

# Learning objects lost in the network

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## *Abstract*

**Most leading universities are using various elements of distance learning. Preparation of high-quality educational materials for the needs of studies, courses and training still consumes the majority of financial resources allocated by institutions for activities in the field of distance learning. The lack of a well-thought-out e-learning strategy for the creation of knowledge resources is a barrier that hinders the sharing of knowledge between training institutions - such as universities, schools and training companies - from various sectors of education, business and administration. This results in a waste of resources, as institutions invest repeatedly in creating the same content. An attempt to solve this problem has led to the development of the concept of learning objects - independent components of e-learning courses that can be used in various distance learning environments and in various educational contexts. The authors of this article have examined whether there is a chance to create an internal university repository of teaching materials that university employees can use. This research is the result of 21 years of work on implementing e-learning at the European University. During research on learning objects, experience was gained from universities in the Netherlands (Open University of the Netherlands, University of Twente), Canada (Athabasca University) and the USA (California State University, Brigham Young University).**

***Keywords — learning objects, units of learning, repository of educational content, e-learning***

## I. INTRODUCTION

Most leading universities are using various elements of distance learning, particularly after the Covid-19 crisis demanded it on a global scale. At some universities, e-learning has been integrated in the curriculum, while in many it is only an additional offer developed by e-education enthusiasts [1]. Preparation of high-quality educational materials for the needs of studies, courses and training still consumes the majority of financial resources allocated by institutions for activities in the field of distance learning. The lack of a well-thought-out e-learning strategy for the creation of knowledge resources is a barrier that hinders the sharing of knowledge between training institutions - such as universities, schools and training companies - from various sectors of education, business and administration. This results in a waste of resources, as institutions invest repeatedly in creating the same content. An attempt to solve this problem has led to the development of the concept of learning objects - independent components of e-

learning courses that can be used in various distance learning environments and in various educational contexts. Research on these so-called objects of knowledge – which appear under many names and definitions in the literature on the subject - is very popular. In this study we adopted a definition of learning objects close to that proposed by Koper [2]: smallest units of learning “providing learning events for learners, satisfying one or more interrelated learning objectives.” According to this definition, one cannot divide the learning unit into smaller components (single text paragraph, image, recording, table, chart, etc.) without losing key properties. We are taking into consideration only one element of the course, which allows the student to achieve at least one learning goal -- for example, in the case of mathematics, students learn how to multiply matrices. In this article we look at the use of a knowledge repository on a university campus. Many educators create educational materials with the goal of them being used repeatedly both inside and outside universities, but without an efficient way to share these materials, hopes for economizing the preparation are not often fulfilled. The idea of having a knowledge repository is to preserve and make public a large number of good-quality learning objects so that the preparation of new educational material simply involves the selection and modification of existing content. This is contingent on the authors willingly sharing the product of their course preparations. The materials placed in the repositories are very diverse, mainly in English and very often inaccessible to the majority of the teachers who teach the subjects in non-English languages.

## II. LITERATURE REVIEW

The topic of didactic material repositories or knowledge object repositories has met with great interest among researchers over the last 20 years. An overview of the most popular repositories can be found, for example, in the works of McGreal [3]. The most frequently described repositories include: ARIADNE, SMETE, MERLOT, GEM LearnAlbert, EdNa, OpenDOAR, CMU OLI and Maricopa Learning Exchange [4].

Researchers classify repositories according to the location of resources, accessibility for users outside the organization, the level of difficulty of the materials placed in them, and the thematic scope and granularity, i.e. the size of the objects. Other criteria of the division are based on the repository's technological architecture, the method of implementing the repository, the number of objects placed, and the quality control mechanisms or additional services offered [3, 5]. We can also find studies on the quantitative parameters of selected

repositories [6] which show that none of the repositories have achieved exponential growth in teaching materials - an active author in the repository publishes an average of 10 learning objects. Case studies which are widely acclaimed by users of repositories of learning objects can be found in the work of the Wisconsin Technical College System Researchers, a CANDLE project consortium of 12 universities from America and Europe and the University of West Florida [7, 8, 9]. The analysis of selected repositories shows that many of them have shortcomings, the most important of which is the placement of didactic materials that do not correspond to the learning objectives, which are to be implemented during the course, and outdated content [10].

