LEARNING SCIENCE WITH ADVANCED LEARNING BLOCKS

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ABSTRACT
Recent studies have shown that teachers need e-learning content that they can easily adapt and reuse for their own purposes. This means that lessons should be made out of small learning blocks or, as they are called, "knowledge objects" / "learning blocks". A new concept of how to create really useful e-learning content was evolved in Slovenia; namely, by "putting the teacher back into the game". The selection of proper technologies and tools for managing e-learning content and the establishment of a user-friendly and easy-to-use environment for creating and modifying e-learning content, are essential to ensure basic support and popularization of e-learning.
In this paper, we will present new ideas with proofs of concepts of "modular, really interactive e-content" build on the top of the mathematical, physical, logical and computer-scientific knowledge using open-source solutions, open standards and some programming. E-learning content which will be discussed is not intended to be an electronic teaching book, but the add-on to the standard learning material. You can see some of the results at http://www.nauk.si.

Keywords: *e-learning content, educational content preparation, knowledge extraction, ICT in learning, ICT in science*

INTRODUCTION

In recent years, the process of a creation of electronic educational learning content (e-learning content) in Slovenia has been carried out for the most part with disregard to the teacher; by utilization of a two-way relationship between the authors and the users of the content - the learners (Horvat et al., 2010).

Using experience obtained while leading and cooperating on several EU and Slovenian research projects involving e-learning and e-content creation (Horvat et al., 2007A, 2007B, Lukšič et al., 2007, Božeglav et al., 2009, Horvat et al., 2009), a new concept of how to create really useful e-learning content evolved in Slovenia; namely, by "putting the teacher back into the game".

The manual for teaching employees of the Institute for Interactive Media and Learning University of Technology Sydney (Teaching Matters, 2009) states that one of the important characteristics of a good teacher is if he or she uses the learning materials in a manner best suited to the course, which he or she is currently teaching. Also, a research done in South Korea (Hwang, 2008) on teachers' satisfaction with available e-learning content, gave interesting results. It showed that one of the main factors that affects satisfaction with the e-learning content (and hence its actual use in the classroom) is the possibility that this content can be adapted to the teacher's method of teaching.

By being involved in two projects "Learning Programming" (Lukšič et al., 2009) and "Active Mathematics" (Lokar et al., 2009), which were co-funded by the Ministry of Education and Sports of the Republic of Slovenia, the authors of this paper cooperated in transfering knowledge and experience of preparation and use of e-learning teaching

materials (Batagelj et al., 2007 and 2009), acquired over the years, to practice. Specifically, the most important experience was again, that teachers need and want e-learning content that they can easily adapt and reuse for their own purposes.

As the teacher usually serves as an intermediate between teaching materials and the learner, he or she should be able to make all proper choices concerning which content to use and how to combine it into a lesson. This means that lessons should be made out of small learning blocks or, as we will call them, "knowledge objects" or “learning blocks”. In this way, the teacher will be able to change the lesson and promptly adapt the learning process to the situation in the classroom.

In this paper, proofs of concepts of "modular, really interactive e-content" build on the top of the mathematical, physical, logical and computer-scientific knowledge, using open-source solutions, open standards and some programming, will be presented. E-learning content that will be discussed is not intended to be an electronic teaching book, but the add-on to the standard learning material. Some of the examples can already be seen at http://www.nauk.si.

CONCEPTS AND ADVANCED LEARNING BLOCKS

The authors of this paper are members of the NAUK team (NAUK – Advanced learning blocks group, Lokar et al., 2009), which is a group that manages several projects in progress, involved in e-learning content creation. The common aim of NAUK projects is to create a computer-powered system for managing and serving e-learning content that will be extremely suitable for teachers. The main difference between NAUK projects and other software systems for e-learning content creation is in the philosophy supporting the project; namely, instead of the author-learner relation NAUK projects want to introduce the three-way author-teacher-learner relation.

The main idea behind the NAUK concepts is that the teacher will take the teaching materials from the already available online sources, prepared within different content creation projects/systems and, with the help of NAUK system, change and combine them to make a lesson that suits his or her style of teaching and/or the current situation in the classroom. As he or she will be using the resulting content in different situations, the underlying system will offer different ways of export, that conform to the most important up-to-date standards.

