffm (2015b) made available information on the software used to synchronously test websites on different devices. Based on reports from other ODLs and our own research it was decided to use Ghostlab and EdgeInspect Tools to test our websites synchronously.

Ghostlab by Vanamco is a software testing tool that allows the user to synchronise web development, testing and inspection. It allows the user to test websites on a number of mobile devices and various browsers simultaneously. Navigation, scrolling and interaction is synchronised across devices. Ghostlab also allows users to modify CSS properties, HTML code and Javascript using the built-in inspector.

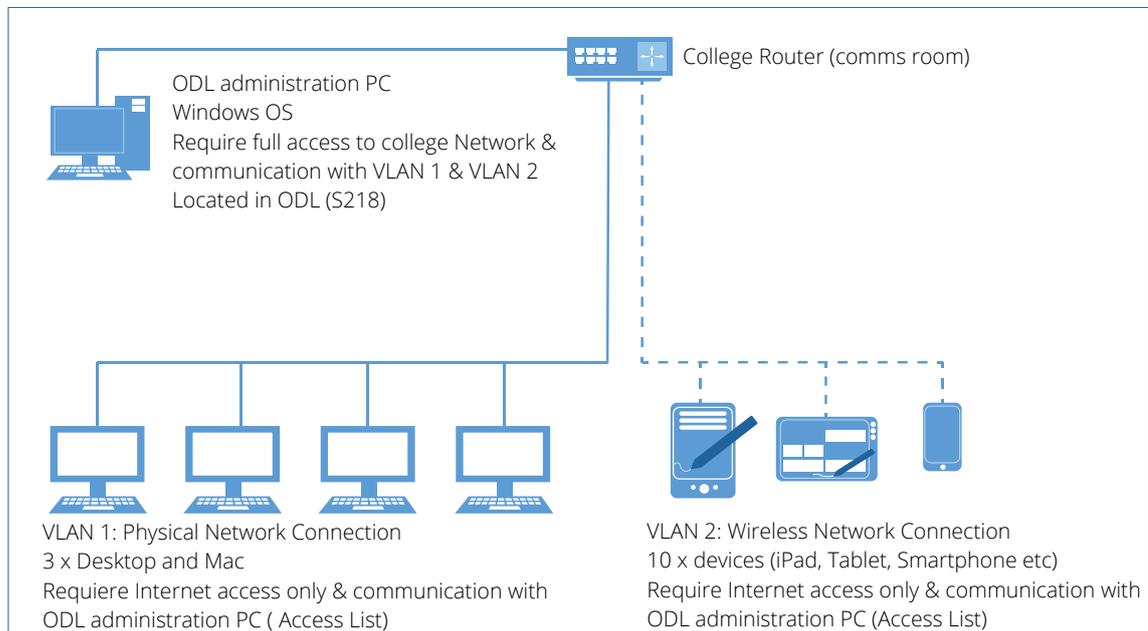


Figura 2. Initial layout for the ODL

Changes can be viewed on one device or on all devices. The main features offered by Ghostlab are:

- Synchronized browsing
- Inspect CSS on any device
- Debug JavaScript anywhere
- Auto-refresh and style injection
- Compile Sass, Jade & more
- Automagic form filling
- One-click workspaces
- Presentation mode for teams

There is a single once off licence fee for using Ghostlab (Vanamco, 2016).

EdgeInspect is part of the Adobe Creative suit. It allows the user to preview, view real time changes and grab screenshots of web applications on multiple devices.

“Edge Inspect is an essential application for web developers and designers who need to preview their content across multiple mobile devices. Wirelessly pair multiple iOS and Android devices to your computer, grab screenshots from any connected device and see real-time results from changes to HTML, CSS and JavaScript.” (Adobe, 2017).

Edge Inspect provides a number of features:

- Synchronized browsing and refreshing
- Remote Inspection
- Screenshots
- Cache management
- Localhost support

- Ability to hide/show Edge Inspect UI on devices

- URL monitoring
- HTTPS support
- HTTP authentication support
- Amazon Kindle Fire support

Table 1.0 shows a summary of the main points for each of these tools.

Cross browser testing is an essential part of testing on devices.

“Cross browser testing is the practice of making sure that the web sites and web apps you create work across an acceptable number of web browsers. As a web developer, it is your responsibility to make sure that not only do your projects work, but they work for all your users, no matter what browser, device, or additional assistive tools they are using.” (MDN web docs, (2017).

There are a number of common cross browser issues that have to be tested. The main issues as outlined by MDN web docs, (2017) are:

- sometimes browsers have bugs, or implement features differently.
- some browsers may have different levels of support for technology features to others.
- some devices may have constraints that cause a web site to run slowly, or display badly.