Based on the literature, it is possible to indicate the key elements determining the success of repositories such as: effective search mechanisms based on metadata, free access to the repository and intuitive navigation, ease of the use of teaching materials, implemented quality control mechanisms and the community created focused on the repository [3, 11, 12, 13, 14]. Bennett's research [15] additionally indicates that one of the main factors motivating users to use the repositories is the ability to use teaching materials as they are, without having to modify the content.

### III. THE LCMS (LEARNING CONTENT MANAGEMENT SYSTEM) PLATFORM AS THE BASIC TOOL FOR BUILDING A UNIVERSITY REPOSITORY OF TEACHING MATERIALS

At most universities where we can find users of repositories of teaching facilities, e-learning platforms have been successfully operating for many years, and have become a standard element of the educational environment. From the organization's point of view the most important thing is to create a large repository of learning objects together with a database of student profiles [16], it is practical to try to use the systems already in existence at the university. The differences between distance learning systems and repositories of learning objects systems are minimal.

Learning objects obtained in repositories can be used, shared, and often stored in LCMS [17]. Users of LCMS systems have the ability to create training content, store it and share it with selected users, as well as launch a workflow mechanism associated with user roles in the system, enabling content versioning. There are other functions that could be added to the standard functions of these systems: a content search engine, the ability to tag content, and also some platforms allowing the creation of teaching objects with metadata in the selected standard. It is also possible to add or configure content rating modules (through a discussion forum, survey system or voting with stars). Because LMS/LCMS systems have been operating at universities for many years, instead of building a new repository from scratch, the universities would save money by using what already exists after modifying it to fit its needs - particularly because they are filled with proven, repeatedly used teaching materials. In addition, to start using the repository, one does not need to conduct additional training or prepare user instructions for the use of resources. Some researchers have equated object repositories and the LCMS system, which is to say that if one knows how to use one, one knows how to use the other [11]. In the literature we can find examples of this type of

repository [12], in which learning objects are made available in the form of ready packages used directly in the classroom; the content is classified according to the organization's structure and programs offered by organization, and it is possible to copy specific courses to the workspace. Those who most benefit from using the LCMS platform as a repository are users who know the platform well and receive materials that they can directly include in their classes. The main disadvantage is the lack of flexibility in the modification software code of the platform. The promoters of repositories based on the LCMS platform are Fern University Hagen in Germany [19], University Colombo in Sri Lanka [20], Natl Chiao Tung University in Taiwan [21], and University of Adam Mickiewicz in Poland [18].

### IV. CASE STUDY FROM A EUROPEAN PRIVATE UNIVERSITY

A private university in Europe that will remain anonymous was the first in its country to introduce classes using distance learning techniques in 1996. The University puts great emphasis on scientific research. The HR Excellence in Research distinction received in 2017 confirms the quality of research carried out at the university. Our researchers are also educators, and the typical teaching load is 240 hours per academic year. The coordination of activities related to the use of distance learning methods and techniques in the education process is handled by employees of the Internet Education Centre. The Centre consists of a manager responsible for developing the university's strategy in the field of remote classes, teaching tools and resources, as well as two groups of employees, i.e. teaching methodologists responsible for consulting and training employees in the selection of appropriate teaching methods, and IT specialists (databases, graphics, administration) responsible for IT infrastructure and the production of teaching materials. Regardless of the field of study, approximately 20% of classes at this university take place solely online. Its widespread use of mixed teaching methods makes the institution a very good field of research for e-learning solutions.

