

# Re-using teaching materials

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*When working with e-teaching materials we often find that the authors of resources, meant for the use of teachers in the teaching process, do not use the opportunities offered by the new technologies. All too often the materials are a monolithic block (or at least their main part is), constructed the way an ordinary book or workbook would be. This demands that the teacher takes them as a whole, precisely in the order they were written in. Is that really necessary? But do all teachers need the same form of resources, do they want to use them in the same order, and do they want their students to see the same examples, do the same exercises? Why not use the possibilities that new technologies offer and at the very least give teachers the chance to adapt the materials to their own and their students' needs.*

## 1 INTRODUCTION

When we are in the process of preparing for a particular teaching process, we perform different procedures. In this process, we must consider who the students we teach are, which possible learning methods should be used.... The overview and choice of the teaching materials to be used is certainly a part of this process. Thus the teachers' manual published on the web pages of the Institute for Interactive Media and Learning at University of Technology Sydney (IML 2009) mentions that an important quality of a good teacher is that s/he uses the teaching materials in the way that is most appropriate for the students being taught at the moment. So one of the important characteristics of a good teacher is to make a sound decision what teaching materials are to be used and what method is best suited for the classroom which is currently being taught. Part of teachers' preparation is therefore the review and the selection of teaching materials as well as deciding which technologies are to be used. Two quotes from the manual mentioned above (IML 2009) state this fact nicely: *"New technologies should be used in the most appropriate way to provide a quality learning experience for students."* and *"The most effective kind of learning experience is determined not by the technology available, but by considering what is most appropriate for the students, the subject and the learning objectives and then selecting the most appropriate technology to use, be it a book, an online discussion, a multimedia simulation, or a workplace experience."*

But when we are searching for appropriate e-teaching materials we much too often find that their authors do not fully use the opportunities offered by the new technologies. As we are in the process of changing the view of mathematical knowledge from a hierarchical structure to a flexible network structure (for example Kadijevich, 2007), the construction of e-teaching materials should also reflect

that change. But the authors of e-materials, meant for the use of teachers, all too often prepare them as monolithic blocks, constructed in the way an ordinary workbook would be.

## 2 USAGE OF TEACHING RESOURCES

If we think about the way "classic" teaching materials (such as textbooks, workbooks, etc) are used by teachers, we realize they are actually constantly making different combinations of different materials. They choose a workbook, tasks, pages on the Internet ... The class the teacher is teaching, the day s/he teaches, the pedagogical situation ... should always be taken into account in this process.

It is rare that for a resource to be taken and used precisely in the way it was written ... from the first letter to the last one ... The students are often told to study certain pages in the textbook, then to do certain sets of exercises, then to read ... And these instructions are constantly changing. One set of instructions is used in one class, another slightly different set in another class. This means that the teacher adapts the combination to the particular group of students.

Have you as a teacher ever considered how great it would be if you could have a slightly different textbook with a different sequence of examples, with a certain part "omitted", some parts added from another source ...? The reason for such a wish is completely natural. Authors of resources (workbooks for example) envisage a hypothetical pedagogical situation with hypothetical students. But the actual teaching process is always at least slightly different and never quite the same as the hypothetical one the author had in mind. Since a good teacher (as the before mentioned quote says) uses resources in the most appropriate way, s/he is "forced" to adapt the resources.

So the major activity in the preparation for teaching is making combinations. And these combinations are changing all the time, according to the class or even to a particular student in the class. Therefore it is no wonder that the most common technological tools used by the contemporary teacher are scissors, sticky tape and a photocopier.