All supported browsers for a device should be downloaded. Availability is Operating System dependant and can be download from the 'store' specific to each OS

- Chrome
- Internet Explorer

- Opera
- Firefox
- Maxthon

Fully testing features requiring interaction with PHP scripts (contact forms) is not possible when testing from a File/Folder. This problem is overcome by hosting the site locally using XAMpp which contains an Apache web-server. Xampp can be downloaded from the Apache Friends website (Apache, 2017).

2.4 ANDROID APP TESTING

Once the lab was set up for testing web applications, the team moved on to testing mobile applications. Again this was an interesting task for work placement students. Part of their placement work was to research the hardware and software requirements for app testing.

A number of options were investigated but the solution that meet all of the projects requirements was using the Jenkins tool. Jenkins is an open source automation server tool. It provides multiple plugins that support the building,

Name	Location	Type	Description	Advantages	Disadvantages	€€ per year
Ghost Lab	http://vanam-co.com/ghostlab/	Visual Performance	Synchronized browsing. Wirelessly pair multiple iOS and Android devices to your computer with IP. Browse in Chrome, all connected devices stay in sync. Take screen shots	Can be used on any browser on any platform, no app needs to be installed on devices. Used to inspect and modify html. Can validate URL & local file/raw html. Sync scrolling	Does not run on Linux. Decides go to sleep (can change setting). Does not take screen shots of devices	Licensed. Once off.
Adobe Edge Inspect	http://html.adobe.com/edge/inspect/	Visual	Synchronized browsing. Wirelessly pair multiple iOS and Android devices to your computer with IP & password. Browse in Chrome, all connected devices stay in sync. Take screen shots. Small Notepad report with details of device & URL	Easy to use. Saves screenshots of all devices and generates report with screenshot automatically. Can be used to inspect and modify html	Only works with Chrome. Only works with URL, not raw html/local files. No performance report. Does not run on Windows XP, Windows Vista, and Linux. Since 2015, it is no longer being actively developed.	Licensed annually

Table 1.0 Summary of features for Edge Inspect and GhostLab

deploying and automating of any project. There are a number of set up requirements to ensure a working environment for Jenkins. These can be retrieved from the Jenkins website (Jenkins, 2017).

All the hardware was already in place. All that was need was some extra cables to connect the devices directly to the Jenkins server machine.

Setting up the Jenkins environment took some time. The main reference used was a paper by Christopher Orr (Orr,C. 2014)

2.5. DISPLAY SECURITY

One of the critical points to the success of the lab was the secure display of the devices. The team brain stormed many ideas and tried out cardboard prototypes. In the end the solution was a display unit with hinged shelving unit for the mobile phones. The display unit had two holes in it for each device. One for the securi-

ty lock for each device and the second for the charging cable. The unit was padlocked on either side. The tablets/iPads are displayed on a shelf above this. This shelf is an inch out from the wall. This allows the cables to be feed down into the USB hub and locks below. (Figure 8.0)

A security display lock was purchased for each device. The Core-10" tablet/iPad security system and Core-7" tablet/ iPad security system were used to secure the tablets/iPad. The Prestigio PUS01B universal rotatable stand for 7-10 inch tables was used for display purposes. CFM mount and recoilers were used to secure and display the mobile phones. These are all locked behind the main display shelf which is padlocked at the side. The devices are all connected to a charging USB hub behind the display unit.

This ensures that the devices can be used and charged without having to be moved from the display unit. (Figure 9.0)



Figure 8.0 Open Device Lab Tralee taken 2015.



Figure 9.0 Open Device Lab Tralee taken 2015.

3. RUNNING THE LAB

It was critical that the maintenance and running of the lab took as little time as possible. The manager of the lab updates the devices as and when required. If students or companies wish to use the lab they email the ODL address. The manager has an online calendar so that time slots can be booked and tracked. No students are allowed into the lab without first having booked the time slot. A record is kept of who enters and when the lab is used.

Demonstrating how to use the lab also needed to be effortless. At the start a detailed manual for users was created. Later this progressed to online video tutorials which are user friendly and readily available. These are all available from the Institute of Technology Tralee open

device lab site ODLITT, (2017). The tutorials available are as listed

1. Connect to Wifi
2. Ghostlab
 - a. Setting up Ghostlab and launching the server.
 - b. Ghostlab workspaces
 - c. Launching a local website with Ghostlab from a file/folder
 - d. Weinre remote inspection with Ghostlab
 - e. Using Ghostlab with xamp server
3. Edge Inspect
 - a. Using Adobe Edge Inspect and synchronizing devices

- b. Adobe Edge Inspect Tools
- c. Weinre remote Inspection demonstration.

