Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 43 (2015) 147 – 153

Procedia Computer Science

ICTE in Regional Development, December 2014, Valmiera, Latvia

Learning Content Development Methodology for Mobile Devices

Nauris Paulins[a]*, Signe Balina[b], Irina Arhipova[c]

[a]*Department of Computer Systems, Latvia University of Agriculture, Liela Str. 2, Jelgava, LV-3001, Latvia*
[b]*Computer Science Centre, University of Latvia, Aspazijas Blvd. 5, Riga, Latvia*
[c]*IT Competence centre, Lacplesa Str. 41, Riga, LV-1011, Latvia*

Abstract

Mobile devices are becoming increasingly popular; basically mobile devices are reaching all levels of society. Thanks to the popularity of mobile devices, mobile learning has become great tool for delivering educational resources. The continuously increasing demand for mobile technology based learning materials, renders adoption of educational resources for these requirements. Technology by itself does not contribute much to education that is why the aim of this research is to present and evaluate methodology for visualisation and production of electronic materials in mobile environments. Methodology focuses on instructional design and mobile content design and the navigation control. Findings showed that given methodology and recommendations is effective for improving m-learning design across mobile devices.

Peer-review under responsibility of the Sociotechnical Systems Engineering Institute of Vidzeme University of Applied Sciences

Keywords: Mobile learning; Instructional design; Content development.

1. Introduction

Mobile devices have become a crucial part of our business processes and daily life. Devices such as smartphones or tablets connect learners to a vast source of information and enables interactivity with others nearly everywhere we go. These devices are available with great improvement in memory storage, performance and high data transfer speed, which has led to use of mobile technologies for educational purposes.

* Corresponding author.
E-mail address: nauris.paulins@llu.lv

Peer-review under responsibility of the Sociotechnical Systems Engineering Institute of Vidzeme University of Applied Sciences
doi:10.1016/j.procs.2014.12.020

Mobile learning (m-learning) can be defined as the use of mobile devices as mediator in the process of learning and teaching, what means that this use can be seen as learning from mobile and learning with mobile[1]. Classically educational resources are developed from learning objects (LO), which are stored in several repositories. Such methodology enables better design and reuse of educational content. However such methodology is mostly used in e-learning and is not so much supported in m-learning. There are several learning management systems (LMS) which deploy content for mobile users, but anyway these resources are developed for desktop environments and not for mobile devices.

Mobile technology is fundamental infrastructure to support mobile learning, but these devices have specific requirements and physical dimensions. There are specific problems that should be solved during development process, like composition of materials and visualisation of such resources. Problem is that there is huge variation of such devices. That is why there is a requirement for common methodology, which would allow creation of educational resources, for all kind of devices.

The objective of this research paper is to develop a learning content development methodology for mobile devices in order to generate educational resources from learning objects and construct LD scenarios within material.

The following sentences briefly outline the main points of the paper proposed to reach the defined goal. Section 2 discusses the requirements of learning content and it's specifics in mobile learning. Section 3 analyses concept of learning design of educational resources. Section 4 presents the developed Learning Content Development Methodology and its validation for mobile devices. The conclusion contains a summary of the main ideas of the paper.

2. Learning content

Hodgins and Duval[2] have defined LO as any digital or non-digital entity that may be used for learning, education and training. LOs are building blocks that can be combined in a virtually infinite number of ways to construct collections that may be referred to as lessons, modules, courses or curricula[3]. These are main components for Learning design construction, which are developed for a learning management systems, like Moodle. Property of granularity allows LO reusability and aggregation them into larger units. During this project LO, in context of mobile learning, was divided in five types (see Fig. 1)