But what about e-resources, namely resources that are prepared with, or exploit the usage of modern information communication technology (ICT)? Could teachers use them more effectively? Several studies (for example Assche and Vuorikari 2006; Lokar 2006) have shown that teachers use few of the e-resources available. A somewhat surprising fact in itself is that math teachers were especially slow to adopt

such materials. Interviews with teachers (Lokar 2006) showed several reasons for the decline in the usage of materials available. The possibility of task modification is one of the properties teaching materials most often lack and math teachers demand. If teachers have at least the possibility of modifying the teaching material provided, they have a much more positive attitude towards using the particular material. And the teachers' attitude towards the task used is perhaps the most important part of the usage of ICT in the teaching process. Math teachers, especially those teaching in upper primary and secondary schools, do not like using close form solutions or solutions where the complete didactical situation in which the task is being used relies on a particular aspect of a certain tool; they want to be in control of the whole process (Lokar 2006).

There is a conflict between the possibilities technology provides, teachers' wishes and e-materials available. Namely, all too often the materials are a monolithic block (or at least their main part is), constructed in the way an ordinary book or workbook would be. This demands that the teacher takes them as a whole, precisely in the order they were written in. Many projects focusing on the development of e-resources are complete portals where navigation, the way of working through the resources ... must be followed in the exact way the author(s) had imagined. We encounter web pages with flash animations embedded, usage of frames, applets without the source ... and thus almost impossible to change.

Too many resources are created from the point of view that the student is the final and independent user. So they are prepared so that the author "prescribes" the exact way in which the resource is to be used. This is suitable (and even this can be debatable sometimes) for "self studying".



Figure 1 Usual resources

On the other hand, the basic proposition when these materials were being developed was that they were to be used in the learning process with the teacher present. Students are not usually exposed directly to the task, as there is a teacher present in most cases. The teacher serves as an intermediary between the task and the student. If these materials are then viewed in this light, the teacher is actually in a worse situation than when using a classic textbook. These e-materials are often so technologically "closed" that there is no tool such as the scissors that are used when "recombining" classic, printed materials. Teachers often encounter problems if they want to use only a part of the e-materials, not to mention the fact it is usually not possible to adapt the materials at all.

### 3 PUT TEACHERS "BACK INTO THE GAME"

So in the design of e-resources the role of the teacher is all too frequently neglected. The authors of the task usually focus solely on the students. They make decisions in

which order the content should be presented, what the examples should be, how many of them, where it is suitable to require the student to do a certain number of exercises, what the responses should be, and any further steps in the event of wrong solutions ... Where is the role of teacher? Is it not his/her primary task to interact directly with the students, performing decisions which resource and in which way should be used at a certain moment? When e-materials are constructed as a whole, the teacher is required to use them in the order prescribed by the author. Is that really necessary? Do all teachers need the same materials, in the same order, with the same examples, the same exercises? Why not use the possibilities offered by new technologies and at least give the teachers the chance to adapt the materials to their and their students' needs. Is not the teacher the one who comes into direct contact with the student, the one who can decide which materials would be appropriate for the situation given. On the other hand, most authors of e-materials still rely on the teacher, since there are few materials that guide the student automatically (choose appropriate tasks, sequence of topics, extra explanations, ... in short all pedagogical actions) and therefore presume the presence of a teacher.

The process of using the task where the teacher's role is forgotten is shown in Figure 1. The author develops a resource and publishes it. A student accesses the resource and uses it. He interacts solely with the resource. Thus the author is required to incorporate all of the necessary guidance and feedback into the design of the resource itself.

However, as mentioned before, the majority of resources are used in a different manner. Students are not usually exposed directly to the resource, as there is a teacher present in most cases. So in the process of the development of resources, the teacher should be introduced into the author - resource - student relation. The teacher "comes first", i.e. s/he should have control over the content s/he uses to teach the student. The teacher serves as an intermediary between the task and the student. S/he chooses the appropriate task. If necessary, s/he adapts it and/or provides additional guidance. So the process is really:

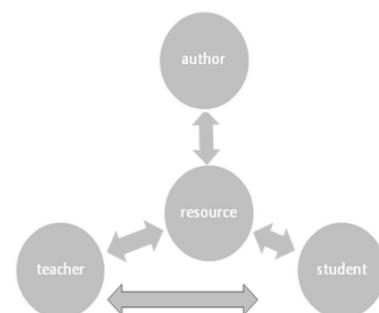


Figure 2 Teacher's role

The relation teacher ↔ resource where the teacher has the possibility to adapt the resource is of extreme importance in the teaching process. This role of the teacher must be respected and taken into account when designing e-materials.

