Transferring On-line Science and Engineering Courses for Use in Developing Countries

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Chapter 20

Transferring On-line Science and Engineering Courses for Use in Developing Countries

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Abstract

Commercial or free (open-source) Learning Content Management Systems (LCMS) are already in widespread use in many academic institutions, especially for blended learning. In the last 3 years, video lessons and Massive Open On-line Courses (MOOCs) have been viewed by some as having potentially high impact in higher education due to their perceived ability to deliver knowledge interactively to a wide audience of learners. Although LCMS and MOOCs are teaching/learning aids, they are orthogonal in several aspects. Generally, MOOCs may not explicitly require the learners to have an in-depth prior knowledge of the subject and are aimed at collaborative audiences or groups of learners larger than a typical classroom or a single educational institution. Accessing internet based on-line resources such as LCMS and MOOCs is challenging in many developing countries or remote locations where access to the internet is not available on demand, especially when they include video based lessons and similar resources that require higher bandwidth for streaming or on-demand access by learners. This chapter presents with real/practical examples and illustrations from a multi-disciplinary course for physics/ engineering, the quasi-automated exportation of an on-line LCMS or MOOC into an off-line portable archive that is especially suited for use in areas/regions with limited bandwidth. Also discussed/presented is the use of the off-line version in several different learning contexts such as personal learning, interactive classroom video, collaborative learning, distance learning and even as a blended learning aid for existing classroom based academic programmes or on-line MOOCs or LCMS based courses.

20.1. Introduction

On-line learning platforms such as learning content management systems (LCMS) and Massive Open On-line Courses (MOOCs) for short are now widely used in many academic institutions. A Learning Content Management System (LCMS) describes an integrated platform that incorporates and provides both the learning environment as well as the tools to manage the environment and learning content. MOOCs have been viewed by some as having potentially high impact in higher education due to their perceived ability to deliver knowledge interactively to a wide audience of learners [1]. There are some similarities between LCMS and MOOCs as they are both used to manage and provide coordinated learning material to learners on-line. MOOCs may not explicitly require the learners to have an in-depth prior knowledge of the subject and are aimed at collaborative audiences or groups of learners larger than a single class, year-group and/or educational institution [2] [3], while LCMS are targeted at a closed group of learners typically limited to a class or year-group from the same academic institution [4]. LCMS also require learners to have some prior knowledge and may enforce mandatory assessments that have to be taken and passed in order to progress to the next lesson or course [3]. In engineering and other science disciplines with a high component of practical laboratory work, on-line systems such as learning managements systems are commonly deployed for blended learning use as opposed to a purely on-line or e-learning system.

LCMS have a text based heritage, and are oriented towards the traditional computer input devices (keyboard and mouse) with output mainly presented through text and graphical or animated diagrams, while MOOC platforms are heavily focused around the use of video based lessons, supplemented by other material [3].

20.1.1. Developing Country Needs

Using on-line learning platforms from developing countries is quite challenging due to access and infrastructural limitations [5]. Many academic institutions located in developing countries provide internet access for use by both staff and students. In most cases, the bandwidth available is over-subscribed and access may be filtered via proxy servers that tend to favour the download of text based resources over video based resources, especially during working hours. For end-users, the main alternative to the institutional based access is mobile internet access, which although it is less restrictive, is not cheap, as mobile internet access is billed according to the quantity of data transferred rather than the speed of access. Generally, mobile internet access is not available on demand nor is the speed guaranteed as the (mobile) network may sometimes suffer from unexplained technical or unknown faults such as configuration issues on the end-user terminal or problems at the remote server [6]. The lack of on-demand access and variable access-speed to the internet adversely affects the use of both video and non-video learning contents for on-line learning; however, this also positively encourages the use of locally deployed LCMS or similar platforms, although end-user access to the locally deployed platform is most times limited to a single laboratory, building, department or campus within the institution.

