DESIGN AND DEVELOPMENT OF A WEB-BASED TOOL FOR SUPPORTING EDUCATORS DURING AN INSTRUCTIONAL DESIGN PROCESS BASED ON LEARNING OBJECTS

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Abstract

Although learning outcomes are recognized as an important component of the instructional design model, few instructional design prescriptions are available for authoring well-structured learning outcomes. This paper focuses on the design and development of a web based tool that facilitates the application of instructional design methodology in order to build courses based upon the notion of Learning Objects and their direct correlation with the expected Learning Outcomes. The tool uses a combination of the Bloom's Revised Taxonomy and the ABCD model for structuring Learning Outcomes. The purpose of the tool is to scaffold and support educators during the educational design process, so as to author well-defined Learning Outcomes. The paper outlines the web tool itself alongside the related work in this field and an initial evaluation in terms of user experience, from using the tool for the needs of Hellenic Open University.

Keywords: Instructional design, learning outcomes, web based tool, ABCD model.

1 INTRODUCTION

The Educational Material is one of the most important components in distance learning. In many cases it constitutes the main learning tool and plays a key role in achieving the goals of learners, while affecting greatly the quality of the educational process. During the design of the educational material of a course, a very important task is to define well-structured learning outcomes, clear in their meaning [1]. Especially, in distance and online learning, the concept and the structure of the learning outcomes play an important role in the successful completion of a course.

Learning outcomes are described as written statements of what a learner is expected to know, understand and/or able to do at the end of a period of learning [2]. According to Mager [3][13], the learning outcome is the behaviour which we expect to appear after the end of an educational procedure. The expected behaviour should be observable and verifiable in an objective way. In order to determine clearly an objective learning outcome it should be characterized as SMART, which is an acronym of the following words: (a) Specific, by the use of an active verb which describes the observed behaviour and accuracy, (b) Measurable, by using a verb which describes a measurable behaviour, (c) Attainable/Achievable (realistic) by taking into account the existing conditions and probable helping elements, (d) Relevant, which means that it should retain consequence with the educational obligations and the work of the learner in the context of teaching and (e) Timely/Time-Bound, which determine a realistic time context in order to obtain performance, wherever this is required.

However, the writing of meaningful learning outcomes, that effectively communicate to students the expectations from a course, still remains a challenging and trying task for instructors. The design process would totally improve if educators could be guided through the steps that should follow to author well-structured learning outcomes [4]. Several institutions, universities, and organisms have developed web-based tools that facilitate instructors and educators during the writing process of learning outcomes. One such tool is

the ObjectivesBuilder [5] developed by the Arizona State University. The tool is based on the Bloom taxonomy and especially on the Cognitive Domain and provides both a user guide for using the tool and a detailed manual for the writing of learning outcomes. In addition, users can download the list of learning outcomes that they have defined. Another tool is the Co-generative Toolkit (CogenT) [6], which constitutes a toolkit that supports the planning, design, implementation and assessment of curricula in higher education. This toolkit comprises four separate, but interfacing, components, such as Vocabulary Builder, Outcome Builder, Task Builder and Design Builder. The toolkit can relate to a specific programme, course, unit or activity and it provides user guides and additional material for the writing of learning outcomes. The Course Builder Course [7] is another tool developed by the Dublin City University for teaching and learning, with the aim to assist educators and instructors with the writing of module descriptors in terms of learning outcomes in the short term and to facilitate on-going academic development in the future. Among the tabs in the Editing Module of the system, the Outcomes Tab can be used to write learning outcomes by using the verbs included in the three Bloom domains.

Although some of the aforementioned tools use the taxonomy of Bloom, none of them adhere to the ABCD model, a widely accepted method for the creation of learning outcomes [3]. In this paper we describe the design and development of a web tool based on both the ABCD model and the taxonomy of Bloom, which facilitates the application of an instructional design methodology that the Hellenic Open University follows. The aim of this methodology is to build courses based upon the notion of Learning Objects and their direct correlation with the expected Learning Outcomes. The tool described in this paper aims firstly to scaffold and support educators during the educational design process, in order to define well-structured Learning Outcomes and secondly to facilitate and reduce the time of implementation of the instructional design methodology for a teaching domain.

The rest of the paper is structured as follows. Following this introduction, Section 2 provides a review of the importance of learning outcomes and a brief description of the instructional design process based on learning objects and learning outcomes. In Section 3, we present the design and development of the web based tool for learning outcomes, including the theoretical background, the definition of the typical users and the functions of the web based tool. Section 4 presents the initial evaluation results in terms of user experience from using the tool by tutors of the Hellenic Open University. Finally, we present our conclusions and ideas for future work.

2 BACKGROUND

2.1 Importance of Learning Outcomes

The learning outcomes describe the knowledge, attitudes and skills that a learner should have acquired at the end of his/her engagement in a part of the educational process [8]. In addition, they are concerned with the achievements of the learner rather than the intentions of the educator or the individual components of the educational process [9]

According to Race [10] the learning outcomes, which describe the effects of learning, provide to learners the possibility to have an accurate knowledge for the way of studying the learning content and the parts they should focus on. Moreover, they make clear what a learner can be expected to know, understand and/or do, after the study of the course material [11].

