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Development Model of Learning Objects Based on the Instructional Techniques Recommendation

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Abstract. This paper presents the progress of the proposal for a model of support in the development of Learning Objects. It incorporates the most appropriate instructional techniques to the cognitive processes involved in the student learning objectives proposed by the teacher, and learning styles of students in order to create the Learning Object. The proposed model is based on Felder-Silverman learning style model (Felder & Silverman, 1988) and the cognitive processes proposed by Margarita de Sanchez (1991). The paper presents the proposed model, the cognitive processes studied, learning styles, instructional techniques included in the study and the relationship of the techniques with cognitive processes and cognitive styles of learning. Finally, it shows the mathematical model and prototype implementation of the mathematical model.

Keywords: Learning Objects; Cognitive Processes; Learning Styles; Instructional Techniques.

1. Introduction

Learning Objects (LO) are considered as the design paradigm of digital educational resources that can be updated, reused and maintained over time (Hernández & Silva, 2001). It should be noted that there is no single LO definition. One important definition is given by David Wiley (2000) who describes the LO like elements of a new type of computer-based instruction and based on the object orientation paradigm, so that the LO can be used in different contexts of study. Polsani (2003) indicates that it is a self-contained unit and learning, predisposed for reuse. The LO are interactive and educational resources in digital format, developed with the purpose of being reused in different educational contexts, with the same instructional need, this being its main feature, for promoting learning.

The reuse of LO is achieved by the introduction of self-descriptive information expressed into metadata, these are a set of attributes or elements necessary to describe the object, with the metadata, you have a first approach to the LO, knowing its main features, such as name, location, author, language, keywords, etc. However, because a LO is a software product for educational purposes, it is feasible to consider pedagogical, technology and Human Computer Interaction (HCI) aspects in its design.

1.1. Cognitive Learning Process

These processes operate in the mental processes of acquiring new information, organization, retrieval or activation in memory. Thus they are related to regulatory processes that govern and control the mental processes involved in learning and thinking in general, affecting several activities of information processing, with special emphasis on learning complex (Rivas, 2008). The cognitive psychological processes are essential for the implementation of complex academic tasks (Díaz-Barriga & Hernández, 2010).

The basic psychological processes mentioned by Margarita Amestoy de Sanchez (1991), are: Observation, Comparison and Relationship, Simple Classification, Sorting, Hierarchical Classification, Analysis, Synthesis and Evaluation. These psychological processes are closely related to the instructional learning objective to be achieved in the design of teaching and learning process and can associate certain verbs used when generating the objectives. Every psychological process defined by Margarita de Sanchez (1991, 1991a, 1993) is described below:

1. Observation: to identify, to name, to describe, to discuss, to list, to locate, to characterize, to observe, to define, to label, to collect.
2. Comparison and Relationships: to interpret, to summarize, to associate, to differentiate, to distinguish, to compare, to relate, to merge.
3. Simple Classification: to categorize, to sort, to group, to sort, to select, to divide, to tabular.
4. Sort: to sequence, to serialize, to sort
5. Hierarchical Classification: to rank, to structure, to combine, to integrate.
6. Analysis: to connect, to predict, to extend, to interpret, to discuss, to display, to report, to experiment, to discover, to solve, to calculate, to analyze, to discriminate, to induce.
7. Synthesis: to estimate, to summarize, to apply, to demonstrate, to plan, to generalize, to complete, to illustrate, to explain, to show, to build, to infer, to create, to design, to invent, to develop, to modify, to formulate, to rewrite, to replace, to integrate, to use, to form, to deduct.
8. Evaluation: to test, to measure, to recommend, to judge, to explain, to evaluate, to criticize, to justify, to support, to persuade, to conclude, to predict, to argue, to feed back.

1.2. Learning Styles

Learning Styles are a sort of personal variables that lay somewhere between intelligence and personality and explain the individual different ways of approaching, planning, and answering to the learning challenges (Kolb, 1984).