Therefore, NAUK project group conceived a concept that would allow combining existing content and with that the creation of one’s own learning pathways. With that the project group wanted to tackle, among others, the following widely recognized problems associated with the existing e-learning content:

- it is often realized as a digitized book, without proper interactivity and is multimedia-poor;
- it is linearly structured, although the process of learning is usually not linear;
- it has no contextual dependencies, which are useful while informing the learner about his / her mistakes and the consequences resulting from these errors;
- insufficiently uses new teaching approaches - students will often use the content when a teacher is not present, therefore the concept of multiple interpretation of the same topic is very important, as well as the motivation, progressive building of knowledge, examinations, etc.;
- learners use the same e-learning content several times - some parts of the content should be modified automatically but in such a way that all presentations require the same process of learning (e.g., counting apples is the same as counting rabbits);
- instructions for the teacher are missing - how to present the material, what is the goal or purpose of the content on each step, etc;

- the content is too strongly integrated into the presentation of the material - no revisions and changes are possible (the structure is too monolith);
- there is no real interactivity - the question is not if but how can the augmented reality and other innovative ways be used to improve the learning process.

While observing available e-learning content, group members also found certain shortcomings in prior approaches, mainly through the reactions of the teachers; see also (Prensky, 2001). Although teachers got the opportunity to combine and adapt the learning content, it was quite a difficult task for them. It required non-basic knowledge of managing of virtual learning environments (VLE) and at the same time substantial knowledge of different ICT standards: HTML, CSS, JavaScript, SCORM, etc.

Furthermore, it was a mistake to expect that teachers will only use the materials. They also had didactic and technical comments, since they will be the ones who will teach with the content. However, the biggest surprise has been that the majority of them did not want to create new content, but just to adapt the existing one. Whether this was due to the lack of motivation, the complexity of the process or the poor quality of the available content, it was necessary to find the problems and to fix them.

One thing that has also been neglected in other content creation tools is the process of knowledge extraction. Teachers do not just want some basic quiz type questions but often want to randomize questions, offer feedback for the frequent errors, use structured questions that challenge the learner and therefore make a nonlinear path through the process of examination and teaching/learning. Because each question is a knowledge object, all this will be possible with the use of the NAUK software. Finally, authors of the content have generally been people trained in ICT. If we want teachers with little or no practice to use the software, the software will have to be very intuitive and user-friendly.

The NAUK team also found out that it is not enough to offer only content; it has to be inserted in the appropriate classification system and properly interlinked. A creation of a large repositories of e-learning materials will start a new process; that is, a process of creation of e-learning books that will become a supplement to well-known physical teaching materials. Although physical teaching materials can be used even decades after they are published (printed), this is not the case with e-learning materials. Since e-learning materials are built using different technologies and standards (Varlamis & Apostolakis, 2006), special care should be taken to develop such a process that adapting the presentation of e-learning books to new technologies and standards, in not so distant future, will be possible.

Group members are involved in several projects in progress that are aimed to make e-learning content for: high-school mathematics, primary- and secondary-school physics, elementary-school logic, all pre-faculty levels of computer science classes and faculty-level mathematics. Creating a repository of e-learning content – see Figure 1 – from six different fields of knowledge (at the same time on different levels), promises a greater range of users but also demands a greater responsibility from the group.

The basic idea of NAUK's approach can be easily compared with the popular Lego[1] blocks; see Figure 2-4. The e-learning material should be built by creating: basic / simple building blocks, predesigned e-learning material, which can be later customized, and instructions for preparing customized e-learning material by using simpler building blocks.

When preparing the content, it is important to take into the account its entire life-cycle, which includes the process of creation, use and alteration of the material. The whole process of managing e-learning content is well described in van Assche & Vuorikari, 2006.

[1] http://www.lego.com

Figure 1: The NAUK group portal (NAUK – Advanced learning blocks)[2].

The lack of tools that are easy to use, but at the same time provide the functionality that is needed for quality education, and technical knowledge that is necessary for the implementation of electronic-based education, are the main obstacles today in Slovenia that make the wider use of e-learning in the school environment as well as outside, impossible.

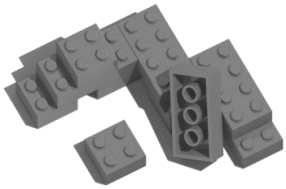

Figure 2: Basic building blocks[3]

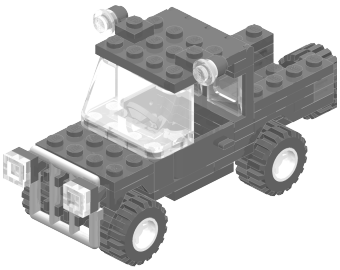

Figure 3: Predesign models (that can be later customized)[4]

Figure 4: Instructions for advanced customized models[5]

