Client-Server Adaptive Model for Using Multimedia in Science Education at Universities

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Abstract

Recently, the use of multimedia in education, particularly science education has been a powerful factor in the learning process. Universities and higher education institutes, especially in the developing countries (e.g., Palestine) suffer from the limited laboratories' resources (e.g., 3D and 4D microscopes). On the other hand, the evolving recent science studies (e.g., molecular dynamics at femto-scale), [5] DNA deformation [4] necessitated the use of empirical examples to demonstrate the concept and reduce the ambiguity. In a consequence, the students' learning and research performance in science courses have dramatically declined. One of the promising solutions is the use of visualization and multimedia in learning. Multimedia may not replace the necessity of using the real labs. However, in some applied science courses (e.g., Introduction to cell biology) the smart use of it will play a leading role in the learning process. Therefore, in this paper we suggest an adaptive, low cost, and scalable model for using multimedia in science courses. This study has shown that using multimedia in an efficient and attractive manner noticeably increases the students' academic performance and gains about 69% saved costs of building real labs.

Key words— Multimedia, adaptive, client server, science education.

1. INTRODUCTION

This paper addresses the importance of using multimedia in science education and its role in illustrating complicated concepts. Furthermore, it suggests a client-server adaptive model that can smartly deliver and update the multimedia materials based on the course contents. Before exploring the potential of multimedia in education and the model benefits, we illustrate some preliminaries and definitions. [2] Various studies have suggested different definitions for multimedia. The first study defines [1] it as computer information that can be represented through audio, video, and animation in addition to traditional media (i.e., text, graphics drawings, images and videos); another definition [3] says that it is the field concerned with the computer-controlled integration of text, graphics, drawings, still and moving images (video), animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed digitally. Consequently, multimedia application uses this collection of multiple media sources e.g. text, graphics, images, sound/audio, animation and/or video to illustrate a message or some concept in some situations where science laboratories are not present. Figure 1 illustrates how multimedia can create in some sense a virtual lab. Hence, various empirical examples of multimedia applications in education have been reviewed and they are namely: CyberMath, Frog Dissection, Yahooligans, Scientific American, Discovery Channel On-Line and Dareware. [[2] [3]

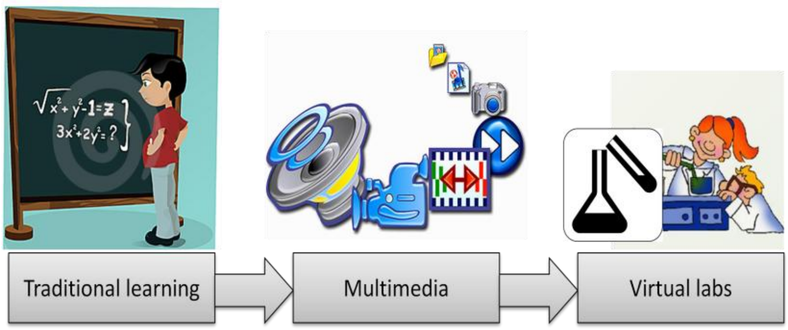

Figure 1. Multimedia in Science Education

On the other hand, science education is the field concerned with sharing science content and process with individuals not traditionally considered part of the scientific community.

2. MULTIMEDIA EFFECTS ON SCIENCE EDUCATION

To examine the effects of multimedia in education, the following points should be considered as some existing studies also empathize [6] [7]: (a) the screen design: the screen design has a significant impact on the multimedia design being used for education. In one of the related studies [8], the definition of screen design extends to include the coordination of textual and graphics elements to present a sequenced content to ease the content explanation. While the educational content may differ from one situation to the next, another study [9] stated that the screen must provide appropriate instructions, attractive navigation tools and visual aesthetics. (b) The feedback and interactivity: interactivity is described [6, 10] as the stimulus response reinforcement when an action is being encountered in an integrated form between the learner and the content. (c) The use of video and audio elements: it has been shown in [6, 7, and 11] that the video may not be the ideal medium in the learning process, particularly in explaining detailed contents. However, the video may become an attractive tool in explaining abstract material, possibly with an emotional appeal. On the other hand, the audio may become useful if it supports the textual information within the content and can be interrupted (i.e., paused) by the students to repeat or pause the sound [12]. Consequently, to explore the effects of these tools on the institutions performance, we consider the learners (1) and the university perspectives. From the learners' perspective, using multimedia in science education helps them increase their attention and feel more interested to ask and infer. Empirically, we have found that after using various multimedia tools in one of the scientific lab courses noticeably enhanced the students' academic performance. To see the effect, Figure 2 shows that using Multimedia Teaching Aid (MTA) has helped the students gain higher scores due to the use of multimedia in illustrating some empirical examples.

