Bridging the digital divide with an **off-line e-learning and e-assessment platform**

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This paper explores a proposal for an off-line e-learning platform that will provide a pathway for digitally disconnected students and educators to join the contemporary ICT intensive world. For individual remote and disconnected learners this represents a chicken and egg problem for engagement with contemporary e-learning offerings. Without the connectivity available to begin, remote learners have no way of engaging with now common ICT intensified learning materials that can teach them how to engage in a ICT intensive world!

The paper takes systems approach to considering the problem, encompassing the nature of hardware, connectivity, economics, support and skills available in remote and developing regions. The solution aims to fit into the world we have, and not one we wish we had in terms of infrastructure. It places contemporary digital learning courses onto a portable and independent e-learning environment that is not reliant on a constant network or Internet connection to function. The toolset uses free and open source components and can run on a range of legacy equipment making it economically accessible.

The digital divide

Groups such as UNESCO have expressed a desire to bring the advantages promised by MOOCs including high-quality, affordable education to the developing world where Internet connectivity is limited or non-existent (Patru & Balaji 2016). This represents a challenge to the current modus operandi of major online educational programs such as EdX, Coursera, FutureLearn who started out with the promise to bring high quality education to the masses but have largely ended up serving the needs of the already highly educated (Emanuel 2013, Christensen, Steinmetz, Alcorn, Bennett, Woods & Emanuel 2013, MOOCs@Edinburgh Group 2013, Norman 2014), affluent (Hansen & Reich 2015) and connected. Similarly, many higher education providers in the developed world are increasingly moving to online 24/7 platforms. The problem of delivering a contemporary learning experience to students located away from the main campus, located in remote areas, or in developing regions is that the significant issue of connectivity still needs to be addressed. While the number of people connecting to the internet worldwide is still increasing, as of 2014 there is an estimated 4 billion people (53% of the global population) still offline with the vast majority of those, 90%, in the developing world (ITU, 2016).

We need to avoid a widening 'digital divide' (Attewell, 2001) between those that are able to take advantage of what e-learning, MOOCs and digital learning have to offer and those that are 'disconnected'.

The nature of the problems faced by remote learners, teachers and institutions can provide insights as we attempt to address this growing inequity. Remote teachers and students have a number of constraints that need to be considered in developing suitable ICT enhanced teaching and learning facilities. In India, Sharma (2015) speaks of potential for MOOCs to expanding the availability for basic education but laments that many students still do not have access to schools, let alone an internet connection and so currently miss out on an education. The United Nations Sustainable Development progress report states that as of 2013, globally 59 million children do not have access to basic primary education (UN 2016). Where schools do exist, problems on the road to adopting e-learning include poor or non-existent access to Internet connectivity, limited budgets, limited IT support resources, limited access to professional development for teachers and a variety of legacy computer hardware (Lyons, Cooksey, Panizzon, Parnell & Pegg, 2006, Tytler, Symington, Malcolm & Kirkwood, 2009). In developing regions access to infrastructure, electrical power, computers, limited financial resources, suitably trained teachers, building local capacity, culturally and socially appropriate learning materials and methods are all issues to be addressed in delivering e-learning or MOOCs on the ground (Castillo, 2015, Trucano, 2013). Even in developed countries like Australia, students in rural and remote areas still frequently need to deal with poor connectivity, small data quotas and high data costs (Bell 2010, Owen 2016).

In the case of teachers wanting to learn the ropes of e-learning, it is now increasingly common that professional development materials are being provided as blended or online courses. Laurillard (2013) argues that MOOCs could be part of the solution to training an estimated 1.6 million extra teachers that will be needed for universal primary education. Thus the 'chicken and egg' problem arises for disconnected teachers wanting to up skill via a MOOC or to learn how to apply e-learning for their own students. Teachers in areas of low connectivity are therefore at a disadvantage to their metropolitan or developed country colleagues, creating further barriers to the use of ICT for learning in remote areas and widening the digital divide in education.

