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Abstract

Along with the development of Internet technology, e-Learning as a flexible and convenient educational method has been widely accepted in tertiary education institutions to enhance and facilitate learning. By avoiding costly duplication and enabling the rapid creation of online courses, the employment of Learning Objects (LOs) and their reusability can benefit any educational institution when developing digital learning content for e-Learning. This paper proposes a learning content development target model utilizing LOs and related technologies to help content authors to design, develop and publish learning content at a minimized cost. The proposed model consists of identified variables that directly or indirectly influence the learning content development cost. Following elaborate development strategies in the proposed cost-effective model, content development process is simplified and cost-effective learning content can be created and delivered to the learners.

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Modelling Process for the Development of Learning Content for Tertiary Education

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Abstract—Along with the development of Internet technology, e-Learning as a flexible and convenient educational method has been widely accepted in tertiary education institutions to enhance and facilitate learning. By avoiding costly duplication and enabling the rapid creation of online courses, the employment of Learning Objects (LOs) and their reusability can benefit any educational institution when developing digital learning content for e-Learning. This paper proposes a learning content development target model utilizing LOs and related technologies to help content authors to design, develop and publish learning content at a minimized cost. The proposed model consists of identified variables that directly or indirectly influence the learning content development cost. Following elaborate development strategies in the proposed cost-effective model, content development process is simplified and cost-effective learning content can be created and delivered to the learners.

Keywords: *Learning Object, Modelling Process, Cost-effective, Development Model.*

I. INTRODUCTION

In recent years, e-Learning has been widely adopted in higher education as a cost-effective approach to enhance the traditional forms of teaching and provide flexible learning and content delivery to students. In many universities, online versions of traditional courses are offered, where students enrolled in the courses can access course notes and participate in interrelated learning activities anytime and anywhere via the Internet.

However, the growth of online courses has been closely followed by an equally significant increase in demand for digital learning content. Increasing demands of high quality learning content have bottlenecked the development of e-Learning; hence, many companies and educational institutions are aware of the challenges and are looking for cost-effective ways to solve this issue. To confront this issue, this paper proposes a cost-effective content development model utilizing Learning Object (LO) and related technologies to help content authors to design, develop and publish learning content at a minimal cost. Steps towards building the target model and research efforts presented in this paper consist of two major parts: firstly, the identification and prioritization of variables influencing the cost of learning content development; and secondly, the construction of a LO development target model that utilizes the identified variables.

II. IDENTIFICATION AND PRIORITIZATION OF VARIABLES THAT INFLUENCE THE COST OF LEARNING CONTENT DEVELOPMENT

Learning Object (LO), a popular term in the e-Learning field, represents a new approach to create and deliver digital learning content. To define a LO, many definitions of the LO have been proposed, and the first widely accepted definition is from the Learning Technology Standards Committee of the Institute of Electrical and Electronic Engineers (IEEE/LTSC), which defines a LO as: "*Any entity, digital or non-digital, that may be used for learning, education or training*" [1]. Along with the development of LO technologies, further refinements to the definition have been added. In 2007, Chiappe provided a particular description of LOs as: "*A digital self-contained and reusable entity, with a clear educational purpose, with at least three internal and editable components: content, learning activities and elements of context. The LOs must have an external structure of information to facilitate their identification, storage and retrieval: metadata*" [2]. These definitions not only depict the attractive features of LOs, which include reusability, interoperability, durability and accessibility, but also indicate that LOs have the potential to aid the acceleration of the learning content development.

Design and packaging high quality learning materials as small, stand-alone Reusable Learning Objects (RLOs), making them sharable and reusable in an Internet accessible Learning Object Repository (LOR), retrieving and aggregating related LOs into learning units within Learning Content Management System (LCMS), and then publishing to learners via Learning Management System (LMS) are efficient methods that are widely used for producing and publishing learning content in the e-Learning field [3]. However, the development of LOs is a complex process that is constrained by many factors and involves a series of pedagogy and technology related matters. To create a LO, the process consists broadly of analysing the learners' needs, defining the educational objectives, and creating activities to assist the learning process and enhance learning experiences. Currently, the lack of knowledge in Instructional System Design (ISD) is the main barrier to content developers rapidly producing and publishing LOs. A LO development model that consists of instructional development strategies could be an effective solution to solve this issue, whilst also reducing the development cost and complexity of LO development.

