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Automated Eclectic Instructional Design: Design factors

Chien-Sing Lee[1] and Hwee-Reei Chong[2]
Faculty of Information Technology
Multimedia University
Jalan Multimedia, 63100 Cyberjaya, Selangor.
Malaysia.
http://pesona.mmu.edu.my/~cslee[1]

Abstract: The need for systematic design of instruction has led to refocus on instructional design as the basis for designing creative learning environments, activities and learning contents. This paper describes OntoID, an Automated Eclectic Instructional Design tool. The Design phase is facilitated through the explication of learning techniques from different methods in different learning theories. Moreover, the Analyze, Design and Development phases are integrated and extensible through the use of XML. Pilot testing on the OntoID for facilitating systematic and creative design is positive and points towards improvement in system design factors.

Key-Words: Educational-oriented systems, eclectic instructional design, guide

1 Introduction

Recent advances in computer-based interactive technologies have presented a broad range of possibilities to create powerful presentations and instructional messages. However, incorporating these new technologies effectively with Instructional Design is not a simple task because the design of effective computer-based or automated instruction is a complex process, for instance in analysing complex skills and finding appropriate learning tasks for practising those skills. This type of complex design activities indeed requires an automated instructional design tool to scaffold the novice instructor or instructional designer.

Instructional design (ID) is the "*science of creating detailed specifications for the development, evaluation, and maintenance of situations, which facilitate the learning of both large and small units of subject matter*" [1]. In short, ID provides a systematic approach to analyse, design, develop and evaluate instruction. The ultimate intention is to improve learning and performance in a variety of settings, especially in educational institutions and the workplace.

Automating instructional design (AID) fundamentally builds on the "*the process for manipulating knowledge objects in a knowledge structure"* to enhance efficiency in accomplishing user tasks [2]. As such, AID can help the instructional designer to visualise the association of concepts and provide guidance in designing and developing learning materials. Thus, the novice instructor who lacks pedagogical knowledge will be empowered to design teaching and learning activities. A well-designed automated instructional design tool therefore holds the potential to not only simplify tasks and cut down on development time and cost, but also reduce the time needed to train novice instructors.

In addition, automated instructional design provides extensibility in design and development. Extensibility through reuse of codes and modular programming has gained popularity among the software engineering community [3]. Reuse and sharing of learning objects across boundaries further enable cultural and knowledge exchange [4]. Hence, it is timely for the instructional design field to maximise the potential benefits of this new paradigm.

2 Problem formulation

Research has been carried out on the use of artificial intelligence and advanced interactive technologies in ID [5]. Generally, these efforts deal with two aspects: provision of automated guidance to support the ID process and automation of a part of the ID process.

GAIDA (Guided Approach to Instructional Design Advising) or commercially known as GUIDE, provides online, case-based lesson planning to function as an advisory system. GAIDA [6] is developed by the Armstrong laboratory, a research unit of the U.S. Air Force. Based on Gagne's nine events of instruction, guidance is provided in the form of completely worked examples or cases of lesson planning. GAIDA contrasts with Experimental Advanced Instructional Design Advisor (XAIDA), also developed by the Armstrong laboratory, which automates a significant part of the process of courseware design, production, and implementation.

ID Expert™, developed by Merrill and the ID2 research group of Utah State University [7], focuses on transactions (exchange of information) between the system and the students in order to achieve a given task. Assistance to instructional designers comes in the form of a rule-based expert system which guides the instructional designer along a set of decision-making steps involving instructional components, formatting, resources, etc.

In a comparison with some examples of commercial authoring software such as Authorware 6.5, DazzlerMaxDeluxe, Everest 2.2, and FLEXeLEARN [8], we find that some of these commercial systems support the preliminary planning stages of instructional design through flowcharting features. However, most of these authoring tools focus almost exclusively on authoring and media production [9] and provide instructors with little guidance over content design or teaching techniques. This may leave the novice instructor who lacks pedagogical training, at a loss as to how to go about designing a lesson. Furthermore, there is a need to enable sharing and reuse of pre-existing learning materials in order to save development time.

With the above issues in mind, the OntoID aims to provide strong pedagogical guidance through the provision of educational models and techniques founded on learning philosophy. We hope to support all ID processes, in order to free instructors to concentrate on curriculum content design. The novice instructor without any teaching experience stands to benefit the most. The issue of extensibility and reuse is addressed through the use of XML technology.

