ON-LINE GEOMETRIC MODELLING

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1. ABSTRACT

An innovative approach is presented here, to the e-based educational database design focused on new strategies in development of electronic educational materials in Mathematics and Geometry. Freely accessible EVLM database on Internet comprises a net of national portals organised via semantic web pages, with on-line modelling and calculations using webMathematica engine. Database consists of basic e-learning materials of different types - Facts, Reusable Learning Objects, independent Modules and sets of Problems organised in the easy-to-navigate structure and distributed to separate mathematical subjects.

KEYWORDS: e-learning in geometry, EVLM database, RLOs on-line

2. INTRODUCTION TO e-LEARNING STRATEGIES and SOLUTIONS

Since the Internet has become a widely used educational environment, education communities have at first adopted a concept of creating educational materials in the form of the complex full text electronic courses, comprising all course material in large educational modules. Traditionally, content came in a several hours chunk called a course. Currently a new concept for e-learning has been adopted, and it is the object-based learning. This approach is a new way of thinking about instructional content. The idea is to decompose existing course material into smaller units, so-called "learning objects" (1). Learning objects are self-contained, modular pieces of course material appropriately annotated

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with metadata. They may be combined to form larger educational interactions, traditional modules, but in a modular way. The goal is to develop an open architecture for online learning that will allow teaching to be centred on the needs and interests of the learner, enabling learning to occur anytime, anyplace and to allow greater customization and flexibility of the learning environment.

Learning objects have emerged as instructional technology's new paradigm. This idea has gained such broad acceptance that the IEEE has formed the Learning Technology Standards Committee to pursue the creation of common standards for the description, interchange, and management of learning objects (2). As time passes, eventually object-based technologies are replacing classical instructional design approaches. This leads to reuse, and reuse leads to faster development and higher quality instructional contents. In addition, as object-based systems are easier to adopt and easier to scale, different re-assembling of reusable learning objects can create large and colourful instructional materials.

This paper aims to describe how reusable learning objects might be used in teaching Geometry with e-technology, in order to enhance better conceptual understanding, and to introduce some from the numerous advantages of the ICT utilisation in teaching. Few comments on the design of data-driven reusable learning object that meets the learners and instructional design requirements is given, followed by several illustrative examples of RLO for modelling in Geometry.

Presented materials were developed in the frame of the European project – European Virtual Laboratory of Mathematics, and the results are included in the EVLM portals and databases and are freely accessible on the www (3). At present, the materials in Geometry available in Slovak and English are finalised and tested by students at the Mechanical Engineering Faculty of the Slovak University of Technology in Bratislava. The aim of the project was an optimal usage and synergy of the pedagogical methods applied in a classical educational process with teacher in the classroom, and the brand new information and communication technologies including WWW in a new form of the pedagogical categories - a virtual classroom.

3. WHAT IS A REUSABLE LEARNING OBJECT - RLO?

In the last years, learning objects have been widely discussed in the open literature in many different perspectives. There can be find many terms that are used in the literature and industry, besides „learning objects„ by IEEE Learning Technology Standard Committee (2). Other terms that imply the general intention to take an object-oriented approach to online learning are ”knowledge objects”, ”pedagogic documents”, ”online learning materials”,

and ”educational software components”. The Learning Technology Standards Committee had chosen the term "Learning objects" to describe small instructional components and provided a working definition: "any entity, digital or non digital, which can be used, reused or referenced during technology supported learning. Examples of technology-supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. Examples of learning objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning".

Currently, we can see more and more instructional content developed specifically to be deployed as learning objects in multiple learning contexts due to its potential for reusability, interoperability, discoverability, and manageability. There can be described two approaches to design the reusable object-based lesson: first - by searching and using the existing instructional materials which can be considered as learning objects from the online learning sources, such as the Internet, second - design or convert the instructional materials into object forms. The key underlying principle of creating object-based lessons from learning objects is that sound instructional design practices must be followed. Standardized principles for design of learning objects and instructional properties are necessary in the design process so that instructional contents can eventually be used for facilitating intended learning outcomes and reused within and between different learning contexts at an appropriate level of granularity.