Generally, learning outcomes provide clarity about the purpose of an educational process and guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meeting training goals [12]. Learners benefit from them as they articulate exactly what participants will be able to do by the end of the training and help them self-assess their progress, to evaluate whether they have comprehended the concepts of the knowledge domain under study [13]. In addition, the learning outcomes help learners assess the completeness and effectiveness of their study [14]. The gradual achievement of the outcomes increases the self-appreciation of the learner and as a result they become more effective and active in the educational procedure [13].

In addition to learners, tutors and instructional designers also benefit by authoring learning outcomes during the instructional design procedure. The learning outcomes constitute also an

evaluation tool for the instructional designer of the educational material, indicating the degree of achievement of the course [14]. Furthermore, the instructional designers will use the learning outcomes for planning of the educational material aiming to assess and evaluate the students.

Summarizing, based on the above, we can conclude that learning outcomes are indeed key to a meaningful education; thus focusing on learning outcomes is essential to achieve informed diagnosis and improve teaching processes and student learning [1].

2.2 The Instructional Design Methodology based on Learning Objects and Learning Outcomes

The use of Learning Objects (LOs) for the development of the digital educational material is a adopted by many contemporary e-learning systems and institutions. As a result, there are several instructional design methodologies based on Learning Objects [15][16][17]. HOU has adopted a methodology [18] that provides tutors with the necessary guidelines in order to help them in the design and development of educational material based on Learning Objects. The resulting LOs will be autonomous, retrievable, reusable and shareable. As a result, the LOs that will be developed by the application of this methodology can be used by the Learning Management System that supports HOU students.

The aforementioned methodology is separated into three phases, each of which is subdivided in individual steps. The first phase is the Analysis Phase in which the procedure is determined. The second phase is the Design Phase which describes how the educational content will be organized into LOs and how the construction of learning path is realized. The third phase is the Development Phase where the LOs are developed and characterized with metadata.

In applying the methodology, each tutor is invited to develop a representation model of the field of knowledge of his/her expertise. This model includes the concepts of the field and the correlations between them (assembly relations, generalization-specialization relationships, complicated relationships). The representation model suggested by the educators is processed by the Technical Integration Team and converted into ontology [19].

The next step of the methodology concerns the creation of Learning Outcomes for the teaching domain for which a representation model has already been developed. The web based tool aims to assist the tutors in the definition of the Learning Outcomes for the concepts of the cognitive domain. The tool operates on the ABCD model and the revised taxonomy of Bloom. For its implementation, web technologies like CSS3, HTML5, Javascript, JQuery, PHP and Drupal were used.

3 DESIGN AND DEVELOPING THE WEB BASED TOOL
3.1 Theoretical Framework

As we mentioned in the previous section, our proposed web based tool bases its functionality on the ABCD model [3]. Consequently, each well-structured learning outcome should consist of the following four elements: the audience, the behavior, the condition and the degree/criteria.

Learning Outcome (for a Concept of the cognitive field)

=

Condition/s+ **Behaviour** +Criteria/s
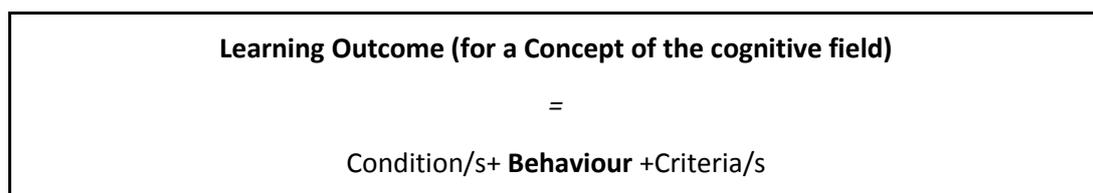
Figure 1: Components of learning outcome

The *audience* describe the intended learner or end user of the instruction. The *behavior* is expressed using an active verb, which describes measurable activities and specific knowledge levels. The *condition* describes the preconditions under which the observed behaviour takes place and also determines the media, the procedures and the facilities that

are provided for the implementation of the learning outcome or in general the environment which affects its achievement. The *degree* (criterion) expresses the degree in which the observed behaviour should take place so that to have acceptable performance levels. For a learning outcome can be included more than one degree, which may express: Accuracy, Quality, Quantity and Time Constraint.

As a result, one outcome of a particular concept of the cognitive field is built up from exactly one verb (behavior), none, one or more criteria and none, one or more conditions (see Fig. 1).

In 2001 the revised Bloom taxonomy was published [20] after many studies. Its main feature is the use of verbs instead of nouns for each category and also a reorganization of the taxonomy levels. The sequence with which the categories are determined is from a low to a high level of cognitive skills. Creativity is in a higher position from evaluation in the context of the cognitive domain. The revised Bloom taxonomy classifies learning outcomes in three broad areas. For the needs of the instructional design methodology a set of verbs have already been defined for every level and every sector of the above taxonomy which is incorporated in the web based tool. The three areas are:

A. Cognitive domain, which consists of levels: Remember, Understand, Apply, Analyze, Evaluate and Create. For the cognitive domain the set of the verbs used is based on the list of verbs by Bologna Process [21].