Exploring Requirements

In order to leverage ICTs for enhanced education, suitable solutions that are congruent with the conditions of remote learners and institutions need to be taken into consideration. Requirements that must be met include being inexpensive to acquire and maintain, relatively simple to operate, largely independent of Internet connectivity and being compatible with a range of existing and sometimes out-dated computer hardware. A case in point is reported by Larson (2017) who's valiant attempt to bring the riches of the MOOC world to English teachers in Mozambique. In a country where Wi-Fi is expensive and rare, and where computers are owned by few there are large barriers access. The generally low level of ICT literacy of the student teachers in the program also created additional barriers to learning. In this case the approach was to form social MOOC group who worked on the course together. Not all in the group had access to a laptop so the group shared laptop computers, printed copies of MOOC materials, watched videos and only had Internet access only at the venue. In the end the participants were successful in completing the course through persistence and mutual assistance. However they were highly reliant on the group facilitator for access to learning materials and Wi-Fi at the learning venue for assessment submission, making the approach to doing e-learning unviable on a larger scale, away from the main learning facility such as for remote community or home based study.

In terms or delivering e-learning capabilities in remote and isolated contexts, Farley et.al. (2015) have demonstrated that an isolated network can be used within prisons to enable e-learning like courses. Learning material is delivered periodically by uploading a static copy of a Moodle course to an isolated network server. Similarly Jacka and Booth (2012) used Sim-on-a-Stick to allow primary schools located behind firewalls to run a virtual world building application. The virtual environment works by starting up a server on board the USB stick after it has been loaded inside Windows. Students at both these sites were able to use modern e-learning tools to create digital artefacts, highlight ICT skills and build knowledge relevant to the contemporary ICT intensive world.

In the cases highlighted by Larson (2017), Farley et.al. (2015) and Jacka and Booth (2012) limited resources, out-dated hardware, limited IT support and skills, as well as poor or non-existent Internet connectivity, were all a reality. However in the latter two cases organisations provided the technology hardware and local administration of networks. As such issues of equipment and power provision were 'solved' but this is not the case for the majority of the developing world, as per Larson (2017), or where learners are on their own in a remote area. The need to self-provision computer and network connectivity in order to access e-learning tools is an issue to overcome. One approach is to bring the equipment to the field. Several projects are developing high-tech classrooms in a shipping container (Dell 2016, Wanshel 2016), that are equipped with computers, servers, a satellite link and solar power. Transporting the technology to the learners is one approach to adding an IT lab to a school, or a local Internet hub for a community. Whilst this is a big step up from no access and does consider the lack of local infrastructure in its conception, such access is still limited to the immediate surroundings and is only part of a possible solution. Similarly using the container for road show style access is not particularly suited to long term and sustained learning required to give students the skill base students need to engage in the modern economy. Further, such efforts are relatively resource intensive in local terms of capital, satellite connectivity costs and ongoing maintenance and so far are dependant on donations. With only several dozen rolled out world wide in the last five years there is a long way to go and are ultimately not scalable to the 59 million school age children who are offline.

Learning management systems (LMS) as an e-learning tool set are commonplace in universities and are beginning to be utilised in a number of pre-tertiary schools and community education programs. Such systems enable the integration of learning materials, digital books, learning activities, assessment tasks and record keeping. Online platforms for MOOCs and systems such as LMSs feature tools to facilitate a social dimension to learning that was not available in the days of paper based correspondence courses. Walji, Deacon, Small & Czerniewicz (2016) looked at how students utilise such features in a MOOC platform and found that peer learning, peer assessment and social interaction, even if as a passive observer, were appreciated by students. This created a richer study environment but it can quickly become ineffectual if interactions and expectations are not designed into the course or are not well facilitated. For those in remote areas it is currently difficult to provide synchronous interactivity at scale due to connectivity issues. However Walji et.al. (2016) also pointed out that the majority of the messages were posted by a small core group with the majority still benefiting from 'lurking' in forums. It remains unclear if an asynchronous back-up plan for remote learner connections would satisfy all remote learners because this may leave them with a role of lurker or at least coming late to some conversations.