The Learning Styles included cognitive and affective features. Cognitive features are related to how students structure the content, form and use concepts, interpret information, and solve problems. The affective features are related to the motivations and expectations that influence learning, while physiological features are related to gender and bio rhythms, such as the sleep-wake of the student (Woolfolk, 2006).

There are many classification models of learning styles, such as David Kolb model (1976), model of Ned Herrmann Brain Quadrants (Herrmann, 1982, 1990) model of NLP Bandler and Grinder (1982), model Multiple Intelligences Howard Gardner (1983), model of the cerebral hemispheres of Bernice McCarthy (1987) and the model of learning styles Felder and Silverman (1988), among others. In this work we used the model of Felder and Silverman, as a model currently working in the area of the LO (Capuano et all, 2005), (Graf, 2005), (Mustaro & Frango, 2006), (Graf and Kinshuk, 2006, 2009), (Chang et all, 2009), (Popescu, Badica and Moraret, 2010), (Alharbi et all, 2011).

1. The model of Felder and Silverman (1988) classifies learning styles based on five dimensions:
2. Sensitive-Intuitive: the sensitive student prefers to learn by studying facts that deal with aspects of daily life and the intuitive student through the study of abstract concepts.
3. Visual-Verbal: the visual student prefers to learn using visual teaching aids while the verbal student prefers to do it by listening or written form.
4. Inductive-Deductive: The best form for understanding the information for the inductive student is when he sees facts and observes and then infer the principles or generalizations, and the deductive student prefers to deduce consequences and applications.
5. Sequential-Global: the sequential student prefers to learn by following a sequential order and the global student prefers to follow a general schema that allows to visualize a whole instead of its compounding parts
6. Active-Reflective: the active student prefers to learn by doing activities and the reflective student through reasoning on things.

1.3. Instructional Techniques

Instructional or teaching techniques are procedures structured logically and psychologically for directing student learning, but in a limited or in a phase of the study of a topic, such as presentation, elaboration, synthesis or critique of it (Nérici, 1992). The technique is less extensive than that of an instructional method and strategy. It is related to the form of immediate presentation of content. It corresponds to the mode of action, objectively, to achieve a goal and fulfill a definite purpose of teaching. It is part of the method in the learning implementation (Nérici, 1992). For example, a case study, projects.

2. The Problem

Students, depending on their learning style, use in a conscious form, controlled and deliberate, procedures (sets of steps, operations, or skills) to learn and solve problems, i.e. structure their learning strategy (Díaz-Barriga & Hernández,

2010). The effectiveness thereof depends largely on the instructional strategy used (Ossandón & Castillo, 2006), in fact instructional strategies do not work in all situations to develop with any content.

The LO are computer and educational resources at the same time, and often in their design the Pedagogical Dimension issues are not considered. People consider models and technical standards that ensure interoperability characteristics, accessibility, reusability, adaptability and durability. For this reason, we must also consider the pedagogical characteristics in the LO (Hernández, 2009), this means, the LO must serve to different types of users, considering the individual characteristics of each and adapting instructional activities according to the learning styles (Arias, Moreno & Ovalle, 2009).

The instructional activities are implemented following instructional techniques; these techniques are part of the instructional strategies. You could say that the strategy is realized and made effective through the methods and teaching techniques (Nérici, 1992). Each instructional technique is assigned different degrees of adequacy and effectiveness in the teaching and learning, according to each learning style. Therefore, learning styles are very important in the teaching and learning process (Paredes, 2008). Felder and Silverman (1988) for example, argue that students with a strong preference for a learning style may have difficulties in the process if the learning environment does not suit their learning style.

Similarly, the Pedagogical Dimension of the LO's considers the proposed objectives, which are closely related to the cognitive processes that must operate in the mental processes of acquisition of new information, for their organization, recovery or activation in memory. Like learning styles, cognitive processes are also crucial in the selection of instructional techniques, because this has different degrees of effectiveness for each cognitive process.