TOOLS FOR E-LEARNING CONTENT CREATION

The selection of proper technologies and tools for managing e-learning content and the establishment of a user-friendly and easy-to-use environment for creating and modifying e-learning content, are essential to ensure basic support and the popularization of e-learning. Of course selecting the technologies and the tools is not a task for the teacher. Creating an environment that will offer quality e-learning creation tools and related services is the goal of the interdisciplinary group of experts with skills from: multimedia,

[2] http://www.nauk.si
[3] source: http://www.turbosquid.com
[4] source: http://www.track7.org
[5] source: http://www.lego.com

web technologies, web services, user interface design, programming, teaching with the usage of ICT, ect. Such a group was formed in one of NAUK's project named e-SIGMA (Services for building interactive content from mathematics), where they intend to offer technological support to educational material creation process in the context of other NAUK projects.

The main component of the proposed collection of services is the repository of materials, which, unlike the majority of existing systems, is not only intended for archiving and serving content, but at the same time offers the possibility of combining existing materials into new learning units. Sustainability and reusability in light of new technologies of thus created e-learning materials is the main advantage to the existing monolithic presentation of e-learning content that can be currently be seen all over the web. The main scenarios that were envisaged before creating the repository are:

- A teacher constructs a learning path, i.e. a complete learning course for teaching specific topics in the curriculum.
- A teacher that uses a virtual learning environment creates an assessment and imports it into the virtual learning environment.
- A teacher prepares homework with the same content as the teaching material he or she used while teaching, but with different data for every learner.
- A teacher modifies and reuses an already prepared assessment.
- A teacher modifies and reuses an already prepared content.
- A teacher adds interactive elements or descriptions on transitions between elements to already prepared content.
- A teacher uses mathematical notation.
- A teacher comments and grades an already prepared content.
- A teacher contributes his or her own content into the repository.
- A teacher creates new teaching materials or assessments.

Since the process of creation and modification of interactive elements should be as simple as possible, the project group decided to use a similar markup syntax used by the well-known wiki environments, e.g. by Wikipedia[6]. Of course, NAUK's syntax contains additional tags, thereby enabling the addition of various multimedia elements and links between e-learning materials, adding responses to user input, etc. Example of the syntax is shown in Figure 5. In the continuation of the project, the project group intends to offer a graphical editor (powered by AJAX technology[7] - Asynchronous JavaScript and XML) to replace the writing of tags and further simplify the process of e-learning content creation.

By using NAUK services that are currently still in beta version and are intended to become stable in October 2010, the teacher will be able to take existing content from the repository, amend or supplement it, and immediately publish it in the repository. The other important functionality of the repository would be the possibility of exporting the content in the SCORM[8] standard. The teacher will be able to use the e-learning content exported in SCORM in his/her own virtual learning environment (e.g. Moodle, BlackBoard, Dokeos, etc.). Thus, by using NAUK's export service the requirement for technical knowledge of the author (teacher) becomes obsolete.

Therefore, the teacher is no longer obliged to blindly follow the ideas of the original authors of the content, but is able to accommodate the content to his or her needs. He or she can easily:

- take a few questions from existing quizzes (or question banks that store Moodle[9] questions, STACK[10] questions) and build a new quiz,

[6] http://www.wikipedia.org
[7] http://www.w3schools.com/Ajax/
[8] http://www.adlnet.gov/Technologies/scorm/
[9] http://www.moodle.org
[10] http://sourceforge.net/projects/stack/

- add or improve responses (feedbacks) depending on the correctness of the answer to a question or an interactive part of the teaching material,
- take an already built teaching material, remove or replace a certain section, change the order of chapters and slides, etc.,
- correct an animation or add his or her own example,
- build a context aware test from a database of questions, where the the next question displayed depends on the correctness of the answer to the previous question,
- add leaps in a learning pathway and thereby build a non-linear structure.

Figure 5: Example for the wiki-like syntax that is used in NAUK projects to describe e-learning content.

The foundation of NAUK system for e-learning content creation uses GIT[11] distributed version control system that greatly enhances the functionality of service by providing the possibility of:

- comparing differences between versions of the stored e-learning material,
- easing the possibility of modifying the already existing content by starting a new branch, and becoming an author (owner) of a new branch,
- cooperating with other coauthors in writing the same content.

Often overlooked feature needed by repositories of educational content are efficient search engines. Most of current repositories in Slovenia contain "search by the title", some of them also include "search by the content", but almost all of them lack the option to search by other metadata taxonomies: type of materials, their purpose, scope, popularity, level of difficulty, etc. This is precisely the problem of current Slovenian educational network - SIO (Čač et al., 2007), which is being filled with an increasing amount of material but has problems when searching for specific content due to the lack of correct classification. We are therefore forced to review a great deal of content on the same subject to see that some consists only of a single PDF document, others are learning paths, the third kind links to other places on the Internet, etc. This is the reason

[11] http://git-scm.com/

why eache-learning content in the NAUK repository must be equipped with metadata, which enables the system to classify the materials with regard to different taxonomies: curriculum, content, etc.