Of the available LMSs, Moodle is the most commonly used LMS worldwide (Menard, 2013) largely because it is open source and free to obtain. The total cost of ownership (TCO) still needs to be examined on a case by case basis taking into consideration the whole life cycle from software acquisition and support through to retirement. Research by Shaikh and Cornford (2011) found that open source can return significant monetary savings and benefits such as using open data standards and avoiding vendor lock-in. The economics in developing countries may well be in favour of open source software systems. In developing countries the labour used to support a self-hosted system is relatively cheap while the alternative commercial licence and support contract fees are relatively expensive, especially when purchased from a developed country vendor. Market research in Africa suggests this to be the case with open source and in particular Moodle being the most common choice for LMS adoption by higher education institutions in Africa (Adkins 2013, p.8). The availability of suitably skilled personnel for education delivery and technical support also needs to be taken into consideration. Moodle features all the common tools available in contemporary online learning environments, is based on common software technologies (PhP, MySQL) and has a large community of teachers and technical support around it. Therefore the selection of popular open source tools and commodity hardware will help minimise the requirement for specialist components and niche knowledge.

Moodle has also been made to run ‘offline’ or ‘portable’ by a number of prior projects. The realisation of an off-line e-learning capability that leverages an already popular LMS is tantalising. Examples include 'Poodle' (MAF-LT 2014) and 'Portable Moodle' (Attwood 2015) both of which run as 'portable apps' within Microsoft Windows plus the aforementioned work by Farley et.al (2015) on an offline Moodle for Prisons. However, all of these solutions were a one-way transmission of learning material, essentially an off-line backup of the course material. There was no means for students to communicate back their responses or to actively participate in an online community of learners. Further more, most of these solutions either rely on a local network or rely on Windows to act as a host operating system on user computers. While Windows is a common platform for many institutions, using it as a host means that the software package is left open to interference and is not able to function natively on Apple platforms. A dependency on the commercially licensed Windows operating system presents additional costs (or the temptation of piracy) for developing countries, smaller institutions and students. If a local network is required to operate an off-line Moodle system then it excludes the use by individual users in remote areas or in small schools where a client-server network may not be available. Ideally, a truly off-line e-learning system should not require a network to function at all for a reasonable duration, but should be able to be used for two-way communication when an internet connection becomes available. This will allow a much greater degree of freedom of movement for learners.

A way forward

An alternative solution that builds on a number of existing projects is proposed as a way forward in addressing the issues of economics, hardware provision, multi-hardware compatibility and integration of assessment in a modular software environment. The recent 'e-Exams System' project led by Monash University in collaboration with eight other Australian university partners and funded by the Australian Government Office for Learning and Teaching developed a prototype portable e-Exam platform designed to work on a variety of student owned hardware (Hillier & Fluck, 2013). It was designed to be independent of the operating system present on the host computer to ensure security and compatibility. The e-Exam System (demo available from http://transformingexams.com) contains the free to obtain Ubuntu operating system that can be run ‘live’ on a range of computer hardware. This is used by ‘booting’ the computer from a USB stick rather than running the software from within Windows or OSX. This completely by-passes the operating system present on the computer to create a controlled software environment. Further, the Ubuntu operating system with the addition of the WINE (a 'Windows' emulator for Linux) is compatible with a range of software applications used in education and business. The inclusion of a server stack within each USB means that each user enjoys an isolated instance of Moodle that can run offline without the need for a live network connection. Therefore, this project provides a good base from which to develop the means of delivering e-learning capabilities that do not require a constant Internet connection or a local network. Further work needs to be undertaken to enable the platform to accept updates and become a two-way communication tool for remote students.

