Learning Assessment for Different Categories of Educational Multimedia Clips in a Mobile Learning Environment

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Abstract: As the amount of educational multimedia content being created is increasing at a fast pace, it is becoming increasingly difficult to navigate this content and provide e-learners in general and mobile learners in particular with the most relevant content. This paper proposes a classification of educational multimedia clips into six generic categories based on their particularities. The classification has the potential to enhance the existing solutions for educational multimedia content retrieval, adaptation and personalisation based on learners' preferences and their device characteristics. The paper also presents the results of a subjective case-study that aimed to investigate the suitability of the proposed categories of educational clips for mobile learning.

Introduction

The increasing adoption of mobile technologies have contributed to a fast growth in mobile learning (m-learning) over the past few years with a global market for m-learning services expected to grow from $3.2 billion in 2010 to $9.1 billion by 2015 (Ambient Insight, 2011). At the same time there has been a fast growth of multimedia services, with mobile video being estimated to increase 16-fold between 2012 and 2017, and to reach 66% of the global mobile Internet traffic by 2017 (Cisco Systems, Inc., 2013).

Following the same trend, educational multimedia content has started to be increasingly used in education from improving learning through a richer display of information, to delivering lecture recordings to online learners (Kaufman & Mohan, 2009).

The exponential growth in multimedia content creation and consumption, increases the need for automatic multimedia classification, indexing, search and retrieval solutions, that are necessary to help users in general and mobile learners in particular to navigate the huge amount of multimedia content and find the most relevant for them (Yang, Zha, Shen, & Chua, 2013).

Multimedia classification in particular is considered to represent a necessary step of multimedia indexing. The latter in turn is primarily concerned with the multimedia content organisation from a database perspective, and aims to enable more efficient and accurate retrieval of the content requested by the user. This is enabled by sorting the content into different categories by attaching meaningful labels that define their genre (e.g., 'sports', 'news', 'commercials', 'movies', etc.), or subgenre (e.g. 'football', 'tennis', 'basketball', etc., in case of the sports genre) (Hu, Xie, Li, Zeng, & Maybank, 2011).

While considerably much more research has been conducted on classification, indexing and retrieval solutions for multimedia content in general, their usefulness to online learning has also been increasingly recognised, with a number of indexing solutions targeted to e-learning having been proposed (Liao, Tsai, Su, Li, & Yu, 2011; Yu, Liao, Su, Cheng, & Pai, 2012). However, few attempts to classify educational multimedia clips into generic categories have been previously made based on their characteristics from a learning perspective.

In this context, this paper proposes a classification of educational multimedia clips into six generic categories. Together with automatic indexing and retrieval solutions, the classification presents usefulness for multimedia content adaptation and personalisation based on learner's preferences and/or learner's device characteristics such as for example the device screen resolution or the device battery energy level (Moldovan & Muntean, 2009, 2011, 2012; Moldovan, Weibelzahl, & Muntean, 2014).

The next section presents the six proposed categories of educational multimedia clips and their characteristics. Following that the methodology and results of the subjective case study are presented, while the last section draws conclusions and presents future work directions.

Proposed Categories of Educational Multimedia Clips

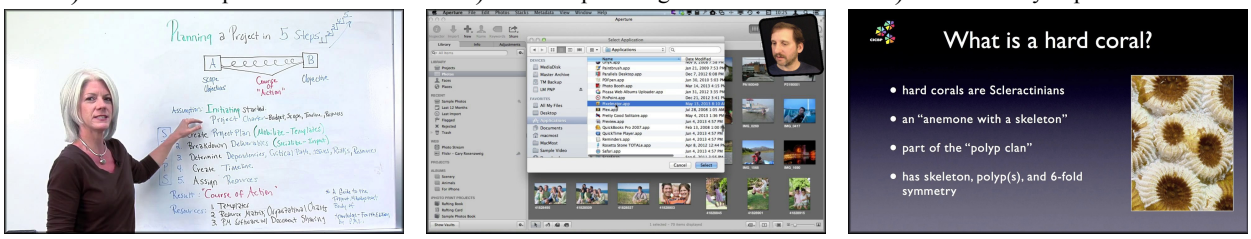
This section presents the proposed categorisation of educational multimedia clips. Six categories of educational clips are proposed, namely: *animations*, *demos*, *documentaries*, *presentations*, *screencasts* and *slideshows*. These categories were identified by analysing over 1500 educational multimedia from more than 200 collections that are available on the Internet through iTunes U[1] and YouTube Education[2] multimedia services. The characteristics of the six categories of educational multimedia clips are presented in Table 1.