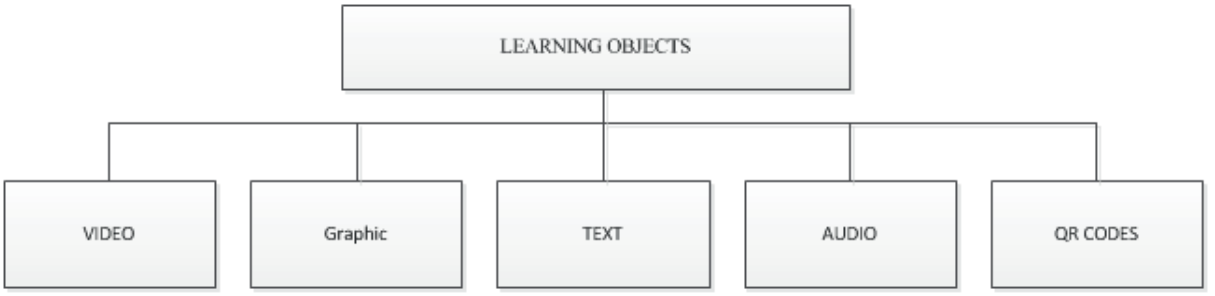

Fig. 1. Learning Objects for mobile devices.

LO were developed to address the need for high-quality and reusable educational fragments that are organized in an accessible manner[3]. LO are kept in learning object repositories (LOR) and indexed with metadata. Metadata are essential for addressing implementations of a learning object. Such concept enables discoverability, retrieval and reuse of LO[4]. In recent years, number of LORs has been developed, such as Merlot[5], Ariadne[6], Careo[7]. Most of these repositories focusing on e-learning perspective and there is no fully achieved interoperability with mobile devices.

Electronic materials for mobile learning basically are the same applications which can be developed in three different ways – like native, web or hybrid applications. Main difference between native and web applications is that native apps are installed on the device, but web apps are used through the browser. That means that native apps must be compatible with specific platform and programming languages that are supported by this platform, at the same

time web apps can support multiple OS. Problem is that web apps cannot effectively access phone hardware, like sensors which are main component for interaction with users. It could be reasonable to use third type of such applications which are hybrids. Hybrids can access the hardware; have the benefit of simpler data updates. The user can download app to the device and the app can access the API, but the content comes from the web[8].

3. Learning design for mobile devices

Designing and developing learning materials that are suitable for mobile devices may present some difficulties to researchers and educators[9]. There is a huge variety of mobile devices and platforms; therefore instructional design for mobile content requires specific adjustments[10].

LO objects must be combined in some package of instructional content. Most widely used standard for content packaging is IMS content Package, which provides aggregation of LO in learning material. Moreover it enables the delivery of learning design packages from one program to another, facilitating easier delivery, reuse and sharing of materials[11].

Important aspect of learning resources composition is Learning Design specification (LD). IMS Global Learning Consortium[12] Learning Design Specification (IMS-LD) is a specification for a metalanguage which provides possibility to model learning processes. LD is defined as: "the description of the teaching-learning process, which follows a specific pedagogical strategy or practice that takes place in a unit of learning towards addressing specific learning objectives, for a specific target group in a specific context or subject domain"[13]. It allows and enables exchange and reuse of learning design across different platforms and supports a wide range of modern pedagogical approaches such as active learning, collaborative learning, adaptive learning and competency based learning[14].

Problem is that IMS-LD based authoring tools require non-mobile platforms; it could be related to the limitations of authoring IMS-LD in mobile environments. IMS-LD has no adequate mobility support and there is no mobile theory of learning which is widely accepted. There are some limitations which are connected with physical aspects of mobile technologies as well. Mobile devices have a lot of integrated hardware sensors which must be supported in material for effective interaction between a learner and learning content.

Important part of interaction between a learner and material is visual design of the content. Mobile devices have several limitations, which also require some specific adjustments. The biggest difference between a desktop and mobile computing device is its size. At the same time although these devices are smaller, learners expect participatory content experiences. Learners also are very mobile, they are using content on multiple devices, but they still want materials to be trusted and sharable.

There are two modes of multiscreening – sequential usage when moving from one device to another at different times to accomplish a task and there is simultaneous usage when learners using more than one device at the same time for either a related or an unrelated activity[15].

That means that content should be served during material runtime. There is a necessity to use some LMS that could retrieve LO form repository, package them in single material and then wrap that material in a visual form. At the same time it must support cooperation with mobile sensors and provide learner centred experience. But this does not mean that content should be used just in LMS, it is just necessary to use an application that could serve content in appropriate form.

