

# Development and Evaluation of e-Course Material for Teaching Natural Sciences in Final Grade of Primary School

Athanasios Tsaprounis

Directorate of Primary Education of Pthiotida, Lamia, Greece  
Email: thtsap@gmail.com

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## Abstract

The aim of the present study is included in the wide field of studies of Natural Sciences and in particular it is aimed at assessing the learning object “The journey of energy”, which was created for the needs of the present research work. The learning object includes a series of enriched interactive activities which are structured according to the structure of the Curriculum for the teaching of energy in Physics at the Primary Schools. The learning object was available in the user repository (e-yliko) of the “Photodentro” and the evaluation results showed that the specific learning object is sufficient and suitable for use in the educational process, meeting all the evaluation criteria of the LOEM evaluation model.

## Keywords

Natural Sciences in Final Grade of Primary School, Alternative Ideas, Learning Object, LOEM, Evaluation

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## 1. Introduction

The learning objects through teaching practices and tools must encourage interaction and intense participation in the learning process as they presuppose the theories of constructivism, exploratory and collaborative learning constituting in a sense their evolution. The evaluation model LOEM (Learning Object Evaluation Metric) (Kay & Knaack, 2008) which was used, is based on a study of educational design and some evaluation models that have been used in the past proposed five basic criteria regarding this model: interactivity, design, engagement, usability and content. In Greece, there is “Photodentro”, which is a Greek National Aggregator of Educational Content, which was designed and developed to

host, organize and distribute Open Educational Resources concerning Primary and Secondary Education.

## **2. Theoretical Framework**

### **2.1. Student Perceptions of Energy**

Children in their attempt to understand the term “energy” in Natural Sciences, attribute different meanings which can be categorized as follows: (Becu-Robinault & Tiberghien, 1998; Doménech, 2000; Kesidou & Duit, 1993; Kruger, 1990; Nicholls & Ogborn, 1993; Trumper, 1993).

Connecting energy with living beings (humanistic or animistic model). This model is adopted more by young children and mainly by girls, who associate energy with people’s age and health status, while boys associate energy with people’s physical condition.

1) Linking energy with movement has absolute relevance to the model that present energy as a product of a situation and specifically when some activities are performed.

2) Connecting energy with the concept of force and more generally with the concept of action: This model assumes that energy is hidden in most bodies and is released due to some external stimulus (cause).

3) The energy performance of storage features (storage model):

4) The consideration of energy as fuel (operating energy): According to this model, children treat energy as a fuel that can be consumed in a variety of ways, mainly by machines.

5) The consideration of energy as fluid (energy transfer-flow model): This view support that energy is something fluid that flows from one object to another.

### **2.2. Theories of Learning and Learning Object**

Behavioral theory deals with the transmission of information (stimulus) and the change in the individual’s behavior (reaction). The development of educational activities, in which the desired educational result is clear, is considered important. According to these approaches, student before going to school have knowledge and what is needed to acquire new types of knowledge. Therefore, the learning objects through teaching practices and tools must encourage interaction and intense participation in the learning process as they presuppose the theories of constructivism, exploratory and collaborative learning constituting in a sense their evolution.

### **2.3. Repositories of Learning Objects—“Photodentro”**

Learning objects are freely available to all and subject to license by Creative Commons BY-NC-SA (Megalou et al., 2016).

On a global scale, the most well-known learning object repositories are considered to be:

- CLOE: Cooperative Learning Object Exchange (<http://www.cleo.on.ca/en>). This repository attempts to promote a collaborative model for the development, use, and reuse of learning objects. Those who register as users on the platform can develop, use and reuse the available resources.

- ARIADNE: (<http://www.ariadneuu.org/>). The ARIADNE repository is a European organization developed to provide educational content across Europe by facilitating the sharing of reusable educational resources.

- MERLOT: Multimedia Educational Resource for Learning and Online Teaching (<https://www.merlot.org/merlot/index.htm>). It is an international repository and considered a “free” and “open” resource designed primarily for higher education educators and learners (Lehman, 2007).