To construct a cost-effective LO development model, variables that influence the development cost should be firstly identified. Based on the common practices of LO creation, the flowcharts of the three main content development processes, namely LO design, development and publication, are given in [4]. Ten variables, which directly or indirectly influence the learning content development cost, are identified, and based on the significance and logical relationships of the variables in the learning content development process, identified variables are prioritized as follows [4]:

(1) Educational Model	(2) Standards
(3) E-Learning Platforms	(4) Production Technologies
(5) Bandwidth and Access	(6) Interaction
(7) Modularity	(8) Evaluation
(9) Quality	(10) Copyright

III. CONTENT DEVELOPMENT MODELLING PROCESS

The reusability of the LO indicates a possible way to create cost-effective e-Learning course. Therefore, the core of the target cost-effective model should focus on developing learning content as RLOs. Moreover, assigning suitable development strategies to the identified variables is another mature solution for minimizing the development cost. In particular, adopting appropriate Open Source Software (OSS)

for content development and publication can minimise the cost of learning content development. These ontological approaches can integrate with basic learning content development processes to form a cost-effective content development model.

This section presents a cost-effective content development model with a configurable structure that helps in the design, development and publishing of cost-effective RLOs. The purpose of this cost-effective content development model is to assist higher education instructors in design, development and publishing of sustainable web-based learning content without the need to become proficient in the concepts of ISD or LO technologies. By following the cost-effective development strategies in the proposed cost-effective model, flexible and reusable learning content with assured quality can be created. Fig. 1 shows the components of the proposed cost-effective content development model, which include refined narratives of the development strategies for the identified variables. The cost-effective content development model covers the entire learning content development process: learning content planning and design, learning content development, and learning content publication and evaluation. The details of the proposed cost-effective model are described in the following sections.

Fig 1. The Components of Proposed Cost-effective Content Development Model.

A. Learning Content Planning and Design Process

As the most significant phase of learning content development, design principles are inevitably involved with both technology and pedagogy. Normally, there are two types of learning content design principles: pedagogical

design principles that focus on creating learning content with effective learning experiences, and structural design principles that concentrate on enhancing the potential reusability of learning content by organizing the content structure in a technical manner [5]. The proposed cost-

effective content development model is inclined towards the latter design principle.

1) Educational Model

To design learning content, the educational model should firstly be confirmed. A distributed learning model is suggested as a prototype model for the entire content development project in the proposed cost-effective model.

Fig 2. The Basic Structure of Distributed Learning Model.

As shown in Fig. 2, all components of the distributed learning model are connected through the Internet. Based on the different budgets of content development projects, e-Learning platforms can be built on one or more servers, and placed in one or more locations. Through the Internet, instructional designers and content authors can upload created LOs to the LOR and manage existing LOs. Instructors can also search and retrieve desired LOs in the LOR, using the LCMS to integrate them together and distribute online courses to learners via the Internet. These e-Learning platforms can be accessed anytime and anywhere, thus resulting in considerable development cost savings.

2) Standards

The proposed cost-effective content development model is based on the SCORM (Sharable Content Object Reference Model) 1.2 standards [6]. Though e-Learning vendors are updating their products to support SCORM 2004 3rd edition [7], SCORM 1.2 is still the most popular and stable version. By complying with SCORM 1.2, the reusability of the created LOs can be ensured and enhanced. Moreover, the proposed cost-effective model suggests adopting IMS QTI 2.1 specifications [8] for creating assessment questions to evaluate learning outcomes. Extra benefits can also be gained every time these created LOs and assessment questions are reused.

3) E-Learning Platform and Production Technologies

To minimize the cost of content development, OSS packages are widely adopted in the proposed cost-effective model for producing and publishing learning content. For example, Reload Editor [9] can be adopted for packaging LOs, CourseLab [10] can be used for converting existing PowerPoint files to LOs, and eXe [11] can help instructors to create new web-based learning content. Furthermore, the e-

Learning platform can also be built by using OSS packages. For example, a web server could firstly be setup based upon an Apache web server [12] and MySQL database [13]. Then, DOOR [14], ATutor [15] and Moodle [16] as a LOR, LCMS and LMS, can be installed and run on this platform. Thus, adopting these OSS packages in the cost-effective model can minimise the cost of content development.