From these perspectives, the LO design is a challenge for a teacher, who must also choose the content, use instructional techniques, based on the student characteristics from the standpoint of the learning style of the user (Ossandón & Castillo, 2006) , and cognitive processes related to learning objective of the student, defined at the beginning of the design of LO. For all the above, what can be recommended to the LO developers in terms of the most appropriate instructional techniques to learning styles and cognitive processes involved in the learning objective?.

3. The Model

In response to the above question, a model for LO development is proposed, based on the assessment of instructional techniques (Figure. 1). The teacher, through a learning platform, defines learning objectives, and then this platform selects cognitive processes involved in the objectives set by the teacher, also the teacher defines student's learning style to whom the LO is directed and finally from a platform selects from a population of 36 instructional techniques, the techniques that best suit to the cognitive processes and learning styles selected.

The teacher can structure instructional strategies, using the techniques indicated and then include the activities in the LO, according to the techniques. The technology platform uses a mathematical model to select the most appropriate techniques to learning styles and cognitive processes involved.

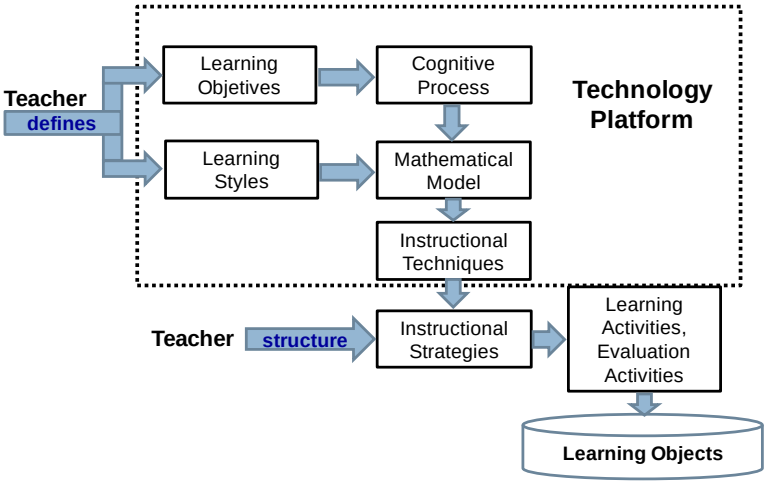

Figure 1: Development Model of LO, Based on the Instructional Techniques Recommendation.

4. The Model

As noted in the previous section, the selection of instructional techniques is performed using a mathematical model, which assigns a value to each technique according to the sum of adequacy factors of each technique to each selected cognitive process and learning style indicated by the teacher. The adjustment factor for each instructional technique to each learning style and each cognitive process is in the range of [2,10].

Equation (1) presents the mathematical model which calculates the value and shows the first three instructional techniques most suitable to each cognitive process (taking only the technical adjustment factor which is greater than 8), in a descending order.

$$t_i' = \sum_{j=1}^{8} \sigma(t_i, p_j) + \sum_{k=1}^{4} \sigma(t_i, e_k) \qquad (1)$$

Where:

$t_i \in T, i = 1,\ldots,36$

$p_j \in P, j = 1,\ldots,8$

$e_k \in E, k = 1,\ldots,4$

$\sigma(t,p)$ = Adjustment Factor of the Instructional Techniques t respect to Cognitive Process p

$\sigma(t,k)$ = Adjustment Factor of the Instructional Techniques t respect to Learning Style e

5. Results

Below it is shown the screen where the teacher indicates the instructional objectives (see Figure.2), then the technology platform shows the cognitive

processes (De Sánchez, 1991), associated with the instructional objectives given by the teacher (see Figure.3) and the teacher selects the learning style according to Felder and Silverman model (Felder & Silverman, 1988).