### V. CONSTRUCTION OF THE REPOSITORY

A university repository of didactic materials was built based on the Blackboard Learn 9.1 Service Pack 6 platform because at this university that is the leading compulsory e-learning platform for students and research staff. This platform has built-in mechanisms to support multiple uses of content. There are two types of objects called reusable learning objects and learning objects (the difference relates mainly to rights of access to the elements), enabling the sharing and reuse of the elements of each course from teaching modules to the individual elements of the course. In fact, on the Blackboard platform there are no restrictions as to the substantive content of educational materials. The repository is based on the learning objects mechanism because they are checked or reviewed by the responsible administrator and, after obtaining approval, placed in a publicly accessible catalogue of learning objects. However, the central catalogue of learning objects or teaching materials can be searched through keywords or individual fields from metadata.

### VI. METADATA

The key issue in building the repository was to define the metadata schema. The IMS data template version 1.2.1 was

chosen as the basis for the university's metadata template. From 96 fields, which are available in the full IMS model, fields from the taxonomy category and metametadata were cut out because objects were embedded in the inner university repository. Some fields from other categories, for example technical metadata, were also considered unnecessary, because the catalogue administrator checks its technical parameters and how it works on the platform before entering the given object. Categories related to the description of the teaching process were considered the most important for the university. Metadata fields are not found in the IMS standard, but important fields for managing learning objects at the university have also been added:

1. The Revise field in the Lifecycle category to specify the update frequency. This is an important parameter because some of the teaching materials never require substantive updating (for example, objects in the field of mathematics), but some must be updated on a regular basis.
2. The Affiliation field in the Lifecycle category, specifying the affiliation of the object to the teaching or organizational unit of the university, usually the department.
3. The Learning Goals field in the Educational Metadata category allows you to search for the content you need more easily.
4. The Standards field in the Educational Metadata category according to a defined dictionary (in accordance with the learning outcomes adopted at the university).
5. The Funding field in the Legal aspects' category, which is relevant in the aspect of sharing content with other institutions.

Educational data is the most important element of metadata, insofar as that data enables the learners/educators or managers of the training material to locate the needed content. The completion of these fields should be ensured.

## VII. LEARNING OBJECTS CATALOGUE

The didactic materials created in the form of a learning object were catalogued in a university repository of didactic materials. After consultation with didactics, the catalogue was organized according to fields and levels of study, and can now be searched both by keywords and by course. People wishing to use existing materials can obtain the information on the learning objects: comments of educators and students, permissions, statistics and metadata. An object that meets user requirements can be embedded in the course being created, or saved in the user's workspace, or downloaded to a disk. The objects included in the catalogue have been reviewed in terms of both substantive and technical content, which is why the user (usually a research and teaching employee) can be sure that they meet the quality requirements set for teaching materials at the university. According to the adopted assumptions, the repository only contained teaching materials that have specific teaching purposes and learning outcomes.

## VIII. RESEARCH METHODOLOGY

### Target group

For research on the usability of learning objects and their repository among academic teachers, academic staff representing four faculties at the university were invited. The exact characteristics of the people surveyed are presented in Table 1.

TABLE 1. CHARACTERISTICS OF THE RESEARCH GROUP COMPOSED OF RESEARCH AND TEACHING STAFF

	Department of Administration and Social Sciences	Department of Economics	Department of Applied Computer Science	Department of Medicine	Total
Women	5	6	1	3	15
Men	2	1	5	2	10
Average age	37,7	35,1	35,5	36,0	36,1
Average working time at the university (in years)	10,8	10,5	10,5	9,4	10,4
Average working time on the Blackboard Platform (in semesters)	10,4	7,4	10,6	9,4	9,4

The study covered 25 people with various levels of seniority (from newly recruited employees to those working already for 18 years). All respondents were highly competent in the use of e-learning in teaching, although not all of them had extensive experience working on the Blackboard e-learning platform. Working time using the platform ranged from zero (only completed training for newly recruited employees) to fourteen semesters (i.e. from the implementation of the platform).