3 Problem solution

Current instructional design models are formulated based on a certain objective and target a specific skill level. For instance, the Dick and Carey model targets human resource training and instruction [10] whereas the rapid prototyping model encourages participatory design by users of the instructional system at various stages of development to facilitate quicker review and adaptation to the user's needs. The Dick and Carey model serves the novice instructor whereas rapid prototyping the expert instructor who has adequate experience to form his or her own decisions.

The fundamental components underlying these models are Analysis, Design, Development, Implementation and Evaluation (ADDIE). The learner's knowledge states and preferences are identified in the Analysis phase. The Design phase involves design of lesson content, sequencing of content, choice of media presentations. Design and planning decisions enable more efficient Development of lesson plans and learning materials and Implementation of system and activities as well as evaluation of learning performance, degree of motivation, effectiveness of learning materials and the system itself as shown in Fig. 1[11]. These ADDIE activities are carried out iteratively.

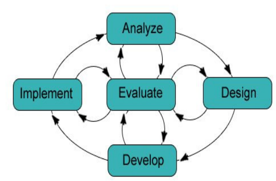

Fig. 1. The ADDIE iterative loop

Function tabs in the OntoID authoring tool (Fig. 2) correspond with the Analysis, Design, Develop, Implement and Evaluate pattern found in all instructional design models [12]. The OntoID models the conceptual hierarchical tree on the left and the development environment on the right. The conceptual hierarchical tree organises the relationships among concepts in a lesson.

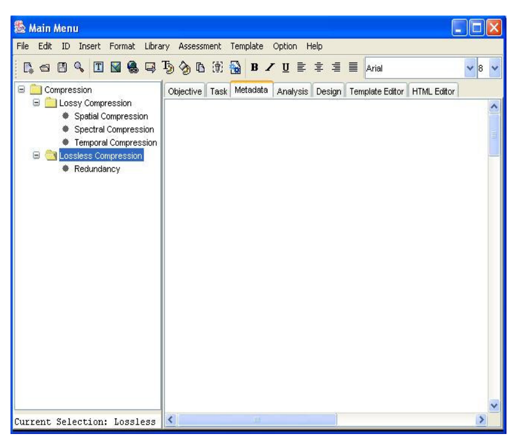

Fig. 2. The OntoID Main Window

In the Analysis phase, the instructor fills in the meta-data (e.g. lesson name, lesson description, prerequisite concept, related concept, student's interest, student's preferences, student's learning style, and student's academic competence) for each lesson or concept created. A wizard (Fig. 3) will compile and store the keyed-in metadata in a SCORM-based manifest file.

In the design phase, a list of methods and techniques from different learning theory categories such as Foundation (Behaviourism), Learning Strategies (Cognitivism) and Learning Transfer (Constructivism) are presented. The instructor can select any technique from any method in any category to fulfil different learning needs. After the instructor chooses the desired techniques, a wizard (Fig. 4) compiles these techniques for the next step, Development.

In the development phase, these selected design techniques are displayed on top of the Template Editor (Fig. 5) to provide a step-by-step Guide, while developing learning materials. The Template Editor provided in the OntoID authoring tool is a WYSIWYG (What You See Is What You Get) editor. This kind of editor does not require the user to have any programming knowledge, which makes it much easier for the average computer user to create a web page.

The OntoID also provides a template library which consists of templates in categories such as business or magazine to further enable easy and fast deployment through well-specified layouts and designs. The instructor needs only to insert text or multimedia resources (e.g. graphics, audio, video, animation) into each block rather than design from the scratch. Besides, the instructor can also create his/her own template using the Template Editor and store it in the template library for future reuse.