Table 1: Proposed categories of educational multimedia clips.

Category	Description and Particularities
Animations	• Clips from this category are characterised by being computer generated; • Often present phenomena that would be very difficult or impossible to capture on camera and help to understanding them (e.g., physics concepts such as electromagnetic force, reactions between various chemical elements, travel of oxygen in human body, etc.). • May present recordings of computer generated virtual worlds such as educational games or virtual learning environments. • Infographics are another type of animations that have also become popular recently (Bellato, 2013); • The dynamicity as well as the level of details of the various clips belonging to this category, including scenes of the same clip may vary broadly.
Demos	• Clips from this category present live demonstrations, in which a person explains and performs different activities/experiments (Doijad & Kamble, 2013); • Some sort of equipments are usually present (e.g., chemistry/ physics/ engineering lab equipments, cooking equipments, etc.); • Camera angle shift from a wider view of the demonstrator and the equipments, to close shots focused on the equipments, demonstrator's hands, etc.
Documentaries	• Clips from this category are intended to document some aspects of reality, such as contemporary education issues (Hurley, 2011), college and campus life presentation, student projects, nature documentaries, etc.; • They are usually characterised by a higher number of scene changes; • The different scenes may be unrelated and can be filmed across different indoor or outdoor locations; • Individual scenes/ sections of the same documentary clip may be classified to belong on one of the other five categories of educational clips; • \item The dynamicity and the level of details may also differ a lot between different scenes.
Presentations	• Educational clips from this category are mainly characterised by the presence of one or more human persons, with specific examples being interviews and lecture recordings (Wieling & Hofman, 2010); • Usually present a slow changing background (e.g., text on a whiteboard, projected slides, overlaid text/graphics, etc.); • The person(s) can gesticulate (e.g., point to particular information displayed, write on a whiteboard, etc.), or they are more static such as in case of interviews; • The camera focus can change from a wider view of the room, to close-up shots of the person(s); • Usually present a lower level of dynamicity and scene changes.
Screencasts	• Educational clips from this category comprise recordings of the computer screen usually accompanied by audio explanations, and have become increasingly used for informal learning and in Higher Education (Wakeman, 2013); • They provide very specific guidelines on how to perform different tasks or use different computer programs and applications; • They are usually characterised by high level of spatial details (e.g., text of program menus); • They are usually static clips with fewer scene changes and dynamic elements (e.g., mouse cursor movement, menu open, etc.).
Slideshows	• Clips from this category mainly consist of a sequence of slides accompanied by audio narration; • Their level of details may vary depending on the information presented (i.e., image slideshow, slides with text, slides with text and images, etc.). • They usually static clips, with the level of dynamicity being mainly determined by the speed at which the transitions between slides occur and/or the various effects applied (e.g., zoom in/out, fade in/out, rotate, etc.).

[1] [] Apple iTunes U, http://www.apple.com/education/ipad/itunes-u.
[2] [] Education - YouTube, http://www.youtube.com/education.

a) Animation clip 'AtomSize' b) Demo clip 'NitrogenIceCream' c) Documentary clip 'ArtOfBook'



d) Presentation clip 'ProjectPlanning' e) Screencast clip 'PhotoEditing' f) Slideshow clip 'CoralsIntro'

Figure 1: Representative frames for the six educational multimedia clips used in the subjective case study.

