

# Baselines for the Preparation of Electronic Textbooks

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The NAUK group (Advanced Learning Blocks group; <http://www.nauk.si>) is engaged in the development of theoretical and practical concepts of ICT use in all levels of education. Recently, the proposed introduction of electronic textbooks (e-textbooks) has become a major topic nationwide in Slovenia. There are multiple dilemmas to be solved, e.g. what a modern e-textbook is, what it should include, in what way should it differ from conventional textbooks, what tools and technologies should be used for its creation, etc. This paper attempts to make recommendations, which we believe should be followed by all the authors of e-textbooks.

**Keywords:** e-learning, electronic textbooks, e-content, recommendations

## 1 Introduction

In every process of education the textbook is an integral part of learning. The definition of a textbook varies greatly, as does the determination of its essential characteristics. This article shall not deal with the textbook theories, as this topic has been widely covered in numerous sources (Nose, 2003; Jurman, 1999; Turk Škraba, 2005; Šporar, 2008). Two short citations should suffice:

*“A textbook is the basic schoolbook made for the specific needs of school education. It is a guide to other sources of knowledge, to discovering new insights. Thus it becomes a book that teaches learning.” (Nose, 2003).*

*“In a contemporary school a textbook is part of methodical-didactical material that cooperates with the teacher in the process of education and learning. The textbook is no longer merely didactical; it is also educational, as it affects the student’s personality in both ways. The textbook thus incorporates the informative function (knowledge) and through it the conative function (values), cognitive function (abilities), and emotive function (emotions).” (Jurman, 1999).*

The role and significance of textbooks keep changing, as the fact that this is the basic schoolbook presupposes that its role reflects the changes in the educational system. “The definition of a textbook depends on the nature of the educational system. The content of a textbook is loosely determined by the state through the curricula that list the content and operative aims of a subject or a subject area. The textbook is one of the resources that help teachers and students to reach the aforementioned aims (Turk-Škraba, 2005).

However, the following fact must not be neglected: the textbook is merely one of resources used by the teacher and the student. When preparing a textbook, the authors envisage a hypothetical learning situation and hypothetical students. The teacher, on the other hand, is the one who has to adapt to the actual learning process conditions. And these conditions usually differ at least slightly from the learning process envisaged by the resource authors.

As stated by numerous authors (e.g. Gerlič, 2010), the role of the contemporary teacher is changing substantially. The teacher is changing from a verbalizer of the textbook content (i.e. a walking textbook) into a strategist, planner, pedagogical diagnostic, organizer, consultant, etc. The need for individualized approach towards the student is often emphasized as well. Therefore a very important part of the educational process is left to the teacher. That is the adaptation

to the learning situation given and with it the preparation of the appropriate selection and combination of all learning resources available. And therefore, a contemporary e-textbook needs to be designed in such a way that its content can be promptly – nowadays manually, but soon automatically – adapted to the current learning situation and the individual that is to use the textbook, be it as a teacher or a learner (Lokar, 2009). It must not be forgotten that every teacher is an individual as well, and thus a person who has his or her own manner of teaching, set of values, and a view of which examples are best used to motivate the students.

## 2 E-textbooks

The form and the content of textbooks are constantly changing; partly also due to the development of information communication technology – ICT. Nowadays e-books and their real-life representations – e-readers are widely known to younger and technologically more experienced population and we can hear more and more about e-textbooks and their usage in educational process. Even on regulatory part of Slovenian educational system, e-textbooks are introduced. Namely in May 2010 Rules Amending the Rules on the Approval of Textbooks have been accepted. There explicitly e-textbooks as appropriate form of textbooks are mentioned; see Figure 1.

Even in daily press numerous articles with headlines such as “E-textbooks are coming into contemporary schools” were published. But behind the hype around e-textbooks it can be seen that even the definition on what the textbook is all about is not clear enough.

When making e-textbooks that are to transfer the knowledge from textbooks into digital environment, it is sensible to rely on the information acquired during different projects dealing with the making of e-resources (educational learning content) and on the standards required to manage them.