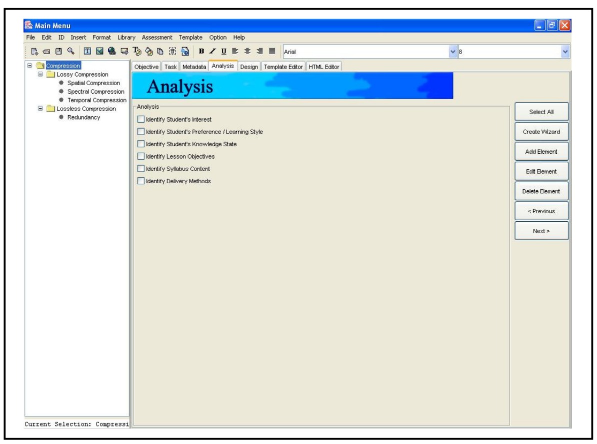

Fig. 3. Analysis Wizard

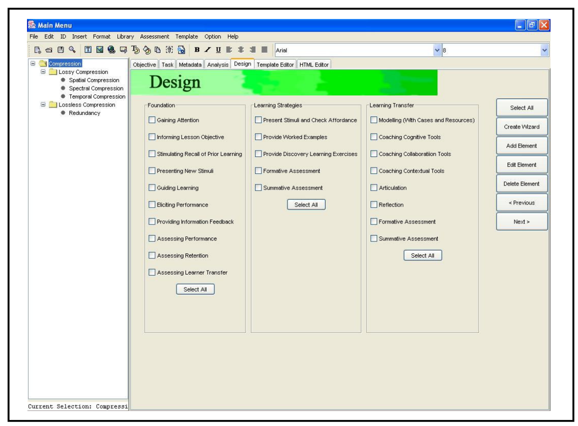

Fig. 4. Design wizard

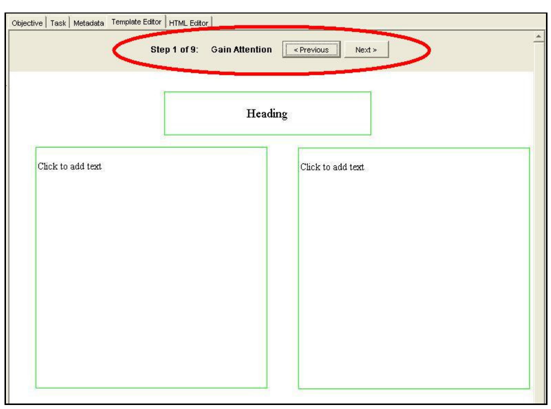

Fig. 5. Template editor

Furthermore, all media files in the media library are tagged according to four parameters: concept name, student's knowledge states, cognitive media type and physical media type. So, the time taken to retrieve the tagged media files for reuse in learning materials will be shortened.

In the implementation phase, the instructor creates the course outline; determines the course delivery; inserts staff information; adds the content of the material; enables preview of material and announcements by the instructor; and finally informs the students how to access the course.

In the evaluation phase, formative or summative evaluation of the lesson can be conducted. Formative evaluations involve continuous assessment such as assignments and/or projects whereas summative evaluation usually involves assessment at the end of the course such as through final exams. The instructor is aided by a wizard in creating online self-assessment tests and exercises by himself or herself or through reference to a question bank. This question bank contains a pool of questions categorized according to the type of question (e.g. multiple-choice question, true/false question, fill-in-the-blank question, subjective question etc.). Each time the instructor creates a new question, the system will store it into the question bank in XML form. As a result, there is greater opportunity to reuse this data inside or outside of the application.

4 User testing

A case study was conducted among six lecturers with average three years of experience in teaching Information Technology courses. None of them have had prior knowledge of pedagogy or Instructional Design. The lecturers were given two weeks to try out the automated instructional design process using the OntoID. Two instruments were used to collect data. The pre-test questionnaire was used to collect general data to obtain more insight into the way the instructor designs his or her unit of study in daily practice. The post-test questionnaire was to validate whether the OntoID AID tool met the instructors' need.

4.1 Pre-test results

4.1.1 Expectations

The lecturers were mainly interested in examples of learning materials and most importantly, reuse of these learning materials.

4.1.2 Perception towards instructional design

Advantages in automating instructional design were generally acknowledged. In the survey questionnaire, respondents were allowed to choose more than one perceived advantage. 4 of the respondents thought that automated instructional design would automate common processes such as defining the objectives of the course, determining the content of the course (including structure and sequence), determining the instructional strategies and methods for presenting the material, thus, shortening development time in producing teaching or learning materials. Another 2 of the respondents said that they thought automating instructional design would assist them in solving complex and tedious tasks, and subsequently simplify the process of instructional design. In addition, 1 of the respondents believed that automated instructional design would provide a systematic and structural way to carry out the instructional design process.

In the event that instructional design were to be automated, 1 of the respondents would like data collection of educational resources and information, lesson plans and etc. in the analysis phase to be automated so that the hassle of searching for information from reference texts and the World Wide Web could be eliminated. 1 of the respondents preferred automation in retrieval and reviewing of previous work to help them in the design phase. On the other hand, 3 of the respondents thought that the automated features should be in the evaluation phase especially with regards to analysis of feedback whereas 1 preferred automatic generation of 'drill and practice' questions and online tests in the implementation phase.