- DLNET: Digital Library Network for Engineering and Technology. It is a repository of learning objects, which also provides a system for evaluating them, on two levels: by expert peers and public review by users (Nesbit et al., 2006).

In Greece there is “Photodendro”, which is a Greek National Aggregator of Educational Content, which was designed and developed to host, organize and distribute Open Educational Resources concerning Primary and Secondary Education. It is a central e-service of the Ministry of Education and Culture for the organization and distribution of digital educational content, it is open and freely accessible to everyone, students, teachers, parents as well as anyone interested.

## 2.4. Evaluation of Learning Objects-Evaluation Models

**LORI (Learning Object Review Instrument):** This model aims at the qualitative evaluation of learning objects (Nesbit, Belfer, & Leacock, 2003):

- The quality of content which is determined by fidelity, accuracy and important ideas
- The alignment of learning objectives between activities, assessments and student characteristics
  - The adaptive feedback given to each different student answer.
  - The motivation that motivates the students’ interest
  - Designing visual and auditory information to enhance learning
- Ease of navigation
  - The provision for persons with special needs
  - The possibility of reuse in various learning contexts.

**MERLOT (Multimedia Educational Resource for Learning and Online Teaching)** This model proposes three criteria for evaluating the usefulness of a learning object:

- The content quality which is based on the validity and educational value of the learning object in relation to the curriculum and degree of difficulty.
  - Its effectiveness as a teaching tool through teachers’ assessments.
  - Ease of use through the views of teachers and students.

**LOES (Learning Object Evaluation Instrument)** Kay and Knaack (2009) recommend this model for teachers and students, as it is suitable for use in the

design and development phase of learning objects, but also as a final tool for evaluating them. This considered suitable for Primary Education and proposes three criteria for the evaluation of a learning object:

1) Learning: In particular, questions concerning interactivity, qualitative feedback, visual guidance and the perception of new concepts are used.

2) Quality or Instructional Design: It refers to technical design issues such as the help provided, instructions, usability and organization.

3) Engagement: In particular, questions are used regarding the topic of learning objects, the learning motivations they offer, the students' willingness to reuse them and the ability of learning objects to make learning fun.

**WBLT-S (Web Based Learning Tool Evaluation Scale for Students)** This model aims to evaluate the effectiveness of the learning object within the classroom and its innovation lies in the fact that the students' point of view is taken into account. The criteria are rated on a seven-point scale. This tool is used both in primary and secondary education.

**WBLT-T (Web Based Learning Tool Evaluation Scale for Teachers)** This model has the same criteria as the previous one, but at this case the evaluators are the teachers.

**LOEM (Learning Object Evaluation Metric)** This model is based on a study of educational design and some evaluation models that have been used in the past proposed five basic criteria regarding this model:

Interactivity in terms of whether it promotes constructive activities and a high level of interaction.

The design in terms of pages, graphics, navigation titles and readability.

Engagement related to difficulty level, theme, feedback, and aggregation of multimedia elements.

Usability

The content regarding the integrity and overall correctness of the material.

The purpose of LOEM is to help teachers to increase the pedagogical influence of ICT in their classrooms by offering proper guidance regarding the selection of appropriate learning material.

### 3. Methodology

The research sample consisted of teachers of Primary Education who taught Physics in the 6th grade, in Primary Schools of the regions of Central Greece. The sample was considered quite interesting as it consisted entirely of teachers who taught Physics during the current phase of the research effort and their opinion as captured in the research questionnaire were considered worthy of interest.

#### 3.1. Research Questions

1) Interactivity: We argue that the learning object offers constructive activities, full control and a high degree of interaction.

2) Design: We argue that the learning object is distinguished by the layout of

the pages, the quality of the graphics, the navigation titles and the readability of the text.

3) Engagement: We support that the learning object is distinguished by the level of difficulty, the subject, the feedback and the aggregation of multimedia elements.