4. Proposed methodology and its validation

Proposed methodology is composed of several components and includes main steps which could solve research questions and could become as conceptual tool for mobile learning content authoring tool (see Fig. 2).

This methodology shows how m-learning development components should interact. The methodology includes full life cycle and best practice for development m-learning content and reusing and redesigning existing LO for mobile platforms. There are several guidelines that offer answers to some m-learning questions; all steps of instructional design to provide assistance in m-learning development were included during this project.

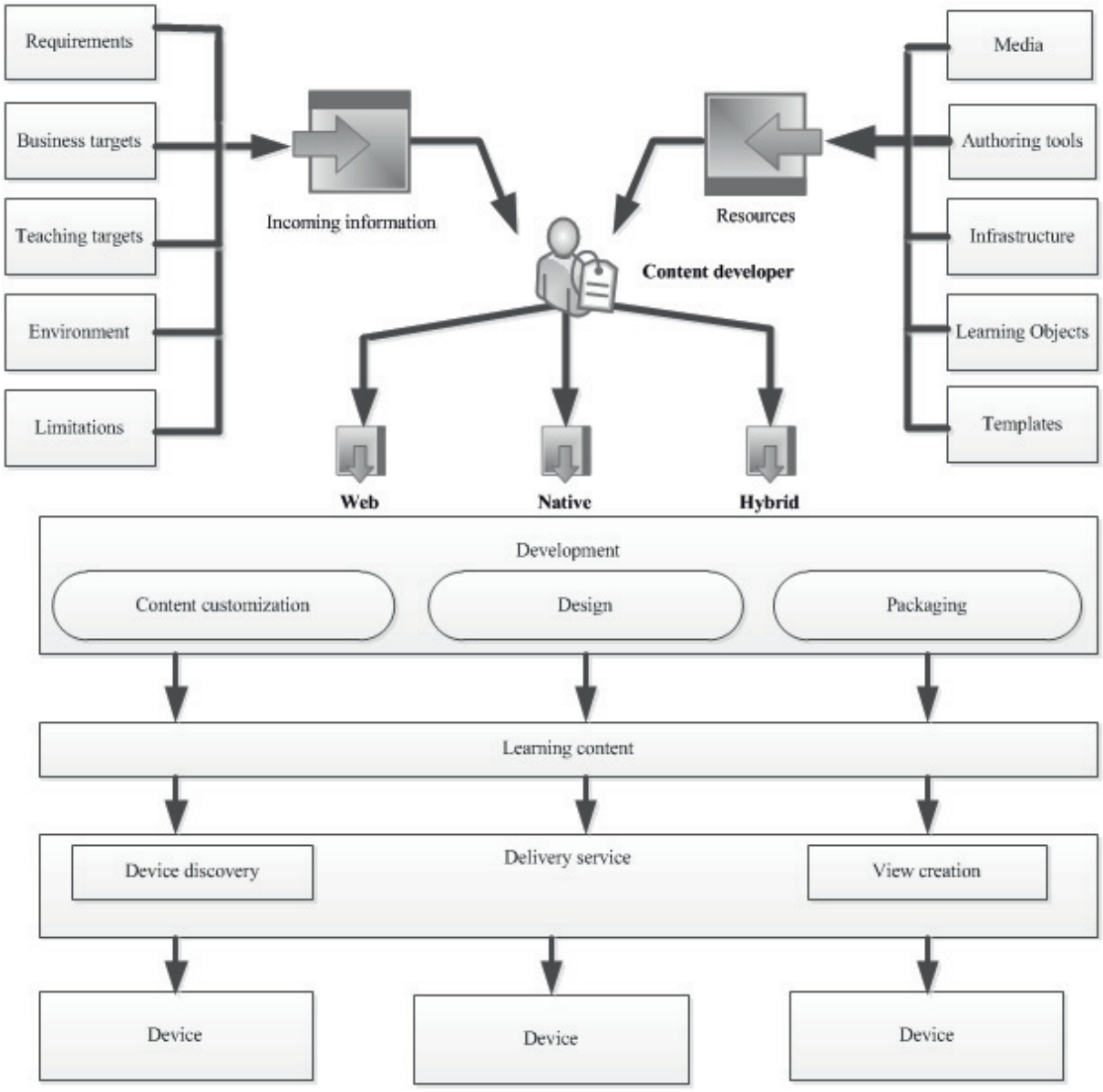

Fig. 2. Learning content development methodology for mobile devices.