A quick overview of resources that are classified as e-textbooks will show certain shortcomings. Those that concern didactics and pedagogical theory (the number and pace of introducing new concepts, the language used, motivation stimuli, etc.) shall not be dealt with here; the ones concerning the field of technology itself, will. Of course the firstly mentioned shortcomings are the key factor that determines whether a textbook can be rated as useful and valuable. This article, however, will presuppose that the textbooks in question are well written regarding the content.

The basic “technical resentments” to the existing e-textbooks are:

- They are often realized as digitalized conventional textbooks (the addition of video clips does not yet make a true modern e-resource; if compared to paper, e-resources are completely different media and therefore the user experience obtained while using both, differs).
- Poor interactivity and limited multimedia; the lack of truly interactive exercises is very notable (the learner should be able to provide answers in the “natural form”, as a drawing, a plan, to use a video camera and a microphone, to interact with e-learning content using gestures, to participate actively in the conduction of experiments, to solve problems through games, to cooperate while learning with other learners and teachers).

### o spremembah in dopolnitvah Pravilnika o potrjevanju učbenikov

#### 1. člen

V Pravilniku o potrjevanju učbenikov se v 1. členu za besedo "dijakom" črtata vejica in beseda "vajencem". Doda se nov drugi stavek, ki se glasi:

"Učbeniki so lahko pripravljene v tiskani, elektronski ali v tiskani in elektronski obliki."

#### 2. člen

V 2. členu se na koncu četrtega stavka piko nadomesti z vejico in v nadaljevanju doda besedilo, ki se glasi:

"razen v primeru učbenika, pripravljenega in objavljenega v elektronski obliki (v nadaljnjem besedilu: e-učbenik), ki neposredno vpisovanje lahko dopušča."

#### 3. člen

V 4. členu se zadnji stavek spremeni tako, da se glasi:

"Te fizične ali pravne osebe smejo biti navedene v kolofonu, v e-učbeniku na začetku ali koncu gradiva, ločeno od izobraževalnih vsebin, logotip ter kratka predstavitev podjetja le na zadnjih dveh notranjih straneh učbenika, v e-učbeniku pa na koncu gradiva, ločeno od izobraževalnih vsebin."

Figure 1: Rules Amending the Rules on the Approval of Textbooks.

Tretjo uro sem delal matematično upanje in varianco: razložil se shemo). Za vajo smo naredili upanje enakomerne in Bernoullije

3. (24. 10. 2005) Delal sem vektorje v  $R^n$

- o linearne kombinacije (tudi delitev daljice v danem razmerju)
- o linearne ogrinjace (omenil sem, da so vektorski podprostorji)
- o linearno neodvisnost (dve definiciji)
- o Gaussova eliminacija za linearne sisteme in njena uporaba
- o baze (omenil sem, da so baze natanko linearno neodvisni)

Literatura:

- o Keith Matthews, Elementary linear algebra, e-učbenik,

Chapter 1

LINEAR EQUATIONS

1.1 Introduction to linear equations

A linear equation in  $n$  unknowns  $x_1, x_2, \dots, x_n$  is an equation of the form

$$a_1x_1 + a_2x_2 + \dots + a_nx_n = b,$$

where  $a_1, a_2, \dots, a_n, b$  are given real numbers.

For example, with  $x$  and  $y$  instead of  $x_1$  and  $x_2$ , the linear equation  $2x + 3y = 6$  describes the line passing through the points  $(3, 0)$  and  $(0, 2)$ .

Similarly, with  $x, y$  and  $z$  instead of  $x_1, x_2$  and  $x_3$ , the linear equation  $2x + 3y + 4z = 12$  describes the plane passing through the points  $(6, 0, 0), (0, 4, 0), (0, 0, 3)$ .

A system of  $m$  linear equations in  $n$  unknowns  $x_1, x_2, \dots, x_n$  is a family of linear equations

Figure 2: A PDF file as an e-textbook.

- For example: interactive use of a star chart, by solving different exercises, provides much better interactivity and learning experience than passive watching of a film, which shows the proper use of such a chart.
- Lack of contextual dependency; hardly any e-resource is able to show the content appropriate to the activities of the user thus far (this function is very useful when the learner should be taught about a mistake made a few steps back and the consequences of that same mistake).

Quite often an “ordinary text” in electronic form (for example as a PDF file) is called e-textbook; one of such examples can be seen in Figure 2.