### Some limitations of research

Participation in the study required familiarization with functions of the Blackboard platform not used in normal teaching practice, which is why participation in the study was not limited to completing the survey only, but required additional efforts from the educators. Only 25 (about 8%) of several hundred academic teachers employed at the university were invited to participate in the study, because the study was conducted during the holiday season. The period of the academic year was not conducive to testing procedures regarding learning objects because of the didactic workload of teachers. We attempted to broaden the selected group beyond

distance learning enthusiasts, but this type of person nonetheless prevailed in the study.

Another barrier in the study was the limited number of learning objects available in the catalogue.

Another important problem is the inefficient process of conducting e-learning classes: the teachers do not technically work out the teaching materials themselves, but rather contact the employees of the e-learning team who are in charge of creating and implementing the e-learning courses.

### Construction of a questionnaire - the usability of repositories of learning objects

The questionnaire used in the study included questions relating metrics, questions about the ease of using the repository, questions about the usefulness of learning objects, and the meaningfulness of features of individual learning objects. The authors tried to use commonly used software usability models. The questions from the UTAUT (The unified theory of acceptance and use of technology) model were used in the part regarding the ease of use and usability of learning objects.

Open questions were placed at the end. The reliability of the questionnaire measured by Cronbach's alpha measure was 0.900, and deleting any question reduces the reliability only to 0.887. Such a high level of alpha means that the questionnaire was built correctly [22], but also testifies to the reliability of the answers given by the teaching staff.

### Research procedure

In the last week of June 2017, due to the inability to set a training date, survey participants received a guide explaining what the learning objects are and what motives are behind creating learning objects and their repository, and detailing how they function on the Blackboard platform. The authors tried not to employ the term learning objects in the guide, so as not to discourage academic teachers; instead, the term teaching materials was used. In case of any problems, the employees of the E-learning team were at the respondent's disposal: personal contact as well as telephone and e-mail contact were possible. After two weeks, the final questionnaire was made available electronically, and was completed by all participants in the study.

## IX. SURVEY RESULTS

The statistical description of the responses in the final survey is given in Table 2.

TABLE 2. STATISTICAL DESCRIPTION OF THE FINAL SURVEY ADDRESSED TO TEACHERS

		Min	Max	Mean	Std. Deviation
<b>Ease of use of the repository</b>					
<b>Searching</b>					
1.	I easily learned to search for teaching materials.	2	5	3,88	1,054
2.	Using metadata fields in searching teaching materials did not cause me a problem.	1	4	2,72	1,137
<b>Adding objects to the course</b>					

		Min	Max	Mean	Std. Deviation
3.	Adding the selected knowledge object in the form of html document to my course did not cause me a problem.	1	5	3,88	1,054
4.	Adding the selected knowledge object in the form of pdf document to my course did not cause me a problem	1	5	4,24	,970
5.	Adding the selected knowledge object in the form of the SCORM package to my course did not cause me a problem.	1	5	2,88	1,424
6.	Adding the selected knowledge object in the form of a checking test to my course did not cause me a problem.	1	5	2,40	1,225
<b>Creating learning objects</b>					
7.	Saving the course content I created as a learning object was easy.	1	5	3,72	1,308
8.	Saving the checking tests I created as a knowledge object was easy.	1	5	2,44	1,387
<b>Utility</b>					
9.	I would like to compose courses consisting of learning objects.	1	5	2,72	1,339
10.	Using the object search functionality made it easier to find teaching materials of good quality.	1	5	3,44	1,193
11.	The description of learning objects in the catalogue is sufficient.	2	5	3,92	,909
<b>Features of learning objects</b>					
12.	Interactivity.	1	5	4,08	,954
13.	Aesthetic appearance.	2	5	4,20	,645
14.	Designed especially for educational purposes.	1	5	4,04	1,060
15.	Linked with the purpose of teaching and learning outcomes.	2	5	3,88	,927
16.	Testing elements for students to check learning outcomes.	1	5	3,76	1,091
17.	Saving results in the Grade book of the platform.	1	5	3,00	1,190
18.	Possibility of moving to another e-learning environment.	1	5	2,48	,963

where: 1 – I totally disagree, 2 – I disagree, 3 – I have no opinion, 4 – I agree, 5 – I totally agree.