For academic institutions in developing countries, choosing and deploying an LCMS platform locally is typically influenced by factors such as:

- Cost: Although free and open source software have an attractive initial cost, there may be added costs involved if modifications to the software and/or additional software development efforts are required. The availability of the software source code is always good but it is useless unless there is a competent developer who can implement the required modifications.

- Flexibility: Outside the immediate or intended use of the LCMS platform, it is important to understand how the platform will handle future needs. For example, is the platform able to handle e-learning, blended e-learning or even hybrid e-learning. Does the platform include facilities for setting up quizzes with multiple choice questions, short essay questions and web 2.0 interactions such as forums/messaging.

- Support for rich/multi-media support: Modern computing environments provide support for a wide range of document formats from many different applications as well as multimedia documents containing audio and video information. LCMS platforms should support the common digital (office) file formats and multimedia documents including audio and video clips both internal or linked from some external site or location.
- Complexity: All interaction with the LCMS should be through a consistent simple interface, such as a web-browser, with a low learning curve for both end users and content providers. Installing and deploying the platform should be simple and end-user access should not be difficult to set up or require the use of non-standard software tools or platform.
- Others: Importantly, it should allow the learner to focus on learning the pedagogical material rather than the technological/component tools or solving LCMS contextual issues outside the pedagogical material.

20.2. Transferring an On-line Course

There are several different strategies which may be used for the transfer of on-line learning material for use in regions with poor internet connectivity such as in developing countries. In certain situations, depending on the source of the on-line learning material and LCMS platform in use, it is possible to create a mirror-copy or backup-archive containing a complete on-line course that is then transferred to a partner institution for deployment. This strategy requires the recipient institution to deploy the same LCMS platform, possibly matching the version for maximum compatibility and requires collaboration from the content provider in creating the backup or mirror copy especially if the content is subject to other restrictions such as software and content licensing.

A similar strategy involves the exportation of learning content to a standard format such as the "Sharable Content Object Reference Mode" (SCORM) or the IEEE Learning Object Metadata (LOM). Here also, the recipient institution would deploy a suitable (but not necessarily the same) LCMS platform. In this case, there might be compatibility issues due to varying levels of support for SCORM or IEEE LOM in different LCMS platforms.

Both strategies (mirror/backup copy and exported copy) discussed above require some investment on infrastructure by the recipient and are generally not suited for direct use by end-users or individuals.

A different strategy completely under the control of the end-user is the download for later use, where the end-user would access the on-line resource and download the lessons or contents of choice to a suitable storage device for later use. This strategy is often suggested as a possible way of mitigating the effect of limited availability of on-demand internet access and variable access-speeds to on-line resources. For example, downloading the on-line content is carried out outside the periods (hours) of peak network usage such as on weekends, late at night or very early morning hours, stored and subsequently used during normal periods. In practice, this strategy may not be cost effective and is not guaranteed to always work as expected if the content (source) provider/platform does not provide or support direct download of content. That is, downloading a video file that is only available for streaming access requires the use of specialized software, and even so, obtaining a suitable uniform resource locator (URL) for downloading may be complicated if the web-site/page makes use of dynamic content and/or some scripting language such as JavaScript in addition to Hyper Text Mark-up Language (HTML).

20.2.1. Off-lining

The download for later use strategy has been successfully employed for web-sites and pages by creating a mirror copy of the web-site using a suitable tool. This point-in-time snapshot copy of the on-line resource may be produced from a simple recursive dump or mirroring of all static pages and associated script contents of the on-line resource. The output of such a direct mirror or copy may not work as expected and typically shows broken links where the connections between individual pages are broken and no longer work as expected, despite all pages being present in the copy. Correcting such problems involves some transformative process aimed at re-establishing the links between individual pages.

Off-lining an on-line resource involves creating a point-in-time snapshot of the downloadable contents and subsequently transforming the mirrored contents for use off-line and completely eliminating the need to access the on-line resource during later usage. The technique of mirroring an on-line resource is different from off-lining as the output of the mirroring process may require interpretation by suitable server software running in a suitable context in order to produce the correct output, whereas the output of off-lining is directly usable by end-users without the need for a server software.