These were tested on a number of staff and students. Now, any new users of the lab are directed to the tutorials which are user friendly and easy to follow. Therefore there is very little time required to manage the lab. This is one of the most critical points to the successful operation of the lab.

Currently there is a user manual for uploading and deploying apps to the devices. This has been tested on staff and students to ensure that it is user friendly and self-explanatory. It is hoped to make a supporting video tutorial in the near future.

While the ethos of the Open device lab is device donation, in reality this does not really work. Nowadays, smartphones are sold on or passed on to family or friends. Therefore, it is important to allow a yearly budget for purchasing new devices. You may also be able to get local companies to sponsor devices on a yearly basis. While testing on all devices it is important to make sure that testing is executed with the most popular devices.

4. USING THE LAB AS A TEACHING TOOL

First year computing students learn to develop responsive websites. Lecturers use the lab to demonstrate the importance of responsive development and testing. Being able to see the issues that arise when displaying a website across multiple browsers and devices increase the students understanding and retention of such issues.

“To say the way computers and the internet and the way we use them has changed a lot

lately is putting it mildly, Very Mildly” (Krug, S. 2014). Usability has become mainstream (Krug, S. 2014). Being able to evaluate the end user experience has therefore become a critical tool for everyone involved in the design and development of user applications. The computing department views this as an essential part of the student learning outcomes. Usability testing can be executed using a number of different techniques. The best usability evaluation will always be to get real users to test the system. However, given time and resource constraints this is not an option for the department. There are however several usability evaluation methodologies that can give the evaluator a good understanding of the issues that the end user will encounter.

Heuristic evaluation: When completing a heuristic evaluation the website is reviewed with respect to accepted usability guidelines. The best know heuristics are those published by Nielsen, J. (1994).

Cognitive evaluation: The cognitive walkthrough is a usability evaluation method in which one or more evaluators work through a series of tasks and ask a set of questions from the perspective of the user (Usability Body of Knowledge, 2017).

Getting a student to complete a cognitive evaluation puts them in the end users shoes. They can see the real issues that the user will encounter. This allows them to take their experience and learning and apply it to their own development projects. Thus students are in a position to evaluate and reflect on their own work and research ideas to enhance the overall usability of the products they create. They can also use these techniques to add a user-centred design approach to their design methodologies.

Second year computing students complete a website usability test as part of their software testing module. Part of the requirement for this

project is to test the website in the open device lab. Students must include screen shots of the displays on the devices and highlight any issues found. This simulates a real-world experience for the students and deepens their understanding of quality assurance for user experience across multiple devices.

Fourth year students use the lab for testing their final year projects. This could be testing a web or mobile app, testing a deployment package as part of a DevOps strategy, automated testing etc. The ODL give students the ability to perform testing that otherwise would not be possible for them. This increases their learning experience and enhances the overall quality of the end product.

5. RESULTS - STUDENTS EXPERIENCE

The students who completed their work placement module in the lab, all gained invaluable experience and have gained employment in the IT sector after graduation. The experience gave them a chance to look at development, testing and quality assurance in a new light. A number of these students have gone on to take up QA positions in IT companies. Joe O'Flathery was one of the students involved in setting up the lab in 2014. He graduated in 2015 and this is what he says about his experience in the ODL.

"I benefitted greatly from exposure to the very latest technologies and concepts relating to the challenge of testing across multiple platforms/devices, I made invaluable contacts with business leaders through my involvement in the ODL project which opened up opportunities to me on completion of my studies in IT Tralee. I enhanced and learned new skills in planning, im-

plementing and managing a project through to its conclusion of launching the IT Tralee ODL, which have all been applicable in my current career. Most importantly I really enjoyed the experience and felt a great sense of achievement on completion of the project"

Joe O'Flathery.

Christopher O'Brien completed his work placement module in the ODL in 2016. His focus was on setting up the lab for mobile application testing. He graduated in 2017.

"I would sum up my time in the lab as massively beneficial in terms of understanding and seeing first-hand how companies are adapting their development processes towards cross platform development as well as even how test automation and usability testing are now becoming a massive consideration when dealing with cross platform development. From using the lab I was able to gain a better understanding of how different screen sizes, resolutions and even the operating system comes into play. An example being Fonts and difference in colour schemes on Android and iOS platforms varying, By seeing tests run on various devices I gained a better understanding of how services such as Amazons device farm worked and now feel that I have a massive advantage in the job market based on these skills alone as many companies are using services like these for testing at the moment. Overall I learned what forms of testing I should be using, what to look for in UI testing, what screen sizes and resolutions are popular for testing as well as how to form metrics based on these

tests in order to improve bottle necks in previous tests.” Christopher O’Brien.