4.1. Incoming information and resources of mobile device learning content development

Mobile computing devices have included technologies that are transportable. That is essence of mobile learning – accessing information and knowledge anywhere, anytime from devices that learners are used to "carrying everywhere with them" and that they "regard as friendly and personal"[16]. Mobile technology based learning mostly focuses on user support and activity based learning, leading experts in this field have mentioned several advantages over traditional e-learning[17]:

- Ability to provide ubiquitous and on–demand learning opportunities which are unconstrained by the learners actual location;
- Ability to provide real-time job aids, such as checklists and calculators, which reduces learners need to memorize factual information and to perform complex mental calculations;
- Ability to democratize the learning process by connecting learners with experts and one to another in real time.

These advantages show that there is a huge variety for usage of mobile devices, but at the same time it is necessary to analyse the space for mobile learning. Any development starts with requirements which define how m-learning solution is designed and developed. Requirement analysis is one of the most important steps during development process. Most of clients are not so comfortable in the field of technology, and requirements may not be completed at one time and so this process must be repeated several times. Information gathering also provides information about potential learner working space, business and teaching targets.

It is important to remember that mobile devices may not be effective in all situations, so it is necessary to recognize possibilities of mobile devices. So it is possible to avoid form problems if these barriers are considered at early stages of material development. The aim of the incoming information is to provide effective solution analysis before real development process.

When instructional designer or developer receives requirements and additional information about learning targets, they can perform solution analysis and project development. But for development process it is necessary to use variety of resources. In most cases content developers already have some LO repositories, but mobile learning exists in variety of forms, so it is necessary to redesign existing content or prepare some new content. Content redesigning for specific project requires extra effort and time; it can be done for specific project but not for enterprise solutions.

During this project learning content was kept on the server and project scalable multimedia platform was used. This platform was introduced by Goh and colleges[18]. That is integration of transcoding non-scalable media content into scalable media content. On this platform it is possible to scale spatial resolutions, bit-rate and visual quality of media. So it is possible to adjust media objects on the server for delivery and playback on the learner's device.

Authoring tools that are used for content development must be compliant with educational standards – IMS Learning Design specification, IMS Content Packaging specification, and IMS Meta-data specification. For better content delivery there are already several templates which can wrap material in defined design and form. Templates are used in mobile application which runs as client on the smartphone.

4.2. Content development and delivery process

Development process is divided in several stages. As already mentioned there is LO repository that is transcoded according to device requirements. Before content packaging necessary resources are located and included in learning design XML file. There are three types of content what are used for transcoding – images, video and audio. System generates HTML and XML content according to the IMS defined standards and bundles generated learning content in designed templates, basically it is package interchange file. For interaction with content Java or JQuery can also be used, but there are problems with Flash which is not as flexible as previous languages. Templates consist of several containers which can be dynamically changed according to device requirements and technical solutions. These containers basically provide interaction between a learner and the material and in the same time it is easier to separate content from formatting. If content development is separated from delivery process, changes and updates in content can be made at any time. During the project hybrid form of material was used, but content can be developed as well in native or web formats, so all three types of development are included in the methodology.

Mobile content delivery is aiming to provide structured and adequate content which is suitable for developed learning scenario. There are two parts in content delivery – a client application and a server application. The client application works on mobile device as separate application, but server part is responsible for content generation and preparation. The client side application is user interface and at the same time it can cooperate with learning device sensors and its platform. The server uses HTTP and TCP/IP protocols for interaction with a client it also stores educational content properties, IMS-LD files, and another information, which is necessary to serve appropriate content to the client side.