B. Affective Domain consists of the levels: Receiving, Responding, Valuing, Organization and Characterization. For that domain the set of verbs used is based on the list of Krathwohl et al. [22].

C. Psychomotor Domain consists of the following levels: Imitation, Manipulation, Precision, Articulation and Naturalization. For the set of verbs the approach proposed by Dave [23] was chosen, as it is more comprehensive in categories and the verbs used are more suitable for adult learners.

3.2 Definition of typical users

Typical users of the web based tool are divided into three categories, the primary, secondary and tertiary. In detail, these are:

Primary Users: Primary Users are the users, who will directly interact with the system. Thus, regarding the web based tool, the primary users are tutors of HOU. These users can log in the system and write, view or edit learning outcomes.

Secondary Users: Secondary users are those who use the system less frequently or through an intermediary. In this category belongs to the group of Technical Integration Team, who will be informed by the web based tool and collect the created learning outcomes.

Tertiary Users: The Tertiary Users are those who never use directly the system but are indirectly affected, as they are obliged to alter some of their operations to adapt to the requirements. In the case of the web based tool such as user is the HOU which employs the educators and the Technical Integration Team.

3.3 Services of the web based tool

The basic tasks which are carried out by users in contact with the system are presented below.

- **Log in/Log Out:** Users who have been given access to the web based tool can connect to it at any time, by filling out the username and password in the field that is at the home page.

- **Navigation/Search:** All users may choose the school, then the curriculum, the theme, the subject; then the form for authoring the learning outcomes is displayed.

- **Authoring:** All the registered users can author new learning outcomes, by completing the required forms.

- **Edit/Delete:** Registered users have the exclusive ability to edit or delete the learning outcomes they have created.

- **View:** Registered users are able to view all the created learning outcomes.

- **Statistics View:** Registered users are able to view statistics for the learning outcomes that they have created.

- **Download:** Registered users are able to download the learning outcomes.

- **Guides:** In the web based tool two guides are offered. The analytic guide for authoring well-structured learning outcomes and the manual of the web based tool.

- **Examples:** Users are able to see examples so as to understand how to author learning outcomes using the web based tool.

As shown below in Fig.2, the elements Behavior, Condition and Criterion of ABCD model are implemented in the tool as tabs. The Audience element in our case are undergraduate and graduate students of the HOU courses.

Figure 2: The form of the learning Outcomes web based tool

The element Behaviour is expressed using verbs derived from the verb list of the Revised Bloom's Taxonomy. The registered users have the ability to choose the verb from any level and taxonomy field to express the learnig outcome. The three sectors are represented in the taxonomy tool using radio buttons. Levels and verbs which belong to them are represented in the tool with a drop-down list. Furthermore, it is worth to notice that the content of the drop-down list is updated by clicking on the field that the user is working with. Also, the user may fill a supplemetary text field in order to express the determination which indicates the chosen verb. Several checks are carried out as a user fills out the form. More precisely, the tabs for the consept of the cognitive field and the active verb (behevior) are required while the critiria and condition are optional.

5 INITIAL EVALUATION

In this section, initial evaluation results from the usage of the web tool are presented. The main objective of this initial evaluation is to measure the perception of the users regarding their experience of using our tool. The evaluation was conducted with the help of 10 Hellenic Open University tutors. The evaluation procedure includes an appropriately designed questionnaire with the aim to assess their satisfaction about comprehensibility/clarity, easy to learn and use, attractiveness, usefulness, and intention to use. For each question a five-point Likert scale was used where 5 means "totally agree" and 1 means "totally disagree". At the end of the questionnaire tutors could write their comments about their experience with the

web based tool. Table 1 presents data analysis results for every differenct category of the given questionnaire.

As we can notice from the Table, the overall satisfaction of users has received a high score for all the different categories of the questionnaire. In addition, according to the comments of the users, it is worth mentioning that some participants have encountered difficulties in editing or deleting the learning outcomes, while the examples which are on the web based tool were characterized as very helpful.

Table 1: Initial evaluation results

Category	Mean	Standard Deviation
Comprehensibility/clarity	4,64	0,48
Convenience of the learning	4,80	0,40
Easy to use	4,60	0,49
Attractiveness	4,70	0,48
Usefulness	4,85	0,36
Intention to use	4,50	0,51
Overall Satisfaction	**4,68**	**0,45**

6 DISCUSSION AND CONCLUSION

In this paper, we presented a brief description of an instructional design process based on learning objects and learning outcomes, together with a web based tool that we developed to support the process. The design and development of the tool were presented alongside its objectives related to the facilitation of the applied methodology and the support and scaffolding of tutors during the instructional design process.

Future work includes the customization of the tool to a generalized tool which is independent of specific HOU courses in order to author learning outcomes for any teaching domain. Additional experiments according to the users experiences will be held. Finally, ongoing work includes the translation of the tool in English.

ACKNOWLEDGMENT

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