ROADMAP FOR EMPIRICAL EVALUATIONS OF LEARNING OBJECTS

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ABSTRACT

New teaching approaches have recently been explored in several areas of knowledge and methods, especially in distance education. In the context of these approaches are the learning objects, because it is believed that they enhance the teaching and learning process. However, in the Software Engineering area, the evidence of the effects of the use of learning objects is still negligible when compared to other areas of knowledge. Thus, performing experiments on the effects of learning with learning objects in Software Engineering becomes relevant. This paper describes a roadmap for conducting experiments with learning objects and two performed experiments, describing the attained results.

Keywords: **learning object**; **roadmap**; **experiment.**

1. Introduction

The importance of using new technologies in education, mainly computer-based tools, is due to the impact caused by computing on our society. This factor is also driven by new demands for skills the labor market and competitiveness in organizations require. Moreover, people born in the last decades of the twentieth century, having extensively used various types of electronic devices, are defined by PRENSKY (2001) as "digital natives".

The generation of digital natives has a mental structure, which requires forms that allow a faster learning through new technologies and differentiated methods (PRENSKY, 2001). This causes a change with relation to the traditional teaching methods which paradigm focused heavily on the content taught by the teacher. This change also requires that teaching based on books and lectures make space for new approaches and resources for teaching and learning.

Among the new technologies used in education are the learning objects, which came to be employed in the teaching-learning of the most different subjects. Such tools are used from elementary education to post-graduation, also passing several other qualification programs and professional areas. In this context, learning objects have shown they can be of great importance in the knowledge and skill assimilation and building processes. Through the learning objects, experiments using virtual elements can be developed, reducing the gap between theory and practice and consequently, learning by doing.

One way to obtain evidence of the effectiveness of new teaching approaches is through empirical studies. Empirical studies are the primary way to obtain information and understanding of specific factors that will allow making well founded decisions (PERRY, PORTER and VOTTA, 2000). In these cases, assessments of pedagogical approaches and learning curves are appropriate (JANZEN et al., 2007). Based on the presented context, this work seeks to give a contribution in the area of empirical studies on the use of learning objects by proposing a roadmap to support the performance of such studies.

2. The teaching-learning process

Education can be seen as a form of perpetuation of the society through the transmission of its cultural achievements from generation to generation. It is a social process that plays an important role in the history of peoples. Education can also be seen as an individual process which aims to stimulate the growth and development of individuals. These two aspects are actually complementary, as individual development cannot be understood without possession of the social heritage, in the same way as social transmission cannot be understood without individual transformation. "From the standpoint of both society and individual, education is an incentive for changes." (CUNNINGHAM, 1975, p. 6). Therefore, the task assigned to education consists in reproducing the moral values of a society across generations, integrating individuals and promoting the reform of social aspects being considered negative ones.

Learning, from the cognitive point of view, is understood as an individual process of inner realization, which corresponds to changes of the internal cognitive structures that can be observed through the external behavior of individuals. Learning is said to be a process since education cannot be understood as something ready and done, but being in constant transformation (VENTURA, 2005). The learning process is given by the subjects' interaction with the environment, through which they receive challenges that activate their mental structures, thus allowing the elaboration of solution schemes that satisfy their adaptation or the transformation of the environment in which they are inserted in. Therefore, it is understood that learning occurs on an ongoing basis, in all situations of life. In a classroom, the teacher develops situations designed to cause the same effect on the individuals, which is understood as teaching. In the teaching-learning process, the individuals acquire experiences that help increase their capacity, change provisions for actions against the environment they live in and make changes in their behavior (BASTOS, 1994).

This learning process can be viewed as a system in which the individual is inserted in. The terms system or systematic approach are commonly used jargons to describe the teaching-learning situations in most situations where development of technology-related educational methods exists (ELLINGTON and EARL, 1996). In a systematic way, the objectives of the teaching-learning process can be classified into three categories: aims, objectives, and learning outcomes (ELLINGTON and EARL, 1996). The learning outcomes or learning objectives are the new skills that must have been acquired by the student (BLOOM, 1956).