Case Study

A subjective study was conducted in order to analyse the suitability of the proposed six categories of educational clips for mobile learning. Mobile devices vary greatly in terms of their characteristics and capabilities. In particular, the screen resolution is an important characteristic that determines the clarity of the video details, mobile devices with a higher screen resolution being capable to display higher resolution videos and thus more detailed. The hypothesis of this study is that some categories of educational clips, in particular those with high level of spatial details due to video elements that are important for learning (e.g., text that is mainly present in case of screencasts, slideshows, presentations), are less suitable for learning on mobile devices. Two mobile devices a smartphone and a tablet having different screen size and screen resolution were used in the subjective case study.

Educational Clips

Six high-quality educational multimedia clips with different content characteristics were used for the subjective case study. The six clips are representative for the broad spectrum of educational multimedia clips, each of them corresponding to one of the six proposed categories. Figure 1 presents representative frames for the six multimedia clips used in the study, while a brief description of the clips is provided below:

- *AtomSize*[3] – Animation clip explaining the size and density of an atom by making comparisons between the size of objects such as blueberry and Planet Earth; the clip was published by TEDEducation.
- *NitrogenIceCream*[4] - Demo clip demonstrating how you can make ice cream using liquid nitrogen to fast freeze the ingredients; the clip is part of On Networks' Food Science series presented by Dr. Kiki Sanford.
- *ArtOfBook*[5] – Documentary clip about the Center for the Book program at the University of Iowa; the clip is part of Iowa Magazine Segments collection on iTunes U.
- *ProjectPlanning*[6] – Presentation clip explaining project management planning in five steps; the clip was produced by ProjectManager.com.
- *PhotoEditing*[7] – Screencast clip explaining how to set iPhoto and Aperture programs in Mac OS to use other external programs for more advanced editing of photos; the clip was produced by MacMost.
- *CoralsIntro*[8] – Slideshow clip giving an introduction to corals and the skeleton they create; the clip is part of the Coral Finder Toolkit training movies of the Coral Identification Capacity Building Program.

[3] [] Just How Small Is an Atom? - Jonathan Bergmann, http://ed.ted.com/lessons/just-how-small-is-an-atom.
[4] [] Liquid Nitrogen Ice Cream - Food Science, http://blip.tv/food-science/liquid-nitrogen-ice-cream-4846598.
[5] [] The Art of The Book, http://itunes.apple.com/itunes-u/iowa-magazine-segments-hd/id413518586.
[6] [] Five Steps to Project Management Planning, http://www.projectmanager.com/5-steps-to-project-management-planning.php.
[7] [] MacMost Now 893: Editing Photos In External Editors, http://macmost.com/editing-photos-in-external-editors.html.
[8] [] Introduction to corals, http://www.coralhub.info/learn/coral-finder-toolkit-training-movies/cft3-introduction-to-corals.

Since the six educational clips were too long as they were originally (i.e., between 5 and 20 min long), shorter test sequences corresponding to various learning concepts were extracted to be used in the subjective study. Two test sequences of approximately 30 sec in length were extracted from each of the six clips.

Methodology

A pre/post-test assessment was conducted in order to evaluate the participants' knowledge before and after viewing the educational multimedia clips. In the beginning of the testing session, each participant was provided with written and verbal instructions about the purpose of the study and the structure of the testing session. After that the participants completed a demographic questionnaire and the pre-test questionnaire. The pre-test questionnaire was presented in a pen and paper format and consisted of six single-choice closed questions (one for each of the six educational clips). As the questions were highly specific to the clips, a non-response type choice, i.e., "I don't know", was also included in order to minimise the number of correct answer guesses. Before starting the actual testing, the participants were provided with a brief training to familiarise them with the testing procedure.

Following the training each participant had to view one by one the 12 test sequences and answer the post-test questionnaire. The post-test questions were also single-choice type, but the non-response choice was not included. A total of twelve post-test questions one for each educational test sequence were used. The participants had to answer each question immediately after viewing the corresponding test sequence, in order to minimise the forgetting impact. The post-test questions were displayed and answered by the participants on the device screen by building an Android application for testing purposes.