Conceptual shortcomings are even more common:

- Monolith units (made of a single huge block, which cannot be easily modified).
- Impossible to combine with other resources (normally the teacher has its own resources that he or she wants to be used by the learner).
- Made as learning paths with linear structure.

**Kvadratne nejednadžbe**

Nejednadžbe s kvadratnim funkcijama zadanim u obliku  $y = (x - x_0)^2 + y_0$

Rješavanje kvadratnih nejednadžbi

Minimum kvadratne funkcije ima koordinate (2,1). Graf funkcije siječe os  $y$  u točki s ordinatom 9. Pronađi sve  $x$  za koje vrijednost kvadratne funkcije nije manja od 19.

$x < -3$  ili  $x \geq 3$ 
  $x < -3$  ili  $x \geq 1$

$x < -5$  ili  $x \geq 1$ 
  $x < -1$  ili  $x \geq 1$

$x < -1$  ili  $x \geq 5$ 
  $x < -5$  ili  $x \geq 3$

$x < -1$  ili  $x \geq 3$ 
  $x < -3$  ili  $x \geq 5$

Odredi tjeme funkcije i napiši odgovarajuću nejednadžbu.

Matematika za srednju školu – univerzalni kurikulum © YDP

Figure 3: E-textbook as monolith Flash application.

- Heavy use of third-party technologies that cannot be adjusted for the presentation (e.g. the resource is a single huge “unchangeable” Flash file).
- No appropriate authoring and management tools for editing, upgrading, and construction of e-resources.
- Form (i.e. the representation of the e-textbook) is not separate from the content (the scenario of the e-textbook).

Quite often visually appealing resources are claiming to be a prototype of a modern (e-) textbook. One of such examples can be seen in Figure 3.

What is wrong with this resource? Mostly, it is the fact that it does not go beyond the limits of an ordinary textbook. Surely it introduces interactivity, some new approaches, but we claim it does not allow the teacher to fulfill his new role. Namely teacher cannot modify this resource to prepare it suitable for the particular group of students and the current didactical situation in the classroom. The authors of the paper believe that a contemporary e-textbook is merely a vision of the author, an idea how to present a learning path and then reach the aim of learning a new concept in a certain hypothetical learning environment and involving a hypothetical student. By no means should such e-textbooks be unalterable objects that the teacher and learner are forced to use exactly as is.

People have different learning styles which are a combination of acceptance, management and information processing; it is a combination of teaching methods that a learner is using in most learning situations (Marentič-Požarnik, 2000). This fact is the essence of the model of multiple intelligences (Gardner, 1999), which defines 7 to 9 different human intelligences. Younger generations learn differently than their teachers learned decades ago; they know how to obtain instant information from the Internet and they expect electronic learning material to be modern by all means. Thus, there is no uniform way to learn something – the learning material should (automatically) adapt to the learner.

E-textbooks should therefore be flexible. The teacher should be able to change and recombine them. Nowadays it is technically possible to recombine resources (Horvat et al., 2010). It is the authors who should respect and value the role of the teacher. The teacher must stay in control: have the option to change, correct, adapt the resource, change the order of particular elements, etc. Some of the resources should be allowed to be automatically altered by the system; this is especially useful when parts of the dynamical exercises are replaced by computerized instances, when parts of the e-learning content gets semantically linked to similar content in the system, etc.

The authors of e-textbooks will offer their own view of using the e-textbook in a hypothetical learning situation. However, the technical implementation of the e-textbook should allow the teacher to adapt it (if necessary). Therefore it makes sense to imagine the textbook as a way of recursively “assembling” and connecting basic blocks of educational resources.

The main characteristics of e-resources that are to be created within the making of e-textbooks should therefore be:

- **Availability:** the possibility of global access to the resources and their transfer to other locations.
- **Flexibility:** the option to adapt the resources to the individual needs of teachers and groups.
- **Cost effectiveness:** the increase of effectiveness and productivity through the reduction in time consumption and costs when preparing resources.
- **Permanence:** the option to adapt the resources to the changes in technology, without high costs and recoding.
- **Interoperability:** the option to use the resources in different learning environments, with different tools.
- **Re-usability:** the option to use the resources in different contexts.