A free and open source software (FOSS) tool called httrack may be used to off-line recursively download a complete World Wide Web site from the Internet (or computer network) to a local directory as it also automatically implements some transformations, such as modifying links in HTML files, required to avoid broken links when the site is viewed off-line [7]. For simple HTML code, the httrack software utility generated output copy of the downloaded site is then available for use without the need to go on-line.

Dynamic script contents such as JavaScript typically executed by client-side or end-user software are difficult to off-line and they are usually mirrored without any transformation by the httrack utility. While this works for simple scripts, it does not work with more complex dynamic scripts and more often than not, the resulting httrack generated off-line copy contains content that does not function correctly. Better off-lining of on-line resources that include dynamic script contents such as JavaScript would require additional transformations (implemented outside httrack), that are aimed at simplifying the scripts or replacing them with functional equivalents.

The first step in off-lining a modern LCMS or MOOC involves obtaining the pedagogical contents such as video files, HTML pages, dynamic scripts and supporting documents directly from the on-line version. This may not always be as simple as it sounds especially for video lessons, where downloading the videos files in a suitable format directly from the on-line storage repository is not always guaranteed to be successful. Consider the following on-line repositories commonly used by academic institutions for storing pedagogical material (video files) on-line:

- **YouTube:** This video repository has the advantage of being relatively low cost as it requires no investment on the part of the content provider. Although, video files of varying length and quality may be uploaded and streamed, YouTube offers no means of directly downloading the uploaded/stored videos. It offers viewers the ability to collaboratively comment or annotate the stored (uploaded) video and also group them together using title, keywords or "YouTube channels". Viewing quality for an end-user is variable and may be affected by both the original quality of uploaded material and the available bandwidth for streaming to the end-user. YouTube is a video only repository and does not appear to support the upload/inclusion of other document formats [8].

- **iTunes University:** This video repository has the advantage of being aimed at supporting education content. Video and other material are typically grouped by institution and may also be sub-divided into various pedagogical categories. Good quality and appropriately formatted video content is usually required for uploading. However, viewing content requires a special application software especially as iTunes University also supports a pay-per-view model for non-free content. Viewing quality is good but may be degraded or not usable if the end-user does not have a functional (high) broadband access to the internet. Also deploying learning content for on-line streaming and distribution via iTunes University may require some investment in the form of hardware for storage of the content by the individual content provider (institution) [9].

- **Internet Archive:** This repository is a freely available digital library that strives to provide universal access to all knowledge. Content is organized according to high level groups such as video, audio, web, text and open-library for books. Specific educational/pedagogical material may be found using the provided search facility. Viewing quality is variable and may be affected by both quality of uploaded material and available bandwidth for streaming to the end-user. The Internet Archive supports the direct download of video files in multiple formats, as well as the upload of multiple files (in different formats) for a video lesson [10].

- **ICTP.tv:** This repository contains rich-media (audio + slides + video) educational material from a single institution, the International Centre for Theoretical Physics (ICTP) [11], available via webcast. Video content is arranged by individual subjects and further sub-divided by dates (classroom timetable) as they were created from the direct recording of a classroom environment. The rich-media system couples webcam quality video with synchronized high-quality still images (pictures) of display-screen/blackboard and audio, as the emphasis is on higher quality for still-images (slides) and audio. Although, the display of content is via a web-browser with a suitable 3rd party add-on (Apple QuickTime or Adobe Flash), the relatively small content-size ensures the ictp.tv archive remains quite usable even when the end-user does not have high-broadband access to the internet. Unlike the previous three repositories, this archive also does not provide a search facility; however, for each lesson, it provides already zipped archives of the rich-media content for direct download [12].