One sequence from each clip was viewed by the participants on a smartphone device (i.e, a Samsung Galaxy SII having a 4.3 inch screen with a 800×480 pixels resolution), while the other sequence from each clip was viewed on a tablet device (i.e., a Google Nexus 7 having a 7 inch screen with a 1280×800 pixels resolution). The test sequences were resized at a video resolution suitable to the mobile device display resolution. To minimise any effects such as tiredness on the post-test results, the two devices were randomised between participants, while making sure that half of them viewed the clips and answered the questions on the smartphone device first and the other half on the tablet device first. Furthermore, the six test sequences corresponding to a particular device were also displayed in a random order between participants.

Thirty participants (M = 22, F = 8) with ages between 20 and 32 years old (AVG = 26), have participated in the subjective case study.

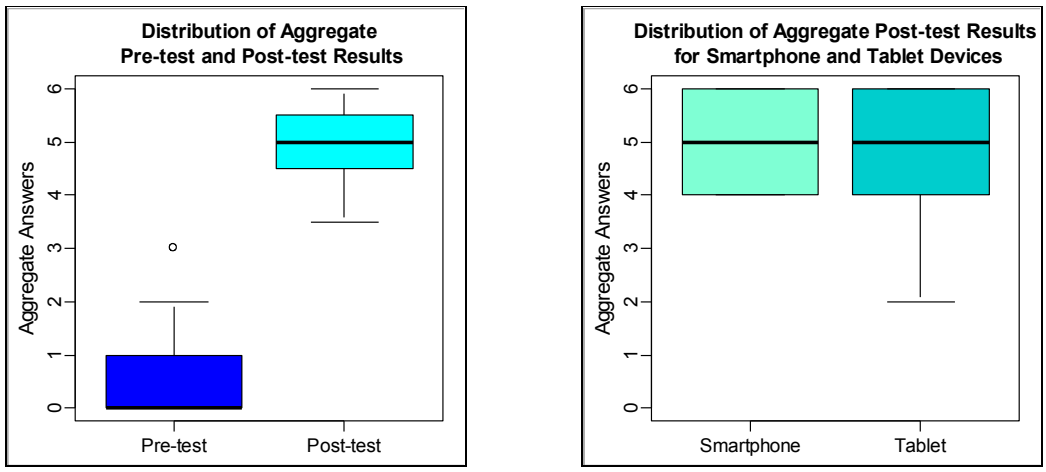
Results

Impact of Visualising the Multimedia Content and of the Device Type

Figure 2a presents the boxplot distributions of the aggregate pre-test and-post questionnaire scores. For the pre-test questionnaire the aggregate scores were computed as the number of correct answers across the six categories of educational clips for each participant. For the post-test questionnaire, the aggregate scores were computed as the number of correct answers across the 12 questions (i.e., six on the smartphone and six on the tablet) divided by two in order to maintain the same scale.

The results for the pre-test questionnaire indicate that the participants were in general not familiar with the educational clips they were about to see, as very few of them were able to answer correctly the pre-test questions. In average across the 30 participants the aggregate pre-test scores were 0.57 (SD = 0.82). The results for the post-test questionnaire showed that the participants gained knowledge in the short time after viewing the educational multimedia clips as they were in general able to answer the post-test questions related to the educational concepts presented in the clips. In average across the 30 participants the aggregate post-test scores were 4.97 (SD = 0.63). Furthermore, the results of a Wilcoxon-Mann-Whitney non-parametric equivalent of student's t-test, indicate with 99% confidence that there is a statistically significant difference between the pre-test and post-test results ($p < .001$).

Figure 2b presents the boxplot distributions of the aggregate response scores across the post-test questions for the smartphone and tablet devices. The results show similar performance across the two device types, with the average aggregate post-test answering score across the 30 participants being 5 (SD = 0.83) for the smartphone device, and 4.93 (SD = 0.98) for the tablet device. The results of a Wilcoxon-Mann-Whitney non-parametric t-test, indicate with 99% confidence that there is no statistically significant difference between the post-test results for the two devices ($p = 0.834$).



(a) (b)

Figure 2: Boxplot distributions of the aggregate correct response scores:
(a) pre-test vs. post-test results; (b) post-test results for smartphone vs. tablet devices.