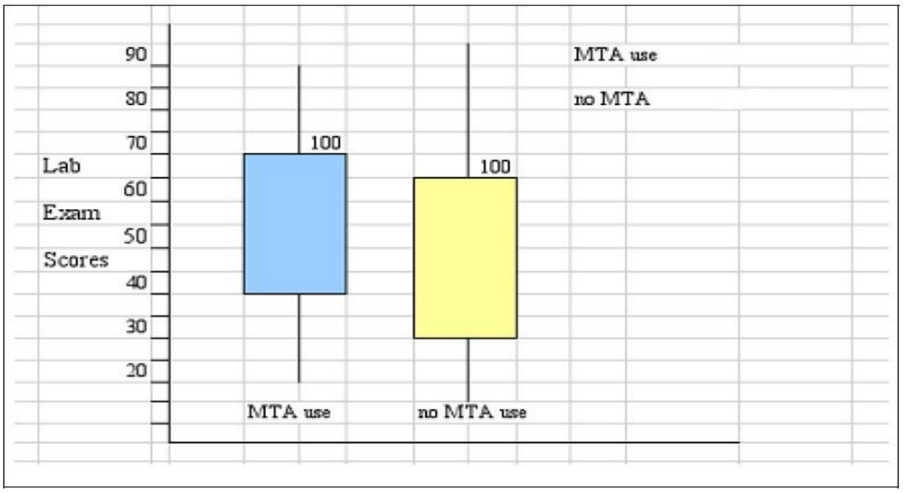

Figure 2. Students' academic performance

Whereas from the university or institute perspective, using multimedia in some courses leads to costs savings in building real labs. Table 1 and Table 2 explore the costs of both using real labs and using multimedia in science courses respectively.

Table 1. Estimated costs of molecular biology lab

Equipments	Cost
Microcentrifuge	$1500
Pippetors	$300
Gel Box	$500
Powerpack	$500
Heating apparatus	$600
Incubator	$2000
Transilluminator	$700

[1] Learners and students are used interchangeably in this paper

PCR machine	$2000
Place	$1000
TOTAL COST	$9100

Table 2. Estimated Costs for multimedia virtual molecular biology lab

Equipments	Cost
Technical's	$1000
laptop	$700
Software for Design	$300
TOTAL COST	$2000

3. CLIENT-SERVER ADAPTIVE MODEL

In this model, as shown in Figure 3, we suggest that a multimedia server is offered by the course. This server contains the multimedia materials (i.e., videos, images, audios, animations…etc). In addition, the server is updated in three ways and they are: 1) manually, where the administrator or the course tutor can add the materials based on the course contents. 2) Learners' contribution, where the learners are engaged to add their own multimedia materials to the server after their tutor's approval. In this case, the cost of developing materials might be reduced. 3) Adaptive update, where the server can be connected to the Internet, particularly to some multimedia websites.

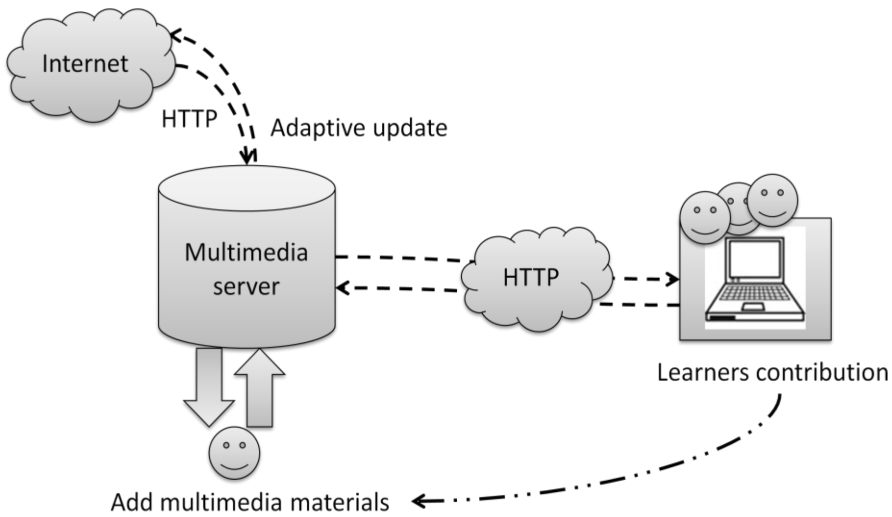

Figure 3. Proposed client-server model

In a consequence, the installed program on this server crawl these websites for new multimedia resources (e.g., Images) based on the course's content and adaptively adds them to the server contents after downloading them from the crawled websites. Furthermore, as shown in Figure 4, the administrator can provide the server with some details in order to update the server via crawling specific links and determine the crawling (i.e., updates) intervals or simply letting it automatically updates. This mechanism aims at organizing the use of multimedia in an effective and efficient manner.