As discussed above, obtaining the video files for off-line use is easy with both the ICTP.tv and Internet Archive repositories, but is not that easy with iTunes U and YouTube, where direct access to the stored video files from the on-line storage repository is not available. Generally, other highly specialized software apart from the previously discussed httrack utility is required for off-lining a video file directly from a web-page when direct download is not possible. The process may be further complicated if the video is only available within an embedded video player that also provides additional functionality apart from streaming/displaying the video content. This is true for certain MOOCs, where the embedded video player is also responsible for listing additional/supplementary resources, collecting data about the usage and interactive access patterns of end-users. Similarly, many on-line resources include JavaScript based video players embedded within web pages because such players ensure a consistent view of content across different viewing platforms (combinations of end-user browsers and operating systems), while also reducing the need for special add-on (or plug-in) software.

20.3. Example: Off-lining Process of an LCMS

Between the years 2007 and 2012, the International Centre for Theoretical Physics (ICTP) located in Trieste, Italy ran a year-long special pre-diploma (Master's degree) programmer on "Physics without specialization". This pre-diploma programmer was co-sponsored by the UNESCO/Italy Funds-in-Trust Cooperation for Africa mainly for students from sub-Saharan Africa, employed a compulsory course-work only format requiring only final examinations without thesis/dissertation. Students who performed exceptionally well were automatically accepted into the institution's postgraduate diploma programmer [13].

The year-long pre-diploma programmer consisted of 9 different courses/subjects taken in two academic semesters as shown in Table 20.1. All subjects were taught, to the multi-lingual group of students, using the English language and the pedagogical content were positioned as a refresher for material that is typically covered during undergraduate level studies. Some of the taught subjects, including Mathematical Methods, Advanced Electromagnetism, Quantum Mechanics and Solid State Physics are relevant and useful for engineering students as well, particularly electronic and electrical engineering. Electromagnetism is one of the topics commonly covered in most multi-disciplinary undergraduate level training for science, technology, and engineering students [14] and [5].

Table 20.1. List of subjects in the Physics without specialization course.

Semester	Course title	No of Lecturer(s)	No of tutor(s)
First	Quantum Mechanics	1	1
	Mathematical methods	1	1
	Classical Mechanics	1	0
	Advanced Electromagnetism	1	0
Second	Advanced Quantum Mechanics	1	0
	Statistical Mechanics	1	1
	Solid State Physics	1	0
	Physics of the Earth System	4	0
	Relativistic Quantum Mechanics	1	0

As shown in Table 20.1, each subject had a single lecturer or instructor except for the "Physics of the Earth Systems" which was taught by four different lecturers/instructors. For the 2011/2012 academic year, an LCMS was deployed for blended-learning use by instructors and students of the pre-diploma programmer. Also, the classroom-based face-to-face teaching was captured on video both via high quality manned recordings and quasi-automated medium quality webcast recordings (for ICTP.tv). The resulting video files in high-quality format were made available within the LCMS (embedded inside individual lessons), as well as from an open access video portal.

Transforming the final pedagogical content from the LCMS into an offline archive began with use of the httrack software utility, which could only partially mirror content from the on-line video-portal due to difficulties with embedded content including JavaScript video player code and Adobe Flash. Although the resulting HTML files (output from the httrack software utility) were not completely usable, they served as a valuable starting point for the offline version. A software (script) utility was written in the Perl programming language to further transform the output HTML code. The Perl script implemented the following steps:

- Analyze the HTML code of a web page from the on-line LCMS and subsequently break it into 3 generic sections: header, body and footer.
- For all pages, modify the header section by removing unneeded code for items such as the on-line search box.
- For all pages, modify the footer by also removing unnecessary links and entries.
- For pages that list videos thumbnails:
  - Modify the body by simply changing absolute links to relative ones.
- For pages with individual videos, modify the body by
  - Replacing the code for the JavaScript/Flash video player with a functional equivalent consisting of an anchor tag around an image tag, where the image file is a thumbnail from the video lesson.
  - Extracting the list of additional resources (PDF files) associated with each lesson from the JavaScript player, into a HTML list object. The filenames of the additional resources are saved for subsequent downloading.
  - Add additional quick navigation links.
- Finally for all pages, recombine all 3 sections into a new HTML file, which is saved as a new file suitable for off-line viewing.