A modular offline learning education assessment platform (MOLEAP)

The MOLEAP concept combines the features of an offline learning management system using Moodle and adds supporting tools such as an office suite, graphics editor and multimedia players, plus the ability to enable two-way communication and updates when a network is present. Additional software tools capable of running within a Linux or Windows environment can be run as plug-in modules. A set of custom components tie these together and provide administrative tools to help teachers and IT support to configure, create, update and duplicate copies of the system. The multi-hardware compatible Ubuntu operating system has been used to provide a consistent software package that will run on the majority of Intel based hardware produced in the last five years that typically runs ‘Windows’, Apple OSX or Linux (other processor architectures can also be used but require a separate build of the operating system). Further, because the system itself runs 'live' from commodity USB sticks it is very cheap to distribute via 'snail mail' means. The system can be used on old machines and even computers where the harddisk drive may have been damaged or removed.

The status of each of the software components of a MOLEAP package provided on a USB stick as well as commodity hardware for administration is outlined in Table 1.

All software components are available on open source licence terms and all hardware components are readily available ‘off the shelf’ making the development and longer term maintenance of the package more sustainable than would be the case for a completely custom built solution. The whole software bundle will be made available as a downloadable disk image (IMG or ISO) file that can then be ‘burnt’ to a USB stick on-site or delivered via the postal service. Once burnt to a USB stick the software components and assessment materials are fixed in place and cannot be damaged by curious users. However additional learning material content, news messages and discussion board messages can be optionally downloaded by the user when a network connection becomes available.

The output of student activity such as, replies to forum posts, assessment responses and formative results can be saved to the same USB for later submission and collation. Submission may occur when a network connection becomes available, or by exporting individual assessment responses to secondary storage or to a printer or by sending the completed course on the USB stick back to the institution via the post. The ability for the platform to work under different scenarios of connectivity, from fully offline, through occasional connections to completely online allows it to serve a wider group of students and teachers than can existing solutions that are either 'always off line' or 'always online'.

A representation of how the MOLEAP solution would work is depicted in Figure 1.

Table 1: Modular offline live learning education assessment platform

Component	Status	Role
Ubuntu	Mature - The most common version of the open source Linux operating system.	Base operating system that forms the ‘Live’ USB that can be used to start most computer hardware. Network connections are also possible but not required. When present a network allows for syncing, updates and submission of responses.
Moodle	Mature - Worlds most common LMS. Several offline uses have been proven in the past. e-Exam project has this working on a Ubuntu Live USB.	Learning management system to house learning resources, assessment submission, quiz, gradebook, etc.
AMP stack	Mature - the most common ‘web server’ software bundle containing Apache web daemon, MySQL database and the PhP language.	This is capable of running a wide range of web applications. In this case, it will enable Moodle to run from the USB stick.
Sync Scripts	Custom – proposal (similar techniques have been used for services such as 'DropBox' or 'OwnCloud'). The sync software will use a common programming language or existing tools.	These work in a similar manner to 'Dropbox' in that it will sync content to and from USBs and the home base server when a network connection is detected. This will be configurable by the user to prevent unwanted data usage.

Configuration scripts	Custom – concept stage (similar techniques have been used in the e-exam project). These use ‘Bash’ script or a common programming language with graphical interfaces also available.	Used to configure and control the software environment. Custom user interface features can also be developed including an automated start-up process for users. Users respond to prompts to use them.
Admin scripts	Custom – in beta development. These have been developed for the e-Exam project. These use ‘Bash’ scripts and have graphical interfaces available.	Used to set-up and administer multiple USBs at once. Used in conjunction with USB hubs for greater efficiency. Users respond to prompts or press buttons to activate functionality.
USB sticks	Common - Commodity components that are economical, easy to obtain and reusable.	A USB stick is used to house the MOLEAP software that students will use to start-up their computers. One USB stick per student.
USB Hubs	Common - Same as above.	Used to set-up new USBs and where required, retrieve student responses. This reduces the repetitive work that would otherwise be required to individually set-up each USB stick.
Home base server	Proposed – Common hardware and LAMP stack, Moodle host, file storage.	Interacts with client USBs when they come on-line. Acts as a repository for content and responses. Can also receive manually uploaded responses exported from client USBs or when USBs are returned and processed via USB hubs using the admin scripts.