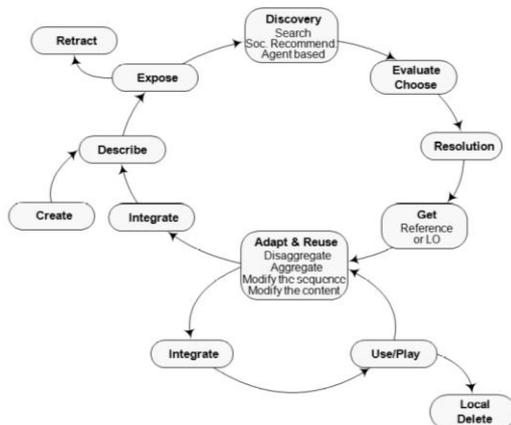
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Although such claims have been heard:

- teachers do not want too many different interpretations of the same issues (more material on the same topic), they want a single prescribed one
- teachers are more or less passive, they want exactly the material specified, then they will keep it and use exactly as is
- teachers do not possess the knowledge or the time to adapt and combine the materials in their own way
- only the author is the one who is aware of the proper sequence of different parts of the material
- ...

they simply don't hold water if put under closer inspection.

When designing and evaluating a particular teaching resource we should envision the whole process of design / usage / modification of the resource. We should respect the entire life cycle of e-learning materials. It comprises the process of design as well as the use and adaptation of such materials. The whole process is well described in (Assche and Vuorikari 2006), where the following illustration can be found.



**Figure 3** Life cycle of an e-resource  
(Source: Assche and Vuorikari 2006)

The lower circle, where the process of reuse and adaptation is performed, is the part all too many resource authors neglect.

Using analogy with toys – a ship made of Lego bricks has a far greater pedagogical value as pre-constructed, unchangeable models. So we should switch the process from building resources in the form shown in Figure 4:



**Figure 4** "Static" resource  
(Source: <http://www3.towerhobbies.com>)

to resources prepared in the way as in Figure 5:



**Figure 5** An adaptable resource  
(Source <http://www.lego.com>)

To conclude: most teaching materials are meant for the teacher, who then instructs the students how to use the materials and is present throughout the learning process. Therefore the authors of e-materials must recognize and acknowledge the role of the teacher. They must make it possible and easy for the teacher to use and adapt the resources.

## 4 E-MATERIALS PREPARATION GUIDELINES

Research conducted in South Korea (Hwang, 2008) regarding the teachers' satisfaction with e-teaching materials gave interesting results. One of the main factors influencing the teachers' level of satisfaction (and consequently the actual use in the classroom) is the possibility of adaptation of the materials to their own ways of teaching

Why should e-materials not be "flexible", then? They should enable the teacher to change them, recombine them... There are technical means that enable such combining nowadays. But the authors need to take the teachers' needs into account and respect them more. The teacher needs to stay in control: to have the option to change, correct, adapt the materials, to change the order of certain parts ... Therefore e-materials should be constructed as a combination of building blocks that can be recombined, corrected ...

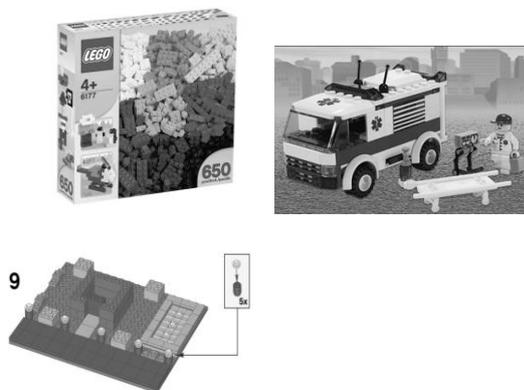
The authors of materials should by all means prepare a finalized learning unit, with a logically combined sequence of tasks. Thus their own view of the use of the materials in a hypothetical learning situation will be presented. But this unit should be so constructed that it can be (if necessary) adapted, changed, upgraded, recombined ... by the teacher. Namely, the authors will follow a certain method, a certain "ideal" group of students, a certain number of lessons available ... However, no two groups of students can be