The resulting product is a 76 GB portable archive containing over 350 hours of pedagogical material (video files, HTML files and additional documents) taken from the on-line LCMS and transformed for off-line use.

20.3.1. Layout and Usage

For end-users, using the off-line archive requires only a graphical web-browser. HTML5 capable browsers can directly play video files and show PDF attachments without the need for helper applications, while non-HTML5 web-browser would require the installation of additional helper applications to play video files and display PDF attachments.

The welcome or main page shown in Fig. 20.1 was created separately and serves the purpose of providing information (including credits) and links to several other HTML pages that discuss:

- How to use the open offline course;
- How to use the open offline course in a classroom environment;
- How to use the open offline course on a local network (Intranet) and;
- A page on the terms of use and the creative commons license.

Fig. 20.1. Welcome page.

The menu-list or left-hand side of the welcome page shows clickable links for all subjects included in the off-line archive.

Clicking or selecting a subject from the menu-list (left-hand side) leads to a subject page where the right-hand side of the page is devoted to a sequential list of thumbnails of the individual video lesson alongside some additional textual information as shown in Fig. 20.2. Clicking on one of the thumbnails would lead to Fig. 20.3.

For individual video lessons as shown in Fig. 20.3, the right-hand side of the page is now composed of a click-able preview image of the video file (the on-line version uses an embedded JavaScript video-player) along with the pedagogical text material taken from LCMS. All additional materials such as PDF documents are listed directed in the right-hand side of the page below the textual contents from the LCMS, in the on-line video-portal all additional materials are managed and listed by the embedded JavaScript video-player. As shown in Fig. 20.3, the additional material named "Lecture notes 1" is available for direct download from the off-line archive. This section (for additional material) also contains links to any external on-line resource found in the LCMS lesson page. The contents of some external on-line resources were not included within the archive due to licensing restrictions.

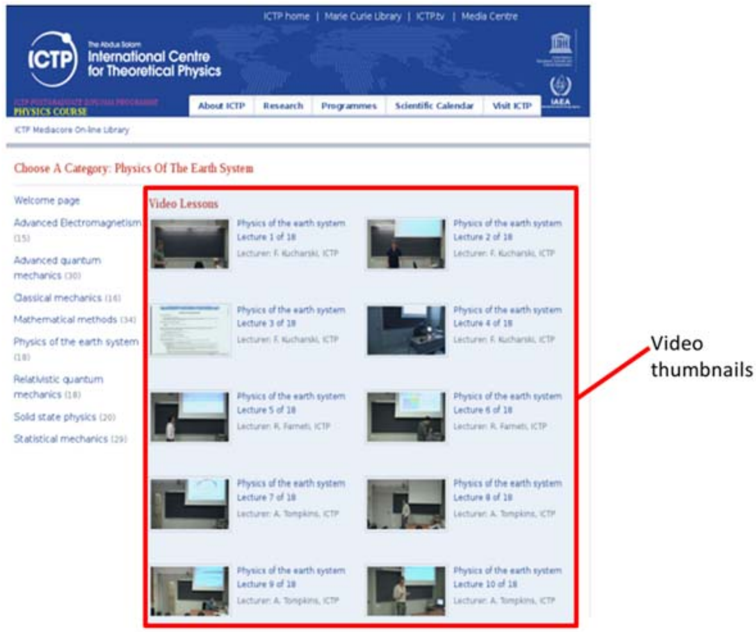

Fig. 20.2. View of a single subject with multiple videos.