4.1.3 Perception towards learning theories in instructional design

5 of the respondents were willing to consider implementing automated instructional design and customize instructional events appropriate to the concepts they were trying to teach but 1 of the respondents did not think so. Fundamentally, majority of them hoped to have well-defined instructional guides and control over the system in terms of pedagogical options and methodologies.

Lecturers preferred to use their own methods to design the teaching or learning materials rather than follow strictly to formal development methodologies. They appreciate flexibility in the system but would prefer control of choice still within their hands.

We analysed the instructors' feedback above by categorising their requirements into LMS (Learning Management System) and authoring tool features. An LMS refers to an e-learning tool that supports content development and delivery, and course administration. An authoring tool is usually complemented by an LMS to form an LCMS (Learning Content Management System). An authoring tool is a software application used by instructors and instructional designers to create online learning content (e.g. develop an interface, define the learning interactions, place a variety of media, and create test and assessment).

Breakdown analysis of the instructors' feedback with regards to LMS and authoring tool features is shown in Table 1.

Expectations from the lecturers	LMS features	Authoring Tool features
Include course characteristic, such as course length, format, availability status, and prerequisites in the catalog description	✓	
Able to generate report indicating course attendance, scoring etc.	✓	
The test questions are automatically graded and recorded.	✓	
Allow for maintaining a version control scheme for online courseware.	✓	
Provide the capability to perform skill gap analysis tasks, including skills defining, tracking and searching.	✓	
Provide library of pre-built templates and media for use in custom content development		✓
Create test, self-assessment and exercise questions.		✓
No programming skills required for content development, WYSIWYG enabled.		✓
Tasks can be added to each navigational element in a lesson, helping to track progress and view the global status of a lesson.		✓
Provide capability for assessment of all learning materials.		✓
Allows for development and delivery of online learning materials.	✓	✓
Provide the capability for sharing authored courses with other regions	✓	✓

Table 1. Expectations from lecturers for LMS and authoring tools

From Table 1, we surmise that some of the expectations for an LMS and an authoring tool overlapped. The expectations from the lecturers with regards to the OntoID were for an LCMS, encompassing an LMS and an authoring tool. From the breakdown analysis, we find all features expected from an authoring tool have been met by the OntoID.

4.2 Post-test

In the post-test, only five lecturers participated. All the respondents agreed that the current criteria in the Analysis phase were sufficient and did not require any modification. 3 of the respondents said that modelling concepts with the conceptual hierarchical tree structure was easy while the rest chose to be neutral. All of the respondents concurred that the metadata in the Analysis phase were adequate to describe the lesson or concept.

In the Design phase, 2 of the respondents viewed the utility of learning techniques positively. Another 2 had no personal preference and 1 did not agree with this statement. This response correlated with their perception of the utility of pedagogical sciences.

In addition, 1 and 3 of the respondents chose *strongly agree* and *agree* respectively with regards to the usefulness of the step-by-step guide during development as it linked the design phase with the development phase directly. The remaining 1 respondent chose to be neutral.

For the Development phase, 2 of the respondents agreed that consistency between this phase and the Analysis and Design phases is achieved. The rest were neutral.

3 of the respondents believed that the OntoID could help to reduce the design and development time compared with the creation of storyboard which required numerous discussions among the instructional designers, graphics designers and instructors. However, 2 of the respondents said that the design and development time spent in both situations would be almost the same. This was because the lecturers required some time to familiarise themselves with the OntoID software and instructional design itself.

As to the overall presentation of OntoID, 2 of the respondents said good and 3 of the respondents said that it was fair. 3 of the respondents believed that OntoID was user-friendly and the rest chose to be neutral.

In summary, most lecturers appreciated the consistency between the Analyze, Design and Development phases through the use of metadata and the link between techniques chosen in the Design phase which form the step-by-step guide in the Development phase. However, there were too many clicks in the interface with too many options. Therefore, we will be refining OntoID to make the interface more user-friendly by deciding which features to provide as options and which should be decided by the system.

5 Conclusion

Facilitating the instructional design process empowers the instructor to be creative and be more systematic in designing instruction and learning materials. Towards this end, the OntoID authoring tool has been shown to show much promise.

We hope that the OntoID will serve to encourage knowledge sharing through global repositories such as Educanext/Prolearn and ARIADNE and create avenues for further collaborations and human resource development initiatives between developing and developed countries.

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