First task for the server is detection of device capabilities. During design process several educational scenarios are prepared, when the learner requests some content it is delivered according to learner's device capabilities (see Fig. 3). During project adoption of content for sound formats, image formats and sizes, video formats and resolutions was made. Server also stores device configuration repository, so it is easier to predict necessary configuration for appropriate learning scenarios.

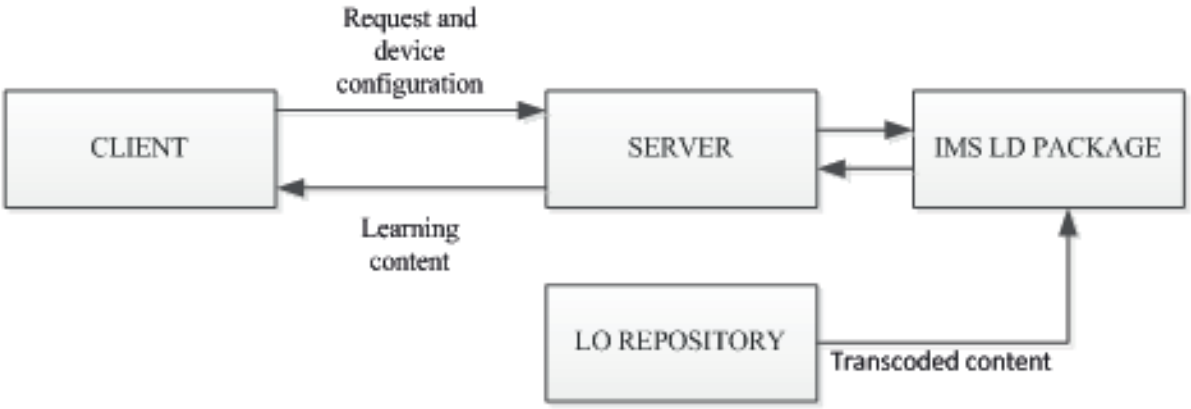

Fig. 3. Server side learning content delivery for mobile devices.

Another part of content serving is collection of information about learning process. Content package can show or hide some material according to the rules that are defined in educational scenario, so it is possible to provide some extra flexibility of educational content. For better content adoption it is necessary to collect some information about learning process and learning situation. During design process LO is assigned with metadata according to IEE/LOM standard[2], metadata allows to join LO to the scenario and also manipulate with them during material runtime. Metadata can be collected from learners through specific forms, but it can also be generated in the system according to the learning situation so it would minimize user input and speed up learning process.

4.3. Validation

To confirm that proposed methodology is compliant with instructional design and standards, it has been evaluated by technology designer experts from joint stock company "Datorzinibu Centrs"[19]. This company is one of the leading software development, e-learning and IT training companies in Latvia, and its service quality is confirmed by ISO 9001:2008 quality certification. Currently company "Datorznibu centrs" has its own collection of learning objects which is indexed with metadata and LMS. Experts involved in the project were able to design learning material which is packaged in IMS-LD compliant material and could be wrapped in m-learning course. Experts validated content compliance with companies LMS and structure of the package. Package elements were successfully processed in companies LMS, content package could be implemented in m-learning course or could be processed as single unit.

5. Conclusion

This article has presented methodology for learning content development, which could be compatible with all kind of mobile devices. Mobile devices compose different hardware and software, so even e-learning content development and m-learning content development have some similarities, the process of mobile learning content requires some specific adjustments. Mobile content must be able to support interaction with device and user's mobility. There are also extra requirements for media files, because mobile devices typically have different resolutions, screen sizes and performance.

Mobile learning is still a new territory for designers and developers; during the research the decision was made that development process should be separated from delivery. This makes it easier to change the content and update the technical solutions. In such manner delivery process can be more dynamic and can provide better content adaption to user devices.

Further research of this project will be focused on content delivery according to the learning context. The ongoing work is being done on methodology transformation to real development tool which could provide educational resource creation in a mobile context and sharing between most of mobile devices. There is still a research needed to reveal appropriate technologies and pedagogical approaches which could remove the barriers to educational diversity.