4) Bandwidth and Access Technology

To decrease the development cost, the cost-effective model proposes two development strategies for content publication that effectively utilize existing resources. According to these two strategies, the e-Learning platform can be established on web servers with either dynamic or static IP address; however, to improve the accessibility of the learning content and facilitate learners' active participation, an easy-to-remember domain name for both situations is required. Moreover, dynamic DNS software is needed if the e-Learning platform runs on the web server with a dynamic IP address. There are many OSS packages or free applications that have gracefully addressed and handled the problems associated with dynamic IP addresses, such as Peanuthull [17] and No-IP [18].

In fact, most of the broadband technologies cannot promise quality of service when learners explore highly interactive learning content during peak hours. Therefore, the proposed cost-effective model believes that the development of learning content should be constrained by the available bandwidth, including the size of each LO and the multimedia file formats within it. To obtain better learning experiences with low latency from learning content download, the components of each web page should be well organized and structured. The following suggestions are proposed in the cost-effective model to solve the addressed problems. Reducing the size of each LO can be achieved by narrowing the granularity of each LO into 'topic' levels, restricting the interactivity level and adopting bandwidth-friendly file formats.

5) Modularity

Normally, designing the structure of LOs would involve using an appropriate pedagogy theory to present learning materials and achieve expected learning objectives. As the design of the LO should refer to specific learning objectives, it is hard to offer a particular model for constructing the layout of the LO. However, based on CISCO's contribution and the SCORM Content Aggregation Model (CAM), the cost-effective model suggests a LO structure that can be considered as a guide for aggregating LOs into an e-Learning course (see Fig. 3).

Fig 3. A LO Structure, according to CISCO and SCORM CAM [19].

In CISCO's vision, a LO should be designed as a standalone learning unit that contains the essential parts and builds upon a learning objective. Moreover, CISCO and SCORM CAM also pointed out that an e-Learning lesson can be built by combining related LOs together, whilst a complete lesson should contain an overview, five to nine theory modules (LOs), a summary, activities, and assessments [19].

In contrast to traditional learning content, the design of a LO should also involve designing metadata to describe related LOs. In the cost-effective model, high quality metadata can be easily added into LOs by using authoring tools. As a self-described component of LOs, metadata provide key information to help make LOs sharable and reusable.

6) Interaction

In addition to reducing the granularity of each LO into lower levels, restricting the interactivity level is another effective way to decrease development costs and ensure quality of service during peak access hours. The proposed cost-effective content development model suggests that the interactivity level for each LO should satisfy interactivity level 2, which is described in [20]. Normally, content authors have enough learning materials to create LOs that match the interactivity level 2. Designing LOs with moderate interactivity levels not only saves on development costs which may then be spent on creating new media files, but also avoids learners becoming bored with plain text learning content.

In creating highly interactive LOs, multimedia elements can often be adopted as learning resources. The cost-effective model suggests converting these multimedia files into bandwidth-friendly file formats, such as .pdf, .mp3, .jpg and .avi. Using bandwidth-friendly file formats can reduce large media files into smaller sizes and hence accelerate content delivery over different bandwidths. In addition, adopting these common file formats can ensure the

presentation of learning content: learners do not need to pay extra for file decoders to view the learning content.

After determining the structure of LOs, an interactive learning environment should be designed for releasing the learning content and supporting learners' learning. Currently, LMS provides a collection of tools to help instructional designers to build a Virtual Learning Environment (VLE). The common elements that should be designed and implemented in the VLE include the syllabus for the course, student registration, access rights, learning activities, communication support, and assessments [21].

The proposed cost-effective content development model believes that an interactive learning environment can enhance learning experiences and facilitate learning outcomes, and thus suggests implementing three interactive modes: interaction between learner and content, interaction between learners, and interaction between instructor and learners. However, to make the development plan executable, instructional designers should become familiar with adopting a LMS before the design process.

7) Quality

To ensure the quality of the created learning content, quality inspection policies should be established. These policies should provide evaluation criteria for quality checking of the created LOs and the learning environment, and will be used as quality checking guidelines in the subsequent processes. According to S. Carliner's description of content quality for classified e-Learning project in [5], the outcomes of the proposed cost-effective model can satisfy the medium level quality checking policy.