Different authors are already making materials in the e-Sigma repository in the context of the projects NAUK. Although the project group is adding new functionalities, the form of the content is largely fixed, which means that teachers do not have to take care of the appearance (representation) of their teaching material, but only of the content, interactivity, multimedia add-ons and their place within the learning path of the e-learning material. Example of an exercise can be seen in Figure 5 and its an automatically generated presentation in Figure 6. The presentation is generated automatically when the teacher enters the type of items that he or she wishes to have, e.g. some text, matching question type, hint button with text for the hint and the jump button.

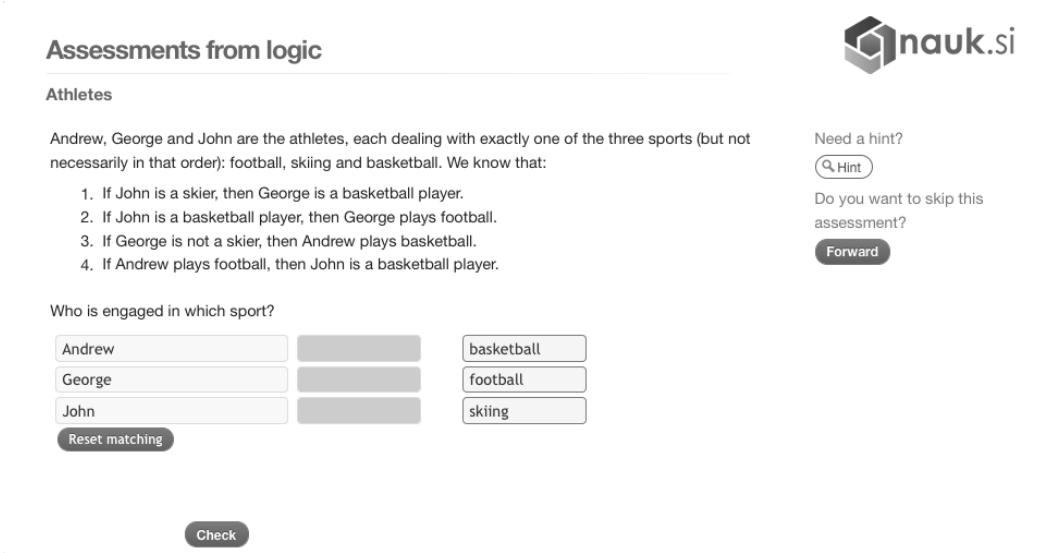

Figure 6: An assessment from logic built automatically by the NAUK system from scenario shown in Figure 5. The learner is supposed to move the correct answers to locations to match sports with players.

Authors can build the content by using the following building blocks: title, subtitle, ..., text, stylized text, table, ordered list, unordered list, link, internal link, button, hint, download, image, video, sound, flash, java applet (Geogebra), gallery, sequence of images, data plot, mathematical notation, virtual book, star map, hotspots, single-choice question, multi-choice question, matching, random-choice exercise, tabbed view, meta data, custom assessments from logic, additional information for teachers, slide menu, etc. The content can be grouped in one, two or three columns that make a slide, slides form sections (with subsections, subsubsections, etc.), sections can be grouped into advanced learning blocks and advanced learning blocks form an e-learning content. The author can choose from different types of slides, e.g. normal slide, popup slide, dragable slide, etc.

Authors can overlay the so-called "tools" above the multimedia content: video, image, plot of the data - measurements, etc. The currently available tools are: angle, distance, vector, vertical lines, horizontal lines, freehand drawing, stop watch, polyline; see Figure 7. By using the tools the author can demand from a learner to "naturally" interact while learning, by solving puzzles, answering quizzes, measuring distances and angles between objects on images or videos, responding to questions by drawing an image or a vector, by constructing a graph, etc.