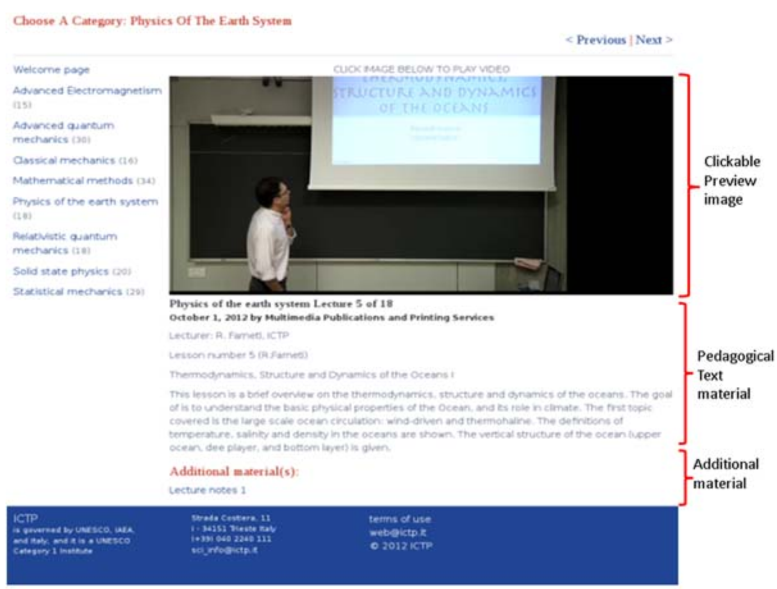

Fig. 20.3. View of a single lesson showing video and pedagogical material.

Each video lesson is accessible with a maximum of three mouse click as follows:

1. The learner selects a subject by clicking on a menu list on the left-hand side of the main page;
2. Then within the subject page, clicks on the thumbnail (right-hand side of page) of a video lesson and
3. On the individual video lesson page clicks on the preview (image) to start the video lesson.

As shown in Fig. 20.3, quick navigation links named "Previous" and "Next" are provided for quickly moving to the previous video page or next video page.

Also, from every HTML page, the learner can quickly return to the main welcome page or access a different subject by selecting an item from the menu-list which is always present on the left-hand side of all pages. When viewing a video or reading a PDF document, the browser's back button is used for returning to the HTML pages.

20.3.2. Additional Usage Scenarios

Apart from the previously described usage scenarios in personal and informal learning, the off-line archive/course is useful as a reference material for instructors and also for collective usage by groups of learners or users, such as within a classroom environment, over a local area network/intranet or as a companion-aid for an on-line resource.

Classroom usage: Due to the rather high quality (H264 codec, MPEG-4, 640×360 resolution at 25 frames/sec) content of the video files, the video lessons from the off-line archive may be projected on to a large screen display for group based viewing. The video lessons may be viewed by groups of learners together such as in a classroom environment (during a normal lecture), where viewing may be combined with other active learning techniques such as group discussions, which are quite natural in a flipped classroom context. Fig. 20.4 shows the combination of playback of video lessons and active learning activities for an "interactive video" effect within a classroom context. This "interactive video" technique permits the vetted (academic) use of video material from a wide range of sources, while also breaking videos of long duration (over 60 minutes) into smaller chunks for consumption by learners [15].

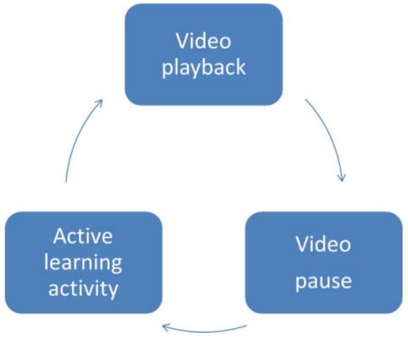

Fig. 20.4. Interactive video for group based active learning in classroom.

Local Area Network resource - Intranet server: The complete off-line archive or parts of it may be hosted on an intranet server and served to learners using a standard HTTP web-server or other suitable means such as file server access. Availability via a local intranet server ensures that the pedagogical content is available to all learners on the local network, and they may subsequently copy portions of the archive directly to mobiles devices for personal use. Note that having the material on personal devices would also promote collaborative learning activities amongst the learners and peers [16].