### Ease of using learning objects and their repository

#### Searching

Searching for learning objects was easy or very easy for most respondents (52% and 28%, respectively). However, if we analyze the search method, it turns out that the simplest search by browsing the course folder is preferred. Detailed searches using metadata fields caused a lot of problems for up to 56% of respondents. Analyzing the answers, we found that employees of the Department of Applied Computer Science, for whom the use of various types of metadata is obvious, had no problems with searching. Perhaps some of the respondents read the guide on using this functionality of the Blackboard platform, which explains the result obtained. Five out of our respondents contacted the employees of the E-learning team regarding the search using metadata.

### **Adding teaching materials to conducted courses**

In order to test the learning objects, exemplary learning objects of various formats were placed in a specially separated folder within the catalogue of courses. Participants were asked to add learning objects to the courses they conduct.

As expected, the easiest option in terms of adding an object was to do so in the form of a simple pdf file and html document. These types of documents are most often added by teachers during classes. In addition, it's easy to preview the content. Adding tests and SCORM packages to the course, however, caused major problems. As many as 56% of respondents completely disagreed or simply disagreed with the statement that adding the SCORM package was not a problem. For tests, this percentage is even more unfavourable, amounting to 72%. In both cases, adding objects to the course, you must specify many of their parameters (height, width, randomization of questions, how to display on the screen, etc.), which is a problem for people outside the team of e-learning specialists. An additional difficulty with courses in the form of SCORM packages (file with the extension .zip) is the lack of possibility to preview the content.

### **Educators' creation of teaching materials for the repository**

The next group of questions concerned the creation of learning objects. Saving learning objects did not caused problems for 68% of didactics, whereas saving already created tests did cause challenges. This was largely due to a lack of ability to create tests that adequately assess students' knowledge, because these tests are usually created by employees of the e-learning team. The last question in this group examined the possibility of self-creating metadata and this task turned out to be the most difficult during the two-week experimental period, because as many as 76% of the respondents completely disagreed or simply disagreed with the statement that it is easy to fill metadata. These problems are confirmed by the observation that teachers who tried to add the metadata of objects filled in only a few of the available fields correctly.

### **Utility of the repository**

The second part of the questionnaire referred to the problem of the utility of the learning objects and the repository itself.

Question Number 11 shows a large diversity of opinions regarding the educators' construction of e-learning courses for their own classes. Analysis of the results by individual faculties shows that the greatest desire to create e-learning courses is demonstrated by employees from Department of Applied Computer Science (average rating 3.28) and Department of Medicine (2.80), whereas employees of the other two Departments – Administration and Social Sciences (2.42) and Economics (2.33) – remain more sceptical. While the attitude of the employees of the Department of Applied Computer Science is not surprising, probably being associated with their competence in the use of new technologies, the position of the employees of the Medical Faculty is surprising. It may be explained by their prioritization of efficiency: there is a high rotation of employees within this department (mainly doctors of medical sciences) who would undoubtedly like to profit from previously created materials.

The remaining questions from the utility category show that the proposed structure of the catalogue of learning objects, their description and association with learning objectives is sufficient. In question 12, as many as 72% of respondents confirmed that it is easier to find good quality objects in the university repository than to do so by using other sources, as long as the provided repository is supplied with the appropriate number of objects. The description of objects using such extensive metadata also met with a positive response of the respondents. It seems that the standard description of educational facilities using only the title and keywords and the type of resources is not sufficient.