First year students are given an overview of the lab and made aware of the presence of the lab and the reasons for it. They learn responsive web design so it increases their understanding of why such an approach to web development is required and the amount of testing that needs to be performed. Peter MaCafferty and Leon Hennesy, first year computing students in 2018, had this to say about the lab.

“I have never seen an open device lab before and was ever impressed, there was so many devices to test on and am very interested and looking forward to using it for my projects going forward.” Peter MaCafferty.

“I found the open device lab to be very interesting especially since it was the first time that I had heard of such a lab before, I could see it being very useful as I progress through my course for testing purposes.” Leon Hennesy.

Second year students complete a usability study on a website and use the ODL for part of their testing. The exercise encourages students to think about the impact different devices, screen sizes and orientation, browsers and operating systems can have on a website.

“The lab is a really useful tool for enabling a student to see how an application or website

will look and act in real time. It shows how varied the screen sizes can be between phones and various tablet sizes and operating systems. It was really interesting to see how a website looks on these different devices. It showed how some devices have trouble loading certain parts/images of a website. It was really helpful to us as students as we wouldn’t be able to test on such a wide variety of devices. It was a really easy to link all the devices to what was being tested. It showed us how important it is to test how an application will look, act and interact with each device. Something as simple as an image could look completely different from one device to another. To add to that different operating systems could cause bugs when using them as the software build for Android can be very different from an IOS build” Gareth Brown 2nd year computing student 2018.

Third year and fourth year students use the lab for testing their projects. Aleksandar Zoric used to lab to test his final year project. He graduated in 2017.

“My final year project involved an Android application that would transfer large files of any type fast, over a peer-peer network. Meaning there was no need for an internet connection.

During development every time I reached a checkpoint in the project, I needed to test the application on multiple devices, with different OS versions,

different screen sizes and different device hardware; the ODL gave me an opportunity to do all this. At first I was not sure how I would install my application on all the available devices, but with clear instructions and a Jenkins' automation system already setup for me, it took me 10 minutes to have my application running on all devices. Overall, the ODL helped me to fully test my application before I had to demonstrate my project to the panel, therefore it allowed me to discover any bugs and faults that I was not aware of at first. Without it, I couldn't have done so on my own" Aleksandar Zoric.

A number of local companies have used ITT ODL lab to help them set up their own test labs in house. It is important that research work completed at the Institute is relevant to industry. This allow the Institutes relationship with regional companies to grow and expand. It also provides students with key required skills allowing them to take up employment locally. Some smaller local companies use the lab for testing on a regular basis. This allows the institute to share its resources and expertise to help strengthen the local economy.

6. CONCLUSIONS

In this paper the author has outlined the reasons an open device laboratory was constructed at the Institute of Technology Tralee. The primary reason was to facilitate an enhancement to the overall student learning experience. The Institute aims to provide its students with real-world “hands on” experience to enhance their analytical and decision making skills during the software development and testing of websites and applications on multiple devices. From the students results and feedback this has been achieved by using the ODL.

The author has outlined the hardware and software required to set up the laboratory. There were a number of issues that arose as a result of the decision to create the laboratory, one of the most important issues being safe access and secure display of devices. The laboratory needs to be set up in a secure, monitored location and the process of booking access for use need to be done through a centralised location. In the laboratory all devices must be displayed in a manner that allows them to be charged while at the same time being secured.

The devices need to be kept up to date, and populated with the more popular devices available on the market. This is important and, for an organisation like ours, needs careful consi-

deration. The donations of smart devices is unlikely, therefore a yearly budget needs to be set aside for the purchase of new or refurbished devices, or alternatively facilitating the sourcing of funding through sponsorship from external organisations.

The Institute has determined that its undergraduate and postgraduate students derive great benefits from using the ODL facility. Their feedback shows that by interfacing with the laboratory they have gained a deeper understanding of the quality assurance issues that arise during development and testing for multiple devices which has greatly enhanced their career prospects.

The ODL laboratory has also provided a test location for some smaller local companies and assisted larger regional companies in setting up their own in-house labs. This further enhanced the institutes’ relationship with local companies.

The addition of the ODL laboratory at the institute of technology Tralee has been a very positive one, and it is an important educational tool that has enhance the students learning of software quality assurance and usability for mobile devices.

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