An instructional content is only considered as learning object if with the following instructional properties:

a) Learning objects must be instructional objects

A learning object is not just a piece of information. It must provide deliberate instruction at appropriated level with meaningful interaction, in order to retain skills or key concepts by the learner. Often if the object is an informational object, the intention is just to inform, but if the object is a learning object, then it will provide an environment that is much more conducive to facilitate learning and reinforce the recognition of skills or key concepts.

b) Learning objects must be relatively small

The learning objects for instructional contents should focus on a single learning objective, so that it will be relatively small, discrete or unit of knowledge to support flexible, individualized learning. It is important to note that simply being physically small does not qualify as a learning object. To equate a learning object, information or content must be small

and focused. If each learning object is based upon a single objective, and the granularity is small enough, then each learning object will be "appropriately" small.

c) Learning objects must be extractable or stand-alone

A learning object must be self-sufficient to provide instructional material in the form of modular units and it must not rely on previously learned information, references or examples in order to clearly provide instruction on a concept (5). The lack of self-sufficiency is one of the reasons why most existing educational materials do not qualify as learning objects.

d) Learning objects must be usable on a standard platform.

Learning objects should work in a variety of standard web platforms. It should require only web browsers and some common plug-ins which are available free for download from Internet for viewing objects created with Flash, Director, Shockwave, Java Applet, and Java Scripts. No prior software component installations should require other than those provided by the web browsers and operating systems.

e) Learning objects must be tagged and searchable.

Learning objects must be shared, accessible and discoverable by others across learning environment, in order to be used, and reused widely to meet real-world performance criteria. They must be labelled as to what they contain, what they teach, and what requirements exist for using them so that users understand what a learning object is about without ever seeing it. Currently there are initiatives for building the metadata schema that will allow for the universal sharing of learning objects. Examples of existing metadata standard which can be used are Dublin Core Meta-data (4) and IMS Metadata (5).

A basic problem faced by the learning community is how to produce and deliver quality content for online learning experiences. Online learning content typically contains:

a) Text, tables, graphics, on-line calculations, or video shots and movies,

b) A navigation scheme (easily a table of contents and/or buttons).

It may also contain collaboration tools as well as other interactive elements and graphical elements designed to produce a unified or branded look and feel, abut the above list is basic.

To be learning content, the content should also be aware of learners. At a minimum, learning content should recognize who the learner is and record information about the learner’s experience. To make this possible, learning content has generally been developed in conjunction with some sort of learning system that keeps track of learners. Learners log on to the system and launch the content. As the learners interact with the content, results are

passed back to the system. If the system allows it, the content can also change its behaviour based on learner information stored in the system. For example, learners might be sent to different places in the content based on test scores, language preferences, learning style inventories, competencies, certifications, organizational roles, and other data.

Interoperability (content from multiple sources working equally well with different learning systems) and reusability (content developed in one context being transferable to another context) are imperative to the sustainability of the reusable learning object design. Without them, anyone with a significant investment in either content or a learning system is locked in to that particular content or system. Without them, every time a course or an interactive electronic training manual needs to be updated, far more of the material must be rewritten than is necessary or desirable. Without them, the process of developing high-quality content is prone to unnecessary duplication of effort, driving up the cost, possibly past what the market will bear.

4. PRESENTATION of RLOs IN GEOMETRY and MATHEMATICS

Many existing on-line databases contain reusable learning objects bringing instructional study material from different parts of mathematics. Majority of them work in so called ‘’closed-shop” exclusively, and these provide access to the study material after the required login and password input. Among those freely accessible on Internet, one can find EVLM - European Virtual Laboratory of Mathematics, product of the European project within the Leonardo da Vinci programme scheme for vocational training (3).
EVLM provides on-line database with different types of e-learning materials distributed into several mathematical subjects (Fundamental Maths, Algebra, Calculus, Geometry, Difference and Differential Equations, Multivariable Calculus, Probability and Statistics, Numerical Analysis, Optimisation and History of Maths) and material types (FACTs, RLOs, MODULEs and PROBLEMs). When learners need a specific piece of information, they can navigate in the EVLM database by material type in a request, and get the relevant, only needed learning objects. Fig. 1 shows the interface page to search the appropriate material type and the object details that appear on the learner’s screen after retrieve from the repository. This particular object is a RLO web page reference that describes what different reusable learning object types of materials are available in the EVLM database repository in Geometry. Besides being used to recombine to form larger educational interaction, e. g. modules in some particular geometric themes, each of these RLOs can be used by learners as an independent learning material to enhance certain concept, principle or idea.