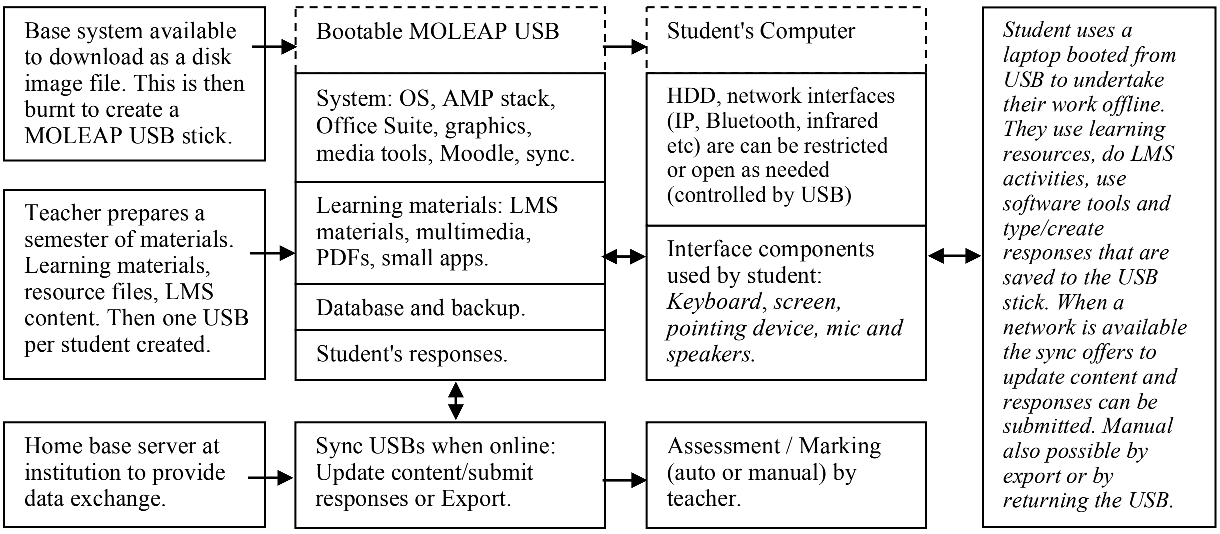

Figure 1: Representation of Modular Offline Live Education Assessment Platform solution

The overall workflow represented above is that the base system is provided as open source code in the form of a disk image that is ready to be written (burnt) to generic USB sticks. The writing process formats the generic USB stick into a MOLEAP USB stick. This can then be loaded with course materials developed by the teacher and configured to work with an institutional home base server. When this is tested and ready, further copies of the USB stick can be made using a large commodity USB hub and the administration software. USBs are then sent to students for use.

Students will use the system by starting (booting) their computer from the MOLEAP USB stick. The USB provides the operating system, all applications and e-learning course materials. The USB can be configured to control what network and hardware services will be permitted, for example networks and local storage. This allows the same software tool set to be configured for either formative, open learning or supervised exam settings (the latter will require a specifically configured version to ensure exam integrity). In the e-learning mode the student is free to use local and network resources as they see fit.

When no network is available, the provided e-learning materials can be used within the Moodle LMS on-board the USB stick. Similarly an office suite, graphics editors, media players, plus other software tools chosen by the teacher, can be used to create and edit documents or play stored media files. Any student work is saved to a section of USB stick and can be optionally copied to local storage on the host computer.

When a network becomes available the system alerts the user and asks if they would like to update or submit work done so far. This places the choice in the hands of the student as to avoid any unwanted data transmission costs. This is important where Internet access accounts may have small data quotas. If the user chooses to submit data then it is sent to an institution server to be collated with the work of other students in the course. This could include submitting a Moodle quiz, assignment file or updating forum posts. Should network based transmission not be possible then the student has the option of exporting data, printing work or posting the USB stick back to the institution for processing.

Given reality of the connectivity and resources available to remote learners, tools such as MOLEAPs are required for students to be able to fully engage with the learning approaches afforded by contemporary software tools of the trade and modern learning management systems. MOLEAP could also form part of a wider education strategy with local Internet hubs providing support for a given region, localisation of course materials and opportunities to connect with other community members. For example, an IT classroom in a shipping container (Wanshel 2016) may serve as the local hub with MOLEAP allowing students to take their work far away into the surrounding countryside, creating a much wider reach and multiplier effect for such investments.