### **Desirable characteristics of teaching materials in the repository**

Features such as the aesthetic appearance and interactivity of learning objects turned out to be the most important. In the case of interactivity, one may wonder to what extent this feature is really desirable, and to what extent it should be indicated. The authors' experience from being on the e-learning team shows that the request to the course author to design interactions usually remains unanswered or interactions are understood only as standard checking tests or course navigation, and in the most advanced cases, –as defining the learning path. Usually, the teaching staff themselves do not have the appropriate skills to prepare interactive materials, which accounts for why they so value materials that have both these qualities (aesthetic, interactivity). The element that ranked as next most significant was the didactic feature of learning objects. The use of materials especially designed for educational purposes turns out to be important or very important for 84% of respondents. There is a lot of content on the Internet that can be used in teaching, but adapting it to one's own group can often be very time-consuming. Materials designed directly for educational applications often have a well-thought-out structure, care for the language and contain testing elements. For 84% of respondents, direct description of learning goals also turned out to be very important.

TABLE 3. AVERAGE USEFULNESS SCORE OF FEATURES OF LEARNING OBJECTS IN DESCENDING ORDER

<b>Features of learning objects</b>	<b>average rating</b>
Aesthetic appearance	4,20
Interactivity	4,08
Designed especially for educational purposes	4,04
Link with the purpose of teaching and learning outcomes	3,88
Testing elements for students to assess learning outcomes	3,76
Saving results in the platform's grade book	3,00
Possibility of moving to another e-learning environment	2,48

Next in order of importance for the features of learning objects is the existence of testing elements that allow the student to evaluate which learning outcomes have been achieved. Interestingly, saving the results in the grade book is not so important for more than half of the respondents. The explanation for this seems to be quite simple: most educators check the students' knowledge of online classes in a traditional way, so it

is important for the student to be able to evaluate himself on the platform to ensure that the learning process is progressing well.

An additional problem may be the specificity of some subjects that require a long, written essay which cannot be checked in an automated manner. In this situation, the platform is seen only as a place of communication with the teacher, who must personally check the work and give one final assessment.

The last, closed-end question in the survey concerned interoperability, namely the ability to move objects between different e-learning environments. Because the surveyed are employees of one university, where a dedicated team is responsible for the implementation of training content, this feature of learning objects turned out to be irrelevant for 56% of respondents, and 32% did not have a fixed opinion on this subject.

#### X. SUMMARY

Based on our results, to ensure the best economy of learning objects within one institution, we recommend that a wide educational campaign be carried out among the employees of a given institution, preferably those of scientific and didactic domains, explaining what learning objects are and highlighting the benefits that can be gained by using them. Educators can be persuaded to create learning objects on their own if they are provided with the support of a technical team that will independently carry out the most difficult elements of learning objects, and even entire objects (in the case of an institution that has financial resources to maintain such a team). Thematic training should be carried out in the field of object search strategy, saving them in personal space, placing in the course, modifying the content of objects (if such an operation is possible) and creating learning objects both on the basis of own materials and on the basis of what is taken from external sources. Objects should be created using proven templates that meet the platform's technical requirements and provide guidance on best didactic practices. The greatest attention should be paid to the selection of the best online teaching strategy, because ultimately the objects are created to improve the teaching, not for the ideal student, but for the ordinary student at the university. None of the respondents were aware of the existence of specialized repositories of learning objects, therefore, more exposure to these should be included in the training program.

There is a big gap between the needs of a technical team wanting to describe learning objects using metadata for smooth management of learning objects and the needs of academic teachers, for whom the most important is the didactic effectiveness of objects. Only a few basic metadata fields should be visible and filled by research and teaching staff. The rest should be filled by professionals. Excessively burdening teachers with the creation and management of learning objects and the actual use of technical repositories will only discourage them, and, as a consequence, block the implementation of learning objects for general use. These conclusions do not differ from those observed by other researchers [23, 24, 25, 26]. The need and challenge for the future is clearly to educate academic teachers more fully regarding the university repository so that its use becomes standard procedure. The most important problem to overcome will be the distrust regarding sharing the results of the work. Of course, all technology changes, including updates

to the existing platform, will require increased attention so as not to waste the institution's existing resources.

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