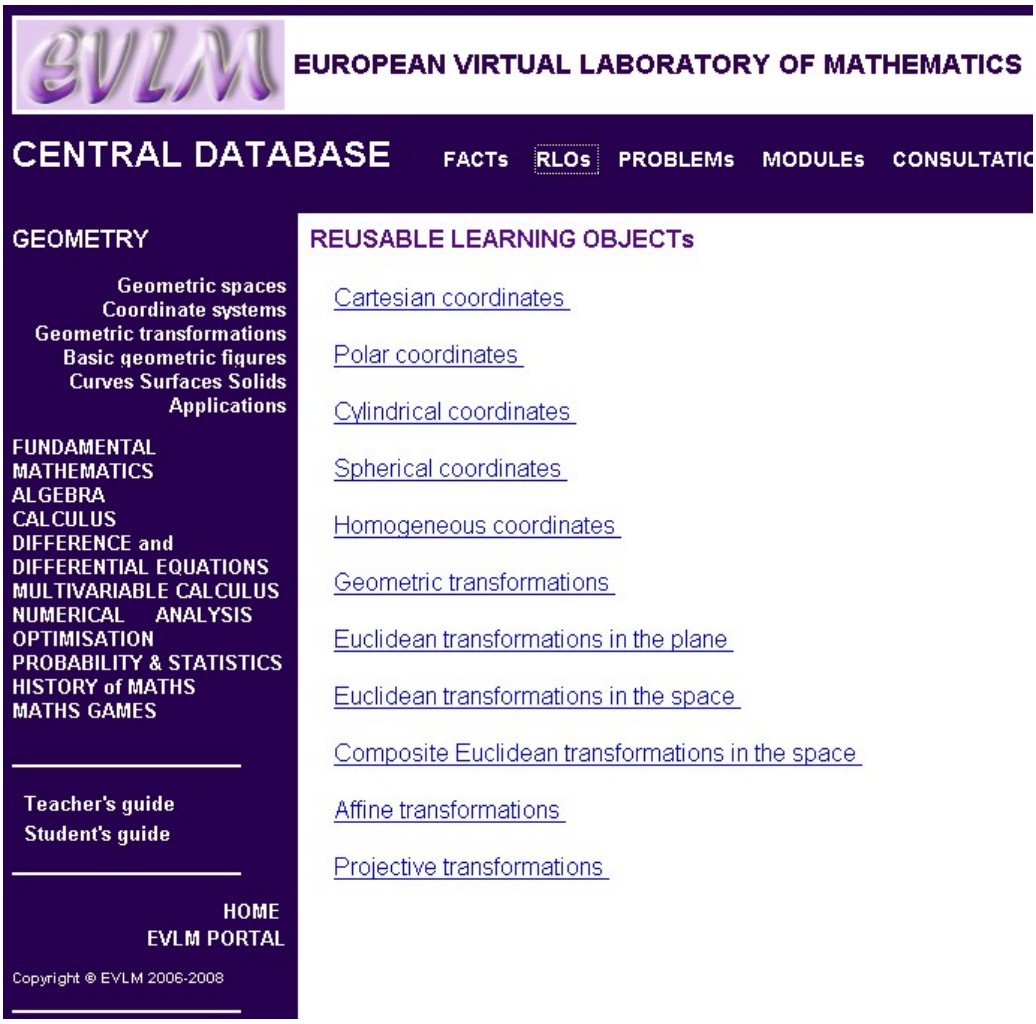

Fig. 1. EVLM database, RLOs in Geometry.

5. CONCLUSIONS

- RLOs are small learning materials reused in ICT supported learning.
- RLOs should be focused, extractable or stand-alone, tagged and searchable, usable on a standard platform, and shared.
- Interoperability and reusability are imperative to the RLOs design.

6. REFERENCES

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