Acknowledgements

This research is part of a project „Competence Centre of Information and Communication Technologies" run by "IT Competence Centre" Ltd, contract No. L-KC-11-0003 co-financed by European Regional Development Fund. More information sees on http://www.itkc.lv/?lang=en.

References

1. Al Hamdani, D.S. Mobile Learning: A Good Practice, Procedia - Social Behavioral Sciiences, Vol. 103; 2013. p. 665–674. doi:10.1016/j.sbspro.2013.10.386.
2. Hodgins W., Duval E. 1484.12.1-2002 - IEEE Standard for Learning Object Metadata, 2002. Retrieved 20.10.2014, URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1032843&isnumber=22180.
3. Chikh, A. A general model of learning design objects, Journal of King Saud Univeristy – Computer and Information Sciences, Vol. 26, 2014. p. 29–40. doi:10.1016/j.jksuci.2013.03.001.
4. Roy, D., Sarkar, S., Ghose, S. A Comparative Study of Learning Object Metadata , Learning Material Repositories , Metadata Annotation & an Automatic Metadata Annotation Tool, Vol. 2, 2010. p. 103–126.
5. Merlot, Multimedia Educational Resource for Learning and Online Teaching, 2009. Retrieved 12.10.2014, URL: http://www.merlot.org.
6. Aradne Foundation, ARIADNE, 2014. Retrieved 12.10.2014, URL: http://ariadne-eu.org/.
7. Careo project, Campus Alberta Repository of Educational Objects, 2014. . Retrieved 12.10.2014, URL: http://careo.org/.
8. Lentz M., Carson B. Designing Content for Multiple Mobile Devices, Learning Solutions Magazine, 2012. Retrieved 10.06.2014, URL: http://www.learningsolutionsmag.com/articles/1018/designing-content-for-multiple-mobile-devices.
9. Alvarez, C., Alarcon, R., Nussbaum, M.. Implementing collaborative learning activities in the classroom supported by one-to-one mobile computing: A design-based process, Journal of Systems and Softwar, Vol. 84, 2011. p. 1961–1976. doi:10.1016/j.jss.2011.07.011.
10. Güler, Ç., Kılıç, E., Çavuş, H. A comparison of difficulties in instructional design processes: Mobile vs. desktop, Computer Human Behavior, Vol. 39, 2014. p. 128–135. doi:10.1016/j.chb.2014.07.008.
11. Wilson, S., Currier, S. What Is IMS Content Packaging?, CETIS Briefing Paper, 2002.
12. IMS, IMS GLOBAL Learning Consoritum, 2014. Retrieved 12.10.2014, URL: http://www.imsglobal.org.
13. Gómez, S., Zervas, P., Sampson, D.G., Fabregat, R. Context-aware adaptive and personalized mobile learning delivery supported by UoLmP, Journal of King Saud University. – Computer and Information Sciences, Vol. 26; 2014. p. 47–61. doi:10.1016/j.jksuci.2013.10.008.
14. Koper, R., Olivier, B. Representing the Learning Design of Units of Learning, Educational Technology&Society, Vol. 7; 2004. p. 97–111.
15. Google, The New Multi-screen World: Understanding Cross-platform Consumer Behaviour, 2012. Retrieved 18.10.2014, URL: http://think.withgoogle.com/databoard/media/pdfs/the-new-multi-screen-world-study_research-studies.pdf.
16. Gikas, J., Grant, M.M. Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media, Internet Higher Education, Vol. 19; 2013. p. 18–26. doi:10.1016/j.iheduc.2013.06.002.
17. Quinn, C.N. Designing mLearning: Tapping into the mobile revolution for organizational performance, The eLearning Guild, 2011. Retrieved 22.10.2014, URL: https://commons.lbl.gov/download/attachments/77828943/mobile2011report-f2.pdf.
18. Goh, K.H., Tham, J.Y., Zhang, T. Context-Aware Scalable Multimedia Content Delivery Platform for Heterogeneous Mobile Devices, The Third International Conferences on Advances in multimedia, 2011. p. 1–6.
19. Datorzinibu centrs, About us, 2012. Retrieved 12.10.2014, URL: http://www.dzc.lv/en/par-mums/