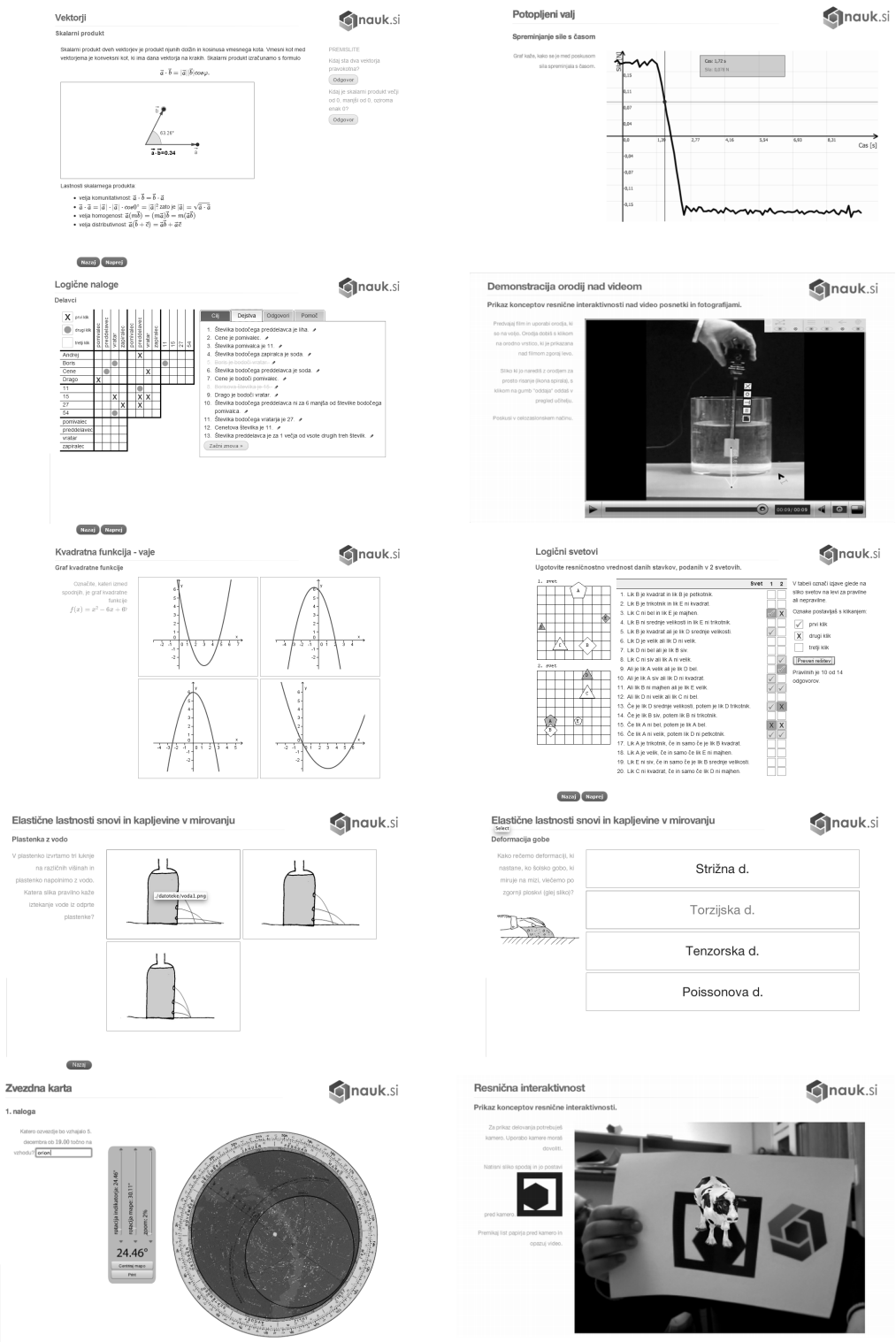

Figure 7: The really interactive learning by using NAUK e-learning tools and concepts.

One of the most important features of the current approach is that every interactive element (quiz element, button and tool) triggers a transition to the next slide, which is selected automatically according to the current context of the learning process. Probably the simplest example of this concept is the following. A learner that makes a mistake by answering a question incorrectly is given a customized response and can be allowed (if this mistake is not too big) to automatically proceed to the next slide, or is returned to

another question, which is slightly modified (eased or changed in such a way that the learner will be forced to use the same learning process to solve the modified problem). Thus, the learning path is nonlinear.

FURTHER WORK

Informal interviews with many teachers as well as the first reactions of users have shown that the described concepts and solutions form a good approach that will provide higher quality of teaching and learning. The NAUK project group determined that it is wise to invest further efforts in upgrading demonstrated concepts. Therefore, the project group intends to build a web based community, where it will be possible to give opinions and comments on existing materials and to grade them.

Since good ICT solutions in the field of education spread quickly (Beyond Textbooks, 2009), all members involved in NAUK projects hope for the success of the presented solutions and concepts, but are also aware that further development in this area relies heavily on the satisfaction of the end-users - the students.

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