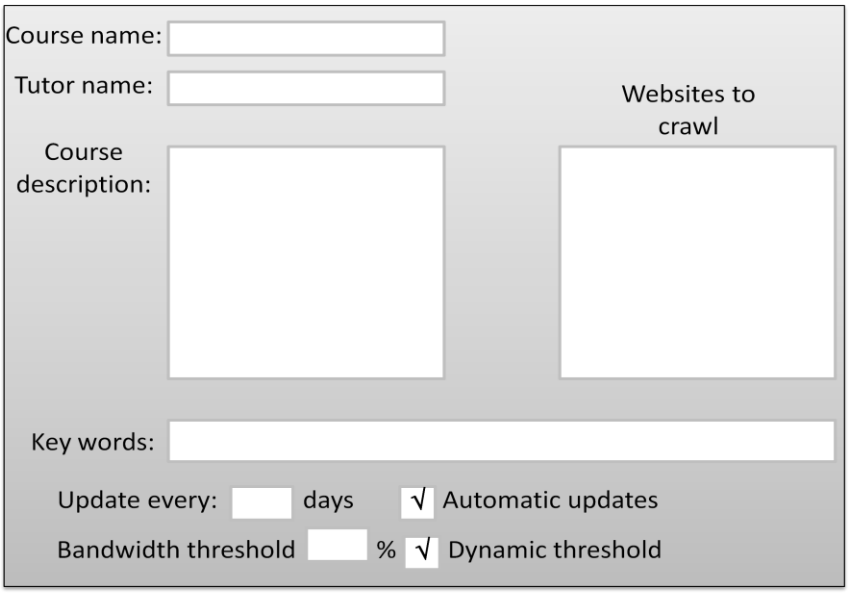

Figure 4. Server configuration screen

After all, learners can easily request the multimedia contents via HTTP requests and using their own client applications through their own client laptops or PCs. To estimate the total costs of this model, consider Table 3.

Table 2. Estimated costs for applying multimedia at university

Equipments	Cost
Technical's	$1000
Server	$1500
Software for Design	$300
TOTAL COST	$2800

4. MODEL BANDWIDTH TEST

To avoid the bandwidth utilization when the server adaptively updates the contents, we propose the following mechanism and as shown in Figure 5: the administrator provides the server with the maximum bandwidth allowed to be utilized (i.e., maximum allowed data usage), then the server tests the network using specific test tools before the adaptive update takes place. If the congestion on the network is above a specific threshold, the server uses the already existing contents and delivers them to the learners. The threshold can be determined either by the administrator or by taking the average of the utilized bandwidth in percentage for some pervious near time intervals (e.g., the last 10 minutes) and add some value to it (e.g. 1) as shown in equation (1):

$$\text{Threshold}=\text{Average}(\text{BandwidthUtilization}_{t\text{-}x})+\gamma \qquad (1)$$

Where t-x indicates the last time interval by x minutes.
And γ is any random integer value between $\{1, 10\}$.

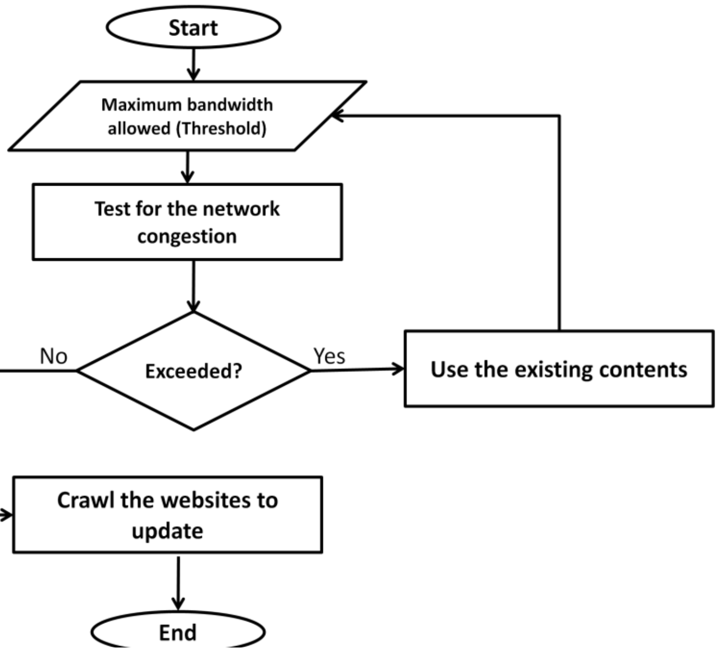

Figure 5. Bandwidth utilization test

Whereas, in case the threshold does not exceed the maximum allowed bandwidth utilization, the server can crawl the multimedia websites for new contents. Thereafter, the learners can be automatically notified.

5. CONCLUSIONS AND FUTURE WORK

Using multimedia in education has proven to be a powerful vehicle for the education process. The proposed model has introduced noticeable enhancements to the education at our university in terms of academic performance and cost reduction. Moreover, the model has been found to be very efficient in using the network resources thanks to the bandwidth test mechanism. Our future work will be toward using the cloud computing technologies to use multimedia in science education.

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