taught in exactly the same way, as teachers are well aware, and therefore the final unit should only be a basis for the adaptation of the unit to the particular teacher's and students' needs.

So e-resources should be flexible and allow the teacher to adapt them, combine in his/her own way ... The ever popular Lego bricks (Figure 6) offers a perfect analogy. The primary concern of the authors of e-materials should be to offer:

- basic building blocks,
- pre-combined models (that can be "corrected" or "recombined")
- plans for making new models

What represents the basic building blocks certainly depends on the particular learning situation. They can be a short explanation of a concept, a picture, an animation, a short video clip, a question, an exercise, an interactive game...



Source: <http://www.lego.com>

Figure 6: E-materials building blocks

But there is more. The basic building blocks should offer the possibility of being adapted. Thus the teacher should be able to reword a question, change the explanation slightly, add a link to another material on the topic in the feedback ...

It also makes sense that the teacher should be able to use a particular building block in different shapes. The "learning cube" should be able to be used as rounded, oblong, triangular ... Regarding the fact that this is not a big technical problem, why should not the teacher be able to use an exercise (a question) as a text (e.g. as part of a test written with the help of a word processor), a question in a Moodle virtual classroom, in the shape of Java assisted interactive question on a web page ... So the teacher would be able to use the technical form that is best suited to the given moment.

The author should merely be an initiator of the resource in various forms. A teacher is the one who upgrades the idea, adapts it to a certain pedagogical situation, his/her beliefs ... Namely, it is the author who creates the resources for an ideal situation, but it is the teacher who teaches in "the real world". The resources a teacher knows to be adaptable

are more widely accepted and used, even though they are not actually adapted most of the time (Hwang 2008).

If we summarize the guidelines into 5 points and try to state them in a slightly more technical manner:

1. **The teacher must be in control.** Every teacher is unique and has a unique teaching style. What is more, the way a teacher teaches differs from class to class. Therefore learning materials should not be limiting and prescriptive as to the way they can be used. The author should provide a learning path, but that path should be easily deconstructed, adapted, changed. And if the teacher believes that the main character's name in the resource should be Johnny and not Jack, that should be as easily accomplished as possible.
2. **Teaching resources consist of small building blocks.** Teaching materials should be constructed from several atomary building blocks which can easily be changed and thus adapted to the individual needs of the teacher. In this way everyone can construct their own learning paths and have the possibility to combine their own resources with resources obtained elsewhere.
3. **Format and tool independent building blocks.** Basic resources should be small, adaptable, transferable and as independent of particular programming tools as possible. Building blocks should be easily obtained in different formats such as text files, html with different styles, original xml format, SCORM 1.2, MoodleXML ... This makes it easier for the users to embed the blocks into their own Internet pages, use them within their virtual classrooms, offer them on CDs provide CD copies of them, adapt them, etc.
4. **The teaching material should only be a sample combination.** A pre-constructed resource should only present one of several patterns possible. It certainly makes sense that authors offer pre-constructed learning paths (in one or several different forms). These paths (constructions) show the possible use of atomary (basic) building blocks to construct a whole. However, the complete resource should be available in a technically easily adaptable way.
5. **Exploit the power of metadata.** All building blocks should have descriptions that enable the user to know of their content even before they are actually entered. Metadata provides quality searching and the user can thus obtain exactly the resource s/he is looking for.