8) Evaluation

The last task of the design flow chart is to design how to assess learning outcomes and evaluate the quality of the LOs. In the proposed cost-effective model, the evaluation is designed and implemented based on the systematic assessment functions provided by the LMS. In fact, the capabilities of the LMS inherently support the tracking and reporting of learners' actions, learning progress and test results. The LMS automatically processes the collected data and produces relevant statistics to instructors as required. In addition, flexible tools in the LMS can help instructors to create assessments that evaluate learning outcomes; thus, a LMS is a cost-effective method to perform the evaluation in the proposed model.

B. Learning Content Development Process

During the content development phase, the main task is to implement the detailed design documents. According to the structure of the distributed learning model, content authors can execute the detailed design documents on their own computers and later upload the created LOs to the LOR.

Before producing LOs, related learning materials should be selected and classified into different folders on the computer. The cost-effective content development model requires copyright inspection to avoid legal problems when content authors adopt authorized learning resources to improve the quality of the learning content. After preparing all learning resources, content authors can start creating LOs by using open source authoring tools. During the LO

production, content authors may need to create some new media files to add interaction between the learner and the content. Flash could be a good option to increase the interactivity level of LOs.

After forming the structure of the LO and related resources, metadata should be tagged to provide additional information about the LO. High quality metadata can enhance reusability of the learning content and enable LO communication with the LMS. As the designed LOs comply with SCORM 1.2 standards in the proposed cost-effective model, created LOs should be encapsulated and exported as SCORM 1.2 content packages. Previewing and quality checking for these content packages are needed before upload to the LOR.

At the end of the content development process, an e-Learning platform should be established to store LOs and prepare for content publication. After content authors upload created LOs to the LOR, instructors can start to retrieve relevant LOs from the repository based on the syllabus. Retrieved LOs are organized into learning sequences and assembled as lessons in the LCMS. These content aggregation packages are then ready to be published in the e-Learning course.

C. Learning Content Publication and Evaluation Process

In the last stage of content development, the e-Learning course will be released and delivered to target learners. Learning content that has been organized into e-Learning lessons can be exported as SCORM 1.2 content aggregation packages from the LCMS. To publish the e-Learning course, instructors must create a course on LMS, import related content aggregation packages into the course, and set the release date.

After publishing the learning content, the proposed cost-effective model suggests that the instructor should establish an interactive learning environment in this virtual classroom to facilitate learners' active participation. Learning activities such as critical thinking tasks and tutorials can help learners to review their acquired knowledge, whilst forums and frequently asked questions enable discussion between participants in the course, and assignments and online quizzes can evaluate learners' learning outcomes during the learning process or at the end of learning sections. Moreover, assessments could be reused as LOs if the created assessment questions comply with IMS QTI 2.1 specifications.

Before publishing learning content, instructors still need to go through the entire learning process to ensure the quality of the created course. If an online course is released with problems, poor learning experiences will result and thus affect learners' engagement in the course. Evaluation is implemented as soon as the course is released, where instructors can track the learning progress of each learner in the LMS. By analysing reports where provided by the LMS, instructors can give feedback to each learner and improve learning activities in the course. At the end of the session, students' feedback and system statistics can help the content author to address problems in the LOs and thus enhance the LO quality.

IV. CONCLUSION

This paper proposed a learning content development target model that assists higher education instructors to design, develop and publish digital learning content. This cost-effective model is constructed by assigning suitable development strategies to identified variables that influence the content development cost. In addition, OSS is widely adopted in the proposed cost-effective model to minimize the development cost. Following the development strategies within the proposed model, SCORM-conformant RLOs can be easily created and delivered to target learners at a minimum cost. Moreover, the modularity of the created RLOs allows for reuse in different courses with similar elements, and this can help institutions to apportion the content development cost over several different subjects.

Current research focuses on the design and implementation of an experimental platform to verify the theoretical basis of the proposed learning content development target model. As defined in proposed model, this experimental platform should be a unified system and consist of OSS packages. A case study will be carried out on this experimental platform to provide a practical example of converting existing course content into SCORM-conformant LOs by following the proposed cost-effective model. Moreover, the standards compliance of this experimental platform will be evaluated. Authoring tools and e-Learning platforms within the platform should adhere to the SCORM 1.2 standard and allow the creation of SCORM-conformant LOs that can be exported and executed on different SCORM compliant e-Learning systems. Finally, case studies and evaluation results will provide more detailed information to the target users about the proposed cost-effective model.

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