Impact of the Educational Clip Category

Figure 3 presents the pre-test and post-test results across the different categories of educational multimedia clips. The figure reports the results in terms of the number and the percentage of correct answers. The results of the pre-test questionnaire show that in average across the 6 questions, only 9% of the total number of answers provided by the 30 participants was correct. Individually across the 6 clips, 20% of the pre-test answers were correct for the Animation clip, 27% for the Demo clip, 3% for the Documentary clip, 7% for the Presentation clip, and no pre-test answers were correct for the Screencast and Slideshow clips. The higher number of correct answers for the NitrogenIceCream clip could be explained by the fact that the question asked if it is possible to make ice cream using liquid nitrogen, being more intuitive for the participants to choose the correct answer (i.e., it is possible).

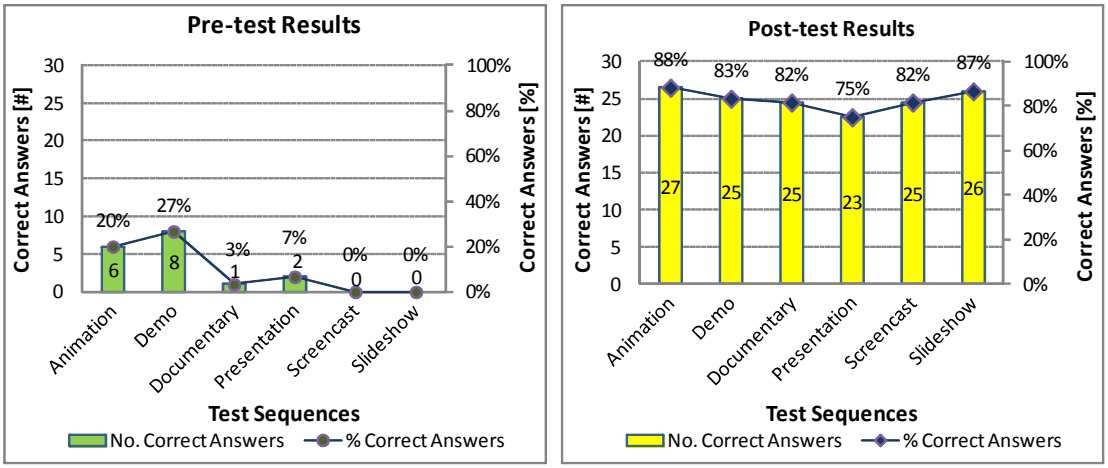


Figure 3: Results for the pre-test and pre-test questionnaires across the different educational clip categories.

The results for the post-test questionnaire show high correct answering rates, with 83% of the total number of answers provided by the 30 participants being correct. Looking individually across the six educational multimedia clips, for all of them at least 75% of the post-test answers were correct (i.e., 88% for the Animation clip, 83% for the Demo clip, 82% for the Documentary clip, 75% for the Presentation clip, 82% for the Screencast clip, and 87% for the Slideshow clip). While the results also show that the post-test correct answering rates are smaller for the presentation clip which presents small text, no statistically significant difference between the post-test results for the six educational multimedia clips was found.

Conclusions

This paper proposed a categorisation of educational multimedia clips into six different categories: animations, demos, documentaries, presentations, screencasts and slideshows. The classification presents usefulness enabling automatic personalisation and adaptation of educational multimedia clips based on learner's preferences and their device characteristics. A pre/post-test subjective case study with 30 participants was conducted in order to assess the suitability of the different categories of educational clips for mobile learning on devices with different screen size and resolution. The results have shown that at least in short term, educational videos lead to knowledge achievement, with the average correct response rate increasing from 9% in case of the pre-test questionnaire to 83% in case of the post-test questionnaire. The results also showed that the educational content introduces the highest variation in terms of knowledge achievement, with different correct response rates being achieved for different educational clips both in case of the pre-test and post-test questionnaires. Moreover, the results have showed that the device type has little impact on the knowledge achievement, as no statistically significant difference was found between the post-test results for the smartphone and tablet devices used in the subjective case study. Future work will continue to investigate how mobile learners achieve knowledge form different categories of educational clips and if knowledge achievement is influenced by factors such as their interest in the clips.

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