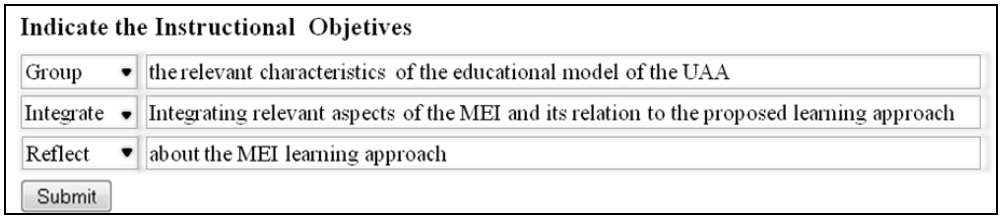

Figure. 2. Instructional objectives indication.

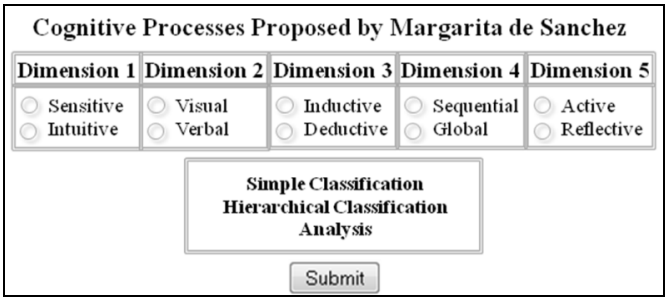

Figure. 3: Cognitive Processes associated with the instructional objectives and learning styles selection.

Process	Instructional Technique	Total valor of Technique
Simple Classification		
	workshop	79
	study conducted	78
	management notes	65
Hierarchical Classification		
	workshop	79
	study conducted	65
	pre questions	63
Analysis		
	workshop	79
	study conducted	78
	management notes	65

Figure. 4. Results of the evaluation of instructional techniques.

The latter figure shows to the left the cognitive processes associated with instructional objectives defined by the teacher, in this case the processes: Simple Classification, Hierarchical Classification and Analysis. For each process, it shows the three instructional techniques rated to each cognitive process. The assessment of each instructional technique, as mentioned, is associated with adjustment factors in each dimension of learning style and the factors chosen for adaptation to the cognitive processes involved. The results show the technical factors in the dimensions of learning style. It is observed that the most valued technique for the Simple classification is "workshop", whose total value is 79, which means that it fits within the value of 40 in the dimensions of the selected learning styles and a value of 39 to cognitive processes.

At the end the cognitive processes show the valuation of all instructional techniques included in the model. Note that the technique "Workshop" is, in general, the most valued, and properly applied in each cognitive process involved. However, the technique "addressed Study", the second highest score among all techniques, is not suitable for the hierarchical classification process. Similarly, valuation techniques which put them in third place, "prior organizers" and "Underline", respectively, are not suitable to any of the cognitive processes involved.

6. Conclusion

Once the teacher selects the learning styles and verifies the cognitive processes associated with the learning objectives for students, he activates the evaluation of techniques, obtaining the best instructional techniques to be used in the development of LO (see Figure. 4). The article presents the evaluation of instructional techniques according to the valuation calculated by its relevance to the learning styles according to Felder and Silverman model (Felder & Silverman, 1988) and cognitive processes proposed by Margarita De Sánchez (1991).

The Felder and Silverman model has been widely used to determine the LO suitability and of teaching resources in general. Similarly, cognitive processes defined by Margarita Sanchez is adapted to cognitive theory, emphasizing the internal forms of assimilation and processing of information.The evaluation of instructional techniques is based on the implementation of the proposed mathematical model, using the stored factors of each technique with respect to its suitability for cognitive process and learning style, these factors can be modified and better adjust by expert teachers.

The proposed model may be incorporated into a LO generator, which permits the use of predesigned templates for each specific instructional technique and directed to the teacher, for the design and construction of LO.

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