Companion-aid for on-line course: The off-line archive is usable by learners as a companion-aid for either the LCMS based course or the more collaborative sharing environment of the open video-portal. This concept is particularly interesting for on-line resources such as MOOCs and distance learning programmes because learners from locations with limited bandwidth access to the INTERNET would use bandwidth for collaborative learning activities and not for watching the video lessons or downloading associated pedagogical learning material.

20.4. Discussion

The work discusses the transfer of on-line science and engineering courses for use in developing countries based on an off-lining process as described in Section 3, where the video lessons were captured directly from classroom-based teaching, and pedagogical material came from an LCMS platform. The off-lining process allows an end-user to create an off-line (mirror) copy of an on-line educational resource such as an LCMS or MOOC. Functionally, the resulting off-line version of a course may also be used as a reference aid for personal/informal learning by both students and instructors, as a classroom-aid for supporting student-teacher interactions and as a teaching aid in distance learning programmes.

In a developing country context, the off-line version is cost-effective as it does not require internet access to function and is portable enough to be used effectively anytime anywhere by end-users, without the need to host the contents on a web-server or similar computing infrastructure.

Table 20.2 presents a comparison of classroom-based, on-line and off-line versions of a course from the perspective of a learner in a developing country. The comparison focuses on learner presence, the cost of each lesson, mode of access to lessons, standards and supporting technology.

An important distinction from pure on-line or distance learning programmes is that the resulting off-line version discussed in this chapter is intended for use in conjunction with either the on-line or classroom-based course of origin or as a supporting tool for student-teacher interactions in a different institution.

20.4.1. Evaluation

The off-line archive described in Section 3 was distributed by the ICTP to over 30 academic institutions located in Africa and Latin-America for use as personal/informal learning/reference aids by students and instructors or as a classroom aid [17]. In several institutions, the "interactive video" technique was also used during classroom lessons and one institution also made the archive available on an intranet server on campus-wide local area network.

Table 20.2. Comparison of classroom, on-line and off-line courses from a developing country perspective.

Learner	Classroom course	On-line version	Off-line version
Presence	Physical presence is required.	On-line presence required for both lessons and activities.	On-line presence limited to only activities.
Total cost of each lesson.	Fees	Fees and internet cost.	Fees and reduced Internet cost.
Access to teaching material (lessons).	Scheduled periods in classroom.	Anytime, anywhere dependent on INTERNET access.	Anytime, anywhere NOT dependent on INTERNET.
Standards and supporting technology	Curriculum based lessons last between 45 and 120 minutes inside walled classrooms.	Classroom curriculum modified for on-line use. Web based system with a deployment server. Uses short (<15 minutes) video lessons, viewed from end-user web-browsers.	SAME curriculum as classroom or on-line. Does NOT require a deployment server. Supports both LONG (>15 minutes) and short video lessons using the "interactive video" technique. Only requires end-user web-browser.
Intended use	Well established learning outcomes.	Standalone tool for personal learning, blended learning or distance learning.	Aid for personal learning, blended learning and distance learning.

A survey was used to collect anonymous evaluation from 148 students and 6 instructors at two institutions, the Obafemi Wallow University (OAU), Ile-Ife, Nigeria and the Addis Ababa University (AAU), Addis Ababa, Ethiopia. The off-line archive was deployed on an intranet server located at the Computational Sciences Department of AAU, from where it was accessed (over the local network) by students from the Physics Department located in a different building and students from Engineering/Technology Faculty located in a different campus. The multi-national/multi-departmental nature of the study guaranteed national, ethnic, lingua and cultural diversity, as well as minimizing well-known effects such as socio-cultural influence, single-instructor or common institution.

At both institutions, a local contact was selected from the academicians that participated in a local pilot study carried out to establish conformance to both international and institutional standards. The author and local contacts ensured only consenting volunteers (valid students) participated in the study, without incentives, risks and disadvantages. Participants in the survey could freely choose to respond to any of the included questions. An information sheet was used to inform participants of the purpose of the study, provide assurance of confidentiality, the intended use and end-of-life of the collected data.

The majority of the participants were from the Computer Science and Engineering Department; Electronics and Electrical Engineering Department; Physics Department and

Computational Science Department. Over 74 % were undergraduate students, with 19 % female.