Conclusion

The need to enable the most isolated and disconnected students to join the connected world of the 21st century can be characterised as a 'chicken and egg' problem. The skills required to engage with ICT are now commonly taught via ICT enhanced learning. The issue faced by those who are disconnected is that they lack access in a world where increasing amounts of learning is being delivered online with the assumption that everyone has a stable and high capacity Internet connection. This is typified in the case of institutions wishing to leverage their e-learning courses for a wider audiences, the trend to MOOCs has made this material available widely 'online' but this wealth of material has not reached those most in need – those who are 'offline' in remote and developing regions.

It is clear that the use of e-learning tools such as LMSs have already been established in most higher education institutions in the developed world in one format or another and this trend will continue. Yet how each educational institution uses e-learning systems is varied and multi-disciplinary. As such the solutions delivered must be similarly flexible to cater for institutions and learners in a range of contexts. As we endeavour to pragmatically work around the limitations faced by remote learners and teachers we will inevitably face further challenges. This concept of the MOLEAP presented in this paper requires further technical development, research and refinement to bring it fruition. It needs to 'just work' in the harsh and unforgiving environment of remote communities and developing countries to be of use to those most in need. We must continue this work, we must find innovative ways to enable those on the fringes to be able to engage in learning experiences of the 21st Century or we risk an ever widening digital divide.

The proposed MOLEAP outlined in this paper can provide a platform and tool set for remote students to engage with learning materials via 21st century e-learning technologies and more authentic forms of digital assessment. This is a means by which we can better equip remote learners and teachers to participate in an increasingly ICT intensive world, regardless of their current level of connectivity.

References

Adkins S.S. (2013) Ambient Insight Regional Report: The Africa Market for Self-paced eLearning Products and Services : 2011-2016 Forecast and Analysis. Ambient Insight. January. http://www.ambientinsight.com/Resources/Documents/AmbientInsight-2011-2016-Africa-SelfPaced-eLearning-Market-Abstract.pdf

Attewell, P. (2001) 'Comment: The First and Second Digital Divides' Sociology of Education, 74(3) July, American Sociological Association pp. 252-259 http://www.jstor.org/stable/2673277

Attwood J. (2015) Portable Moodle (software), SourceForge, http://sourceforge.net/projects/portablemoodle/

Bell, G. (2010). Getting Connected, Staying Connected: Exploring Australia's Digital Futures. Adelaide, SA.: Government of South Australia.

Castillo, N. M., Lee, J., Zahra, F. T., & Wagner, D. A. (2015). MOOCS for development: Trends, challenges, and opportunities. Information Technologies & International Development, 11(2), 35–42.

Christensen, G., Steinmetz, A., Alcorn B., Bennett A., Woods, D., & Emanuel, E. (2013) The MOOC Phenomenon: Who Takes Massive Open Online Courses and Why? Working paper, Social Science Research Network, http://dx.doi.org/10.2139

Dell (2016) "Solar-powered classrooms harness the power of technology and teamwork to educate youth", Corporate Social Responsibility, Communities http://www.dell.com/learn/us/en/uscorp1/corp-comm/solar-power-youth-learning

Emanuel, E. J. (2013). Online education: MOOCs taken by educated few. Nature, 503(7476), 342–342. doi:10.1038/503342a http://www.nature.com/nature/journal/v503/n7476/full/503342a.html

Farley, H., Dove, S., Seymour S., Macdonald, J., Abraham, C., Lee, C., Hopkins, S., Cox J. & Patching, L. (2015) Making the Connection: Allowing access to digital higher education in a correctional environment. Proceedings of ascilite 2015, Perth, Australia. (pp. 432-439)

Hansen, J.D. & Reich, J. (2015) Socioeconomic Status and MOOC Enrollment: Enriching Demographic Information with External Datasets, Proceedings of the Fifth International Conference on Learning Analytics And Knowledge, March 16-20, Poughkeepsie, NY, USA http://dx.doi.org/10.1145/2723576.2723615