The fixing of educational objectives, also known as taxonomy of educational objectives, or more popularly as the Bloom taxonomy, is a structure that hierarchically organizes the educational goals. The Bloom taxonomy is well known and used in education for defining learning objectives and verifying of their achievement. Bloom has identified three domains of learning, each organized as a series of levels or pre-requisites. The identified earning domains are (BLOOM, 1956):

- Cognitive: knowledge domain. It refers to structures of knowledge and development of intellectual skills;
- Affective: attitude domain. Refers to the emotional aspects such as feelings, values, gratitude, enthusiasm, motivation and attitudes;
- Psychomotor: skill domain. It refers to the ability to perform movements, coordination and further motor skills.

In the cognitive domain, Bloom identified six levels starting from the knowledge, remembrance or recognition of facts, classifying it the most basic level, rising up to the more complex and abstract mental level, classified as evaluation. The deep levels of the cognitive domain are: knowledge, comprehension, application, analysis, synthesis and evaluation (BLOOM, 1956).

At the moment of the learning outcome definition it is necessary to define the cognitive domain levels to be achieved. The content and materials used should be prepared considering the defined learning outcomes. These levels can be used as a basis of comparison to be applied for identifying how much a particular method helped in the teaching-learning process.

3. Roadmap for empiric evaluations of learning objects

The roadmap is intended for the empirical assessments of learning objects. It is based on Kochanski's (2009) work. Empirical evaluation or experiment is a type of study performed in order to determine the factors that cause change in the results of a particular object of study. The roadmap is divided into five parts.

The first part of the roadmap contemplates the context in which instructions are given, the preconditions for the subjects to receive the instructions, the list to be followed, and the general objectives of learning. It also has the detailing of the learning objectives into specific objectives with appropriate contents and strategies used, the evaluation method to be employed and the literature related to the subject.

Once the context of the experiment is defined, it is necessary to describe its planning. The planning of the experiment is carried out in Part II of the roadmap. Planning is a very important step in order to ensure that a minimum of deviations occurs in the execution of the experiment. The success of an experiment can largely depend on its planning. At planning of the experiment, the selection of the context, the definition of research hypotheses, the definition of control variables, the way of selecting the participants, the design of the used experiment, the instrumentation planning, and the validity evaluation are performed.

Once the planning is finalized, the experiment operating procedures can begin. These procedures are defined in Part III of the roadmap. Such statements contemplate information about the participants' role in the experiment, the importance and possible risks that may be subject to or benefits they are receiving, as well as the list of materials to be used in the experiment, as well as how they will be used, at what moment they will be required and any existing confidentiality in relation to the contents of the materials.

Moreover, in Part III, the form is considered, which will be used to increase the possibility or guarantee that the participants are committed to carry out the activities of the experiment without influencing the control variables, as well as the description of how the process will be conducted to collect the experiment data and how will be guaranteed that the data passed to analysis be authentic to the collected data, avoiding possible transcription errors.

In Part IV, the settings are made on the analysis and interpretation of the results. After completion of the experiment and consequently after the data collection, these data have to be analyzed and interpreted. In the data analysis and interpretation the type of test used, statistical calculations, the way the analysis of possible points of dispersion (outliers) will be carried out, and how testing will take place in each of the research hypotheses should be taken into account.

In Part V, the definition of the experiment result presentation is performed. The structure of the result presentation is composed of an abstract, introduction, problem statement, experiment performance, discussion and conclusions, recommendations and future works, acknowledgments, references and exhibits.

4. Roadmap application

In order to check the applicability of the roadmap and to obtain data on the effects of the use of learning objects, the planning, execution and analysis of the results of two experiments was carried out. The interest in developing support elements to the use of learning objects is consistent with the actions being taken by UNIASSELVI /NEAD regarding the development and improvement of learning objects. In these experiments, the following research hypotheses were used:

- H_0: The learning effect in the levels of knowledge, understanding and application of the experimental group are not higher than those of the control group.
- H_1: The learning effect in the levels of knowledge, understanding and application of the experimental group are higher than those of the control group.
- H_2: The use of learning objects makes the process more attractive.