The data analysis technique for the open questions was based on the constant comparative method [18], this involved identifying commonalities in the answers and subsequently grouping them into separate categories before counting. The categories presented in the resulting tables below were determined based on the individual question and phrases identified in the provided responses.

The sample population were already reasonably familiar with accessing and streaming academic video lessons from on-line resources including two MOOCs (Coursera & Udacity), also YouTube & ICTP.tv, web pages from various institutions found through internet search engines. The results of the end-user's subjective evaluation covering viewing quality, content quality and effect on learning/grades are presented in Tables 20.3, 20.4 and 20.5. The data were collected from the respondents a few weeks after they were exposed to the off-line archive described in Section 20.3.

The results are suggestive of a positive impression and encouraging effects on learning. Over 75 % of the sample population later affirmed that they would recommend the off-line archive to fellow peers/students.

Table 20.3. Respondent's impression of the viewing quality of the video lessons(s)

Category	Frequency	Percentage	Notes
NONE	60	38.96	Included omitted responses
Very poor	1	0.64	Very negative comments
Poor	16	10.39	Negative comments
OK	23	14.94	Acceptable
Good	38	24.68	Positive comments
Very good	16	10.39	Very positive comments

About 50 % of the survey population were satisfied with the viewing quality, only about 11 % of the respondents had problems with the viewing quality, they commented about varying speed, slow response, bandwidth/network issues related to problems of streaming/downloading from the intranet server.

Table 20.4. Respondent's impression of the content quality of the video lessons(s).

Category	Frequency	Percentage	Notes
NONE	64	41.56	Included omitted responses
Very poor	1	0.65	Very negative comments
Poor	9	5.84	Negative comments
OK	21	13.64	Acceptable
Good	42	27.27	Positive comments
Very good	17	11.04	Very positive or excellent comments

Table 20.4 shows that almost 52 % of the survey population found the content quality adequate, only less than 7 % of the sample population felt the content quality was not good

enough. Some of the negative evaluations on content quality were from the postgraduate participants, who found contents of the off-line archive as “weak” (below their levels).

Table 20.5. Respondent’s self-assessment of effect of video lesson(s) on learning and grades.

Category	Frequency	Percentage	Notes
Cannot say	64	41.56	Declined answering
Did not help	22	14.29	Negative about it
Helped	53	34.41	Agreed grades/learning was better
Helped a lot	15	9.74	Felt helped substantively

Table 20.5 shows that about 44 % of the sample population felt either their learning or grades improved due to use of the off-line archive, while less than 15 % did not feel helped. About 41 % did not respond to the question. However, there was no attempt to correlate the data in Table 20.5 to various assessments tests/exercises undertaken by students, as use of the off-line archive (or parts of it) was voluntary and anonymous, as well as the fact that similar testing methods across different departments do not always yield comparable results.

20.5. Conclusion

This work has presented the off-lining of on-line educational resources such as Learning Content Management Systems (LCMS) and Massive Open Online Courses (MOOCs) as a viable technique for transferring on-line science and engineering courses for use in developing countries. The common-used/related technique of mirroring on-line contents generates outputs that are not suited for personal or direct off-line usage by individual end-users. The off-lining process goes beyond mirroring, and adds transformation of the on-line content for off-line usage. However, the transformation process is non-trivial when the on-line resource includes dynamic script contents.

An illustrative example that includes the transformation of dynamic script content such as an embedded JavaScript video-player into functional HTML code for direct off-line usage by end-users is discussed along with a multi-site evaluation of the resulting off-line archive by students from two African Universities.

The off-lining process may be applied to any LCMS or MOOC in a quasi-automated/customized manner and the resulting output deployed as a personal or informal learning aid, an off-line reference aid and a supporting aid for collective group learning or student-teacher interactions, capable of enhancing the use of on-line resources such as LCMS, MOOCs and distance learning programmes from developing countries or areas with limited internet connectivity.

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