Hillier, M. & Fluck, A. (2013). Arguing again for e-exams in high stakes examinations. In H. Carter, M. Gosper and J. Hedberg (Eds.), Electric Dreams. Proceedings ascilite 2013 Sydney. (pp. 385–396) http://www.ascilite.org.au/conferences/sydney13/program/papers/Hillier.pdf

International Telecommunication Union (ITU). (2016) .ICT facts and Figures. Geneva, Switzerland. April. http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf

Jacka, L., & Booth, K. (2012). What about the firewall? Creating virtual worlds in a public primary school using Sim-on-a-Stick. Paper presented at the Australian Computers in Education Conference 2012, Perth, Australia.

Larson, K. (2017), MOOC groups for improving access to MOOCs in developing countries: Lessons from a MOOC group in Mozambique for English teachers, Presentation at *Open and Distance Learning Association of Australia conference*, Melbourne, 5-7 Feb

Laurillard, D (2014) Which problems could MOOCs solve, and how? University World News, Issue No: 328, 11 July http://www.universityworldnews.com/article.php?story=20140708091436155

Lyons, T., Cooksey, R., Panizzon, D., Parnell, A., & Pegg, J. (2006). Science, ICT and mathematics education in rural and regional Australia: The SiMERR national survey: University of New England, National Centre of Science, ICT and Mathematics for Rural and Regional Australia.

MAF-LT (2016) Poodle (software), Mission Aviation Fellowship Learning Technologies Division http://www.maflt.org/products/poodle

Menard, J. (2013) World Map of Learning Management Systems 08/2013, List Education Technology http://listedtech.com/content/world-map-learning-management-systems-082013

MOOCs@Edinburgh Group (2013)'MOOCs @ Edinburgh 2013: Report #1', The University of Edinburgh 10 May, http://hdl.handle.net/1842/6683

Norman, A (2014) The who, why and what of MOOCs, In B. Hegarty, J. McDonald, & S.K Loke, (eds) Rhetoric and Reality: Critical perspectives on educational technology. Proceedings ASCILITE, Dunedin, NZ (pp. 717-721)

Owen, M (2016) Satellite data limits stymie NBN's great expectations, The Australian, 21 May

Patru, M & Balaji, V. (eds) (2016) Making Sense of MOOCs: A Guide for Policy-Makers in Developing Countries, United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris, France. http://unesdoc.unesco.org/images/0024/002451/245122E.pdf

Shaikh, M & Cornford, T. (2011) Total cost of ownership of open source software: a report for the UK Cabinet Office supported by OpenForum Europe. UK Cabinet Office, London, UK. http://eprints.lse.ac.uk/39826/

Sharma, Y.P. (2015) Massive Open Online Courses (MOOCs) for School Education in India: Advantages, Challenges and Suggestions for Implementation. Microncosmos International Journal of Research,1(2), 1-5.

Trucano, M (2013), More about MOOCs and developing countries. EduTech Blog, The World Bank 11 December.

Tytler, R., Symington, D., Malcolm, C., & Kirkwood, V. (2009) Assuming responsibility: Teachers taking charge of their professional development, Teaching Science, 55(2), 9–15.

UN (2016) Progress towards the Sustainable Development Goals, Economic and Social Council, united Nations E/2016/75 http://www.un.org/ga/search/view_doc.asp?symbol=E/2016/75&Lang=E

Wanshel, E. (2016) "This Container Brings Internet To People In Need, Refugees In Remote Areas" The Huffington Post, 11 June. http://www.huffingtonpost.com.au/entry/solar-powered-zubabox-internet-shipping-container-rural-areas-refugee-camps_us_5757155ce4b0b60682df2435

Hillier, M (2017) "Bridging the digital divide with an off-line e-learning and e-assessment platform", Presented at *'Expanding Horizons in Open & Distance Learning', Open and Distance Learning Association of Australia conference*, 5-7 February, Melbourne, Australia

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