If quality use of e-teaching materials during lessons is to be attained, it is imperative that there are e-materials that can be adapted and combined according to the needs of individual teachers. For this purpose the following things are required:

- a repository of well described (metadata equipped) building blocks. These should be (where logical) in different formats and thus functional in different situations. The building blocks should not be too extensive and should only cover one way of dealing with a certain topic.
- examples of learning units constructed with those blocks. They can provide a base for the teacher.

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However, this base must be adaptable to the individual teacher's needs

- instructions for the use of building blocks, for the construction, changing, and adaptation of the pre-constructed units
- tools which enable preparation, changing ...

## 5 IDEAS IN PRACTICE: ADVANCED BUILDING BLOCKS - NAUK

In order to test the above mentioned ideas in practice, the NAUK group was formed at the Faculty of Mathematics and Physics and the Institute of Mathematics, Physics and Mechanics (<http://www.nauk.si>). The group was to deal with the construction of e-materials in the fields of mathematics, ICT, physics ... following the guidelines mentioned above.

The materials designed in the first project concerning mathematics, called *Active maths – handouts and truly interactive quizzes* can be accessed at <http://am.fmf.uni-lj.si/>. The second project touched the field of teaching programming – *How to teach a beginners' course of programming language*. These materials are available at <http://up.fmf.uni-lj.si/>.

Figure 7 The Active maths portal homepage

Figure 7 shows an example of basic building blocks on Geometry in plane and space, the topic covered in the second year in Slovene grammar schools. Teachers can choose between various animations, worksheets, question banks, STACK supported questions and thus develop their own teaching sequence. Each resource is supported by a brief explanation and a short preview. All resources are freely downloadable in various formats.

Figure 8 Various formats of the resource

For example, the question bank seen in Figure 8 can be obtained in HTML and Moodle XML format, as well as a SCORM packet and also in clear text format. So the teacher decides which format is the most appropriate for his/her needs. We are aware that user experience as well as the way of usage varies quite a lot with different formats. But sometimes the computer lab cannot be used. On the other hand it is true that questions such as the ones in Figure 7 can be valuable in paper and pencil environment as well (with the teacher correcting them manually, of course). And the authors of the resource are the ones for whom it is easiest to offer the resource in a text format suitable for printing and possible modification.

All materials are obtainable in raw formats with all necessary files included (for example HTML is equipped with appropriate JavaScript files). So these basic blocks can be modified too.

We developed various scenarios of usage of those resources. The scenario a teacher chooses depends on his/her teaching style as well on his/her technical expertise in using ICT in the teaching process. If the teacher is inexperienced in ICT usage, the resources can be used directly through the portal. But it is assumed that the majority of teachers will download suitable resources and will combine them with resources obtained from other sources. So it is really the teacher who is in charge here as he/she develops the appropriate learning path.

Informal conversations with many teachers as well as the first reactions to the so constructed materials show that teachers find this approach to be good and believe it will enable them to improve the quality of teaching. Feedback showed that the main drawback of the approaches used in the two projects mentioned was that only basic building blocks were prepared. Pre-constructed models of units should be available as well. We are trying to eliminate the drawbacks within the new projects currently going on within the NAUK group.

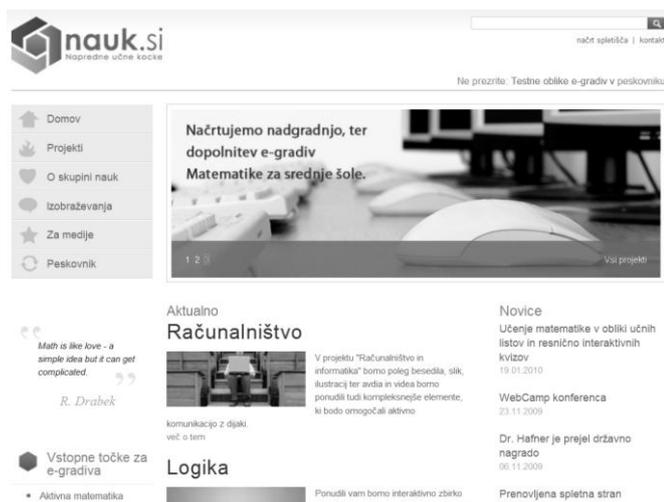


Figure 9 The new NAUK portal homepage

We took the same resources (and also developed several new ones) and produced several pre-constructed models. For example, we took the question bank on Geometry mentioned before and made a test in which the selection of the next question depends on the success at answering the previous question.