4) Usability: We argue that the learning object provides the user with convenience in terms of use, clear instructions and navigation.

### 3.2. Research Process

For the evaluation of the learning object the process was divided into two phases. In the first phase, users (educators) browse per chapter all the interactive activities of the learning object. The goal is for users to understand how it works and which are the requirements of each activity and the learning object as a whole. During the second phase, users capture their views on questionnaire, according to what they discerned when using the learning material object. The questionnaire included four criteria for evaluation (“interactivity”, “design”, “engagement” and “usability”) which they examined individual questions.

### 3.3. Data Collection Tool

For the evaluation of the learning object, a questionnaire was given to the teachers, which contained four different elements: interactivity, design, engagement and usability. In the questionnaire, the indicators were recorded according to LOEM model (Learning Object Evaluation Metric) for the evaluation of learning objects (Kay & Knaack, 2008). The LOEM was chosen as the learning evaluation method object, because the criteria it examines focus on the most effective teaching.

- LOEM is related with many variables, examining the learning object in detail and giving a complete picture of its characteristics
- LOEM focuses on ease of use and in its correct linguistic presentation.
- LOEM emphasizes interactivity which contributes decisively to its result teaching, as the active participation of the students also ensures the success.

## 4. Results Based on the LOEM Model Questionnaire

### 4.1. Evaluation Results in Terms of Interactivity

Interactions with the learning object are of key importance and provide the user with a better understanding of the concept than if they were using a text-based medium (79.2%). The learning object provides the user with sufficient control and presents a great added educational value (75%).

### 4.2. Design Assessment Results

Most activities are distinguished by their coherence (91.7%). In terms of layout, it was found that the organization of most activities is clear (62.5%). The elements of the learning object’s activities are well laid out and the navigation

**Table 1.** Description of learning object evaluation metric

Scale	No. items	Possible range	Actual range observed	Mean (SD)	Internal reliability
Interactivity	3	3 to 9	3 to 9	6.0 (1.7)	r = 0.70
Design	4	4 to 12	4 to 12	9.3 (2.1)	r = 0.74
Engagement	5	5 to 15	5 to 15	9.4 (2.8)	r = 0.77
Usability	5	5 to 15	5 to 15	10.3 (2.7)	r = 0.80

headings are clear and easy for users to understand (91.7%). The text of the learning object is correctly sized, the font type is sharp. The text of the learning object activities is presented in concise sections and readability is facilitated (85.3%).

### 4.3. Engagement Assessment Results

The learning object provides feedback correctly formulated in an appropriately understandable way giving the user complete guidance and information (75%). In terms of appeal, the learning object contains easy-to-read text with a modern interface (91.7%). The learning object utilizes many different types of educational material: Find the words, Drag the text, Drag and drop, Image Sequencing, Multiple Choice, Quiz-Question Set, Image slider, Column.

### 4.4. Usability Evaluation Results

The learning object provides its user with an intuitive interface and ease of use (91.7%). The learning object provides sufficient navigational cues with concise, worded instructions (87.5%). Finally, the language of the learning object is at an appropriate language level (91.7%) (Table 1).

## 5. Conclusion

The learning object “The journey of energy”, was evaluated by the Primary Education teachers who taught Physics in the 6th Grade as satisfactory and suitable for use in the educational process, meeting all the evaluation criteria of the LOEM evaluation model.

The learning object is hosted in the repository <http://photodentro.edu.gr/ugc/>, as an interactive book or as individual learning objects.

The small sample who took part in the research, as well as the area where it took place, are considered two limiting factors for the result of the research.

Considering the results, we suggest the following two proposals for future research emerge:

- Conducting a corresponding research based on different learning object evaluation models, in order to establish the degree of reliability and validity of the learning object evaluation results.
- Carrying out the same survey on a larger sample, in order to examine whether the results of the evaluation of the learning object can be generalized.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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