The first experiment was conducted in Blumenau - SC with a group of undergraduates of the seventh semester of Information Systems. The experiment was conducted during the teaching period in the subject of Software Engineering. The second experiment was performed in San José - SC with a group of undergraduate students of the eighth semester of Computer Science. The experiment was conducted during the lessons of the subject of Software Engineering II. For the experiment performance, the prototype of the learning object X-MED was employed. X-MED is a learning object prototype that provides teaching support in the software measurement area designed for beginners in the measurement area, but who have a basic theoretical knowledge in software measurement and analysis (LINO, 2007).

In planning it was decided that the kind of study to be conducted would be the experimental one with pretest and posttest design. The Experimental type of study is that in which the distribution of the participants of the experimental group and of the control group is random (KOCHANSKI, 2009). Each experiment was performed in two days. On the first day the participants had a lesson lasting about 90 minutes on software measurement. After class they performed the pre-test which contained 25 questions on the subject matter. On the second day participants were randomly divided into two groups, the experimental group and control group. The experimental group is the one which is undergoing treatment/intervention or the application of the method being investigated in the experiment, in this case, the use of learning objects. The control group is comprised of participants who do not receive the treatment/intervention or the application of the method being investigated, constituting the basis for comparison with the results of the experimental group.

The experimental group was sent to a computer lab which work included the use of X-MED learning objects. The control group, however, was directed to another computer lab where the activity to be developed was the use of other software unrelated to the study objectives. Completed the laboratory activities both groups were reassembled in the classroom and completed the posttest. In order to reduce any possible discrepancies, the applied questions were exactly the same of the pre-test, but distributed in a different order.

Carried out the experiments, the collected data were transferred to a spreadsheet in order to allow the analyses and testing of the research hypotheses. A scatter graph was produces to find possible points of abnormal or false data, also called outliers. If there are no points to be eliminated, the data were organized into tables for the application of statistical tests. The type of the selected statistical test was the nonparametric, therefore, the Mann-Whitney method was used due to the characteristics. The Mann-Whitney method is used when the statistic test is nonparametric, samples are independent and obtained from the same population (KOCHANSKI, 2009).

From the obtained results, a quantitative assessment was performed through which it was not possible to demonstrate significant differences that allow refuting the research hypothesis H_1. In this case, the research hypothesis H_0 can be accepted as valid, i.e., the learning effect on the levels of knowledge, understanding, and application of the experimental group is not significantly higher than that of the control group. Before performing the experiments it was believed that the use of learning objects could cause a significant effect on learning among graduation academics in the Computer Science/Information Technology area.

In addition to the quantitative assessment in order to test the research hypotheses H_0 and H_1, a qualitative assessment in order to test the hypothesis H_2 we performed. The hypothesis H_2 states that the object of learning makes the learning process more attractive. To test this hypothesis a specific question in the questionnaire of awareness of the research activities was formulated. The purpose of the question was to obtain the participants' perception regarding the use of learning objects. The data show that most participants indicated that they liked to use the learning object. Thus, evidence that the use of learning objects made the experience more attractive can be obtained.

5. Final considerations

Given the importance learning objects are going to take in the teaching-learning process, especially in correspondence course education, there is need to explain how the effects of such learning resources are being evaluated. Using the roadmap, it can be verified that it allows the researcher to focus on relevant issues related to the context of the experiment, ridding him of concerns about activities that needed to be done, as well as the sequencing of these activities. Using the roadmap, all the experiment related activities can be performed with less margin for planning faults, material preparation and data collection.

It is believed that the fact that the roadmap simplifies the process of conducting experiments, can encourage conducting more experiments with learning objects. The result, as a consequence of further empirical studies, is the increasing improvement of learning objects and the attainment of better results from their use.

Although the results of experiments have shown that the learning object has not contributed to the teaching-learning process as it was believed, these results have great relevance. Such results serve as support for making changes in the learning object so that it can become an important resource in the knowledge building process.

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