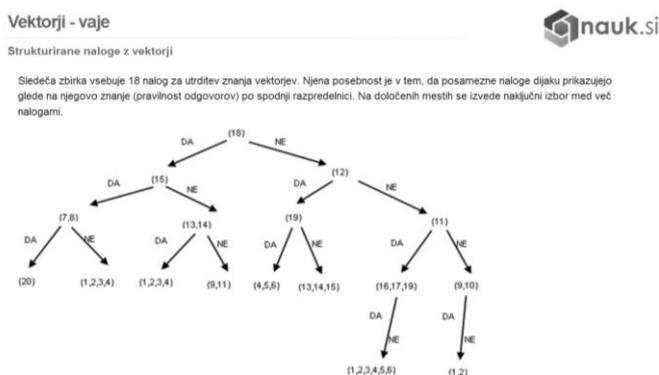


Figure 10 Model of a test

Teacher can take this model and use it as it is. Or he/she can change the questions as well as the path through this model. And of course we still support downloading the resources in various formats.

During the project we found that several new tools needed to be developed, too. Namely, we want to hide as much technical details from the teachers as possible to still maintain the flexibility of the way teachers modify the proposed models as well as basic resources.

A research study is also in preparation. It should show the teachers' reaction to the idea that they can have control of the teaching materials, get the materials in the shape of models that can be adapted and combined, as well as how they believe this will affect the quality of knowledge and

teaching. The research should also show the importance of the community (of teachers and students) for the development and usage of such materials. The approach mentioned brings several different options of using teaching materials which makes the exchange of experiences even more important.

## 6 CONCLUSION

Teaching resources should be designed in a flexible way, supporting appropriate use of different ICT tools. An appropriate view on e-resources preparation should deal with the whole process of their design, usage and modification. Teachers should have the possibility to adapt resources respecting the knowledge, skills and needs of their students.

## REFERENCES

van Assche, F. Vuorikari, R. (2006). A framework for quality of learning resources. In U. Ehlers & J.M. Pawlowski (Eds.), *European Handbook for Quality and Standardization in E-Learning*. Springer. 2006, (pp. 443-456).

Hwang, D. (2008), EDUNET: The Core of Korea's Knowledge Bank, presentation at 2<sup>nd</sup> Strategic meeting EdReNe, Lizbona, June 2008

IML (2009) Teaching Matters: A handbook for UTS academic staff, Retrieved 15 May 2009 from <http://www.iml.uts.edu.au/learnteach/resources/tm/teacherprep.html>

Kadijevich, Dj. (2007). Towards relating procedural and conceptual knowledge by CAS. Paper presented at CAMES5, University of Pécs, Hungary. Retrieved 15 May 2009 from <http://www.lkl.ac.uk/research/come/events/CAMES/>

Lokar, M. (2006). Electronic teaching and learning resources in math teaching in Slovenia, In D. Quinney (Ed.), *Proceedings of the 3rd International Conference on the Teaching of Mathematics at the Undergraduate Level*, Istanbul, Turkey. Hoboken, NJ: John Wiley.

Napredne učne kocke – NAUK (Advanced building blocks), available at <http://www.nauk.si>, access 16.1.2010

## BIOGRAPHICAL NOTES

Matija Lokar works at Faculty of mathematics and physics, University of Ljubljana, as head of computer centre and as a senior lecturer. His current research is focused on usage of ICT in the teaching process and on preparation of e-teaching resources; mostly for teaching mathematics and computer science in primary and secondary schools.