### 3 How to design an e-textbook

The solutions for the following problems should already be thought about during the initial design of e-textbooks:

- What is the life span of the particular e-textbook?
- Adapting content to the future changes in technology? For example: GeoGebra<sup>1</sup> files will not work even if the changes in the player versions are minimal; can e.g. WordStar<sup>2</sup> files be opened today?
- The display of the e-textbook on different / new hardware? The learner experience is different on novel multi-touch devices than on interactive whiteboards.
- What is the appropriate quality of multimedia resources included in e-textbooks? As before, different hardware calls for different standards, sizes and quality?
- Will the option of searching through the resources by content be available? Managing and using metadata and integration of other repositories are important.
- Will innovative highly interactive elements be part of the content? Those do not only include quizzes, but also activities in the form of drawings, games, the inclusion of a camera and microphone.
- Will the e-textbook provide integration with outside services? Searching for similar content, connecting to GIS, Moodle<sup>3</sup> quiz banks, etc.?

In an e-textbook interactive and multimedia elements must be connected (quizzes can include elements such as: images – choose the situation presented in the picture, “hot spots”, conduction of interactivity over multimedia elements – measuring distances over an image, measuring the duration of an audio or video clip, skipping to a particular part of a video clip, full screen enlargement, etc.).

It is desirable that the content is available in different end-modes (“full” format, tailored to chosen virtual classroom or LMS, wiki, “no internet access”, “on paper”), which should all, except the “full” one, function minimally curtailed (e.g. a classic wiki does not include all interactive elements).

1 GeoGebra is a geometry package providing for both graphical and algebraic input; <http://www.geogebra.org>.

2 WordStar was a word processor application, published by MicroPro International already in 1978.

3 Moodle LMS; <http://www.moodle.org>.

It must be ensured that the use of e-textbooks can be adapted as successfully as possible to different output technologies and devices (mobile education: multi-touch devices, “smart phones”, interactive whiteboards; new open standards (HTML 5 and similar), use of different proprietary devices that act as readers, such as iPad and Kindle, etc.). It is also desired that different versions of same e-textbook assume the execution in different output models (e.g. a web textbook in a standard browser, an e-textbook to be used on an interactive board, etc.).

The following matter is also of great importance. The final form of the textbook should be realized with solutions that ensure support for special needs groups (hearing or vision disabled, etc.) that have their own needs and principles, behavior patterns, and are of different ages. The functional and visual standards of designing e-resources must be observed. And since such groups are numerous and varied, the problems of how to cater for different presentational needs should already be thought of during the process of design. The content shall thus remain the same; only the modes of its presentation should differ.

Therefore free access into the structure of the textbook is vital – in order to ensure the textbook’s adaptability to new demands, special needs, and different paradigms. The general technical orientation is also important, regarding the choice of technologies, standards, components, frameworks and implementation tools. This ensures the simplicity and transparency of the system components maintenance (Horvat et al., 2009).

How should the resources that will comprise an e-textbook in the end be prepared then? Based on the above-men-

tioned requirements and needs, the NAUK group has formed the following recommendations.

**RECOMMENDATION 1:** The presentation of the resource should be separate from the content.

Explanation:

- Standards and technologies of transfer and display of content over the Internet change rapidly. Ever-new forms of output technologies appear (palm books, “smart phones”, interactive whiteboards, multi-touch devices, such as Microsoft Surface, e-readers such as Kindle, etc.). The pedagogical didactical environment itself sometimes demands different technological executions. Therefore it is necessary to avoid the need to frequently change and remodel the content each time that the technology is changed or modernized.
- The adaptation of e-textbooks to different output technologies is to be done by automatically and not by content experts. The adaptation procedure itself should be executed automatically, regarding the settings chosen by the author of the resource and the situation when and how the resource is being used. There are already tools aware of different output technologies. For example in Figure 4: Choosing an output device without changing the content is an example of future Adobe tools, presented at Adobe MAX 2010 conference (Lynch, 2010), where you choose an output device and the content is presented accordingly. And this is not possible if you do not separate the content and its presentation.
- The resource must support the use by special needs groups (hearing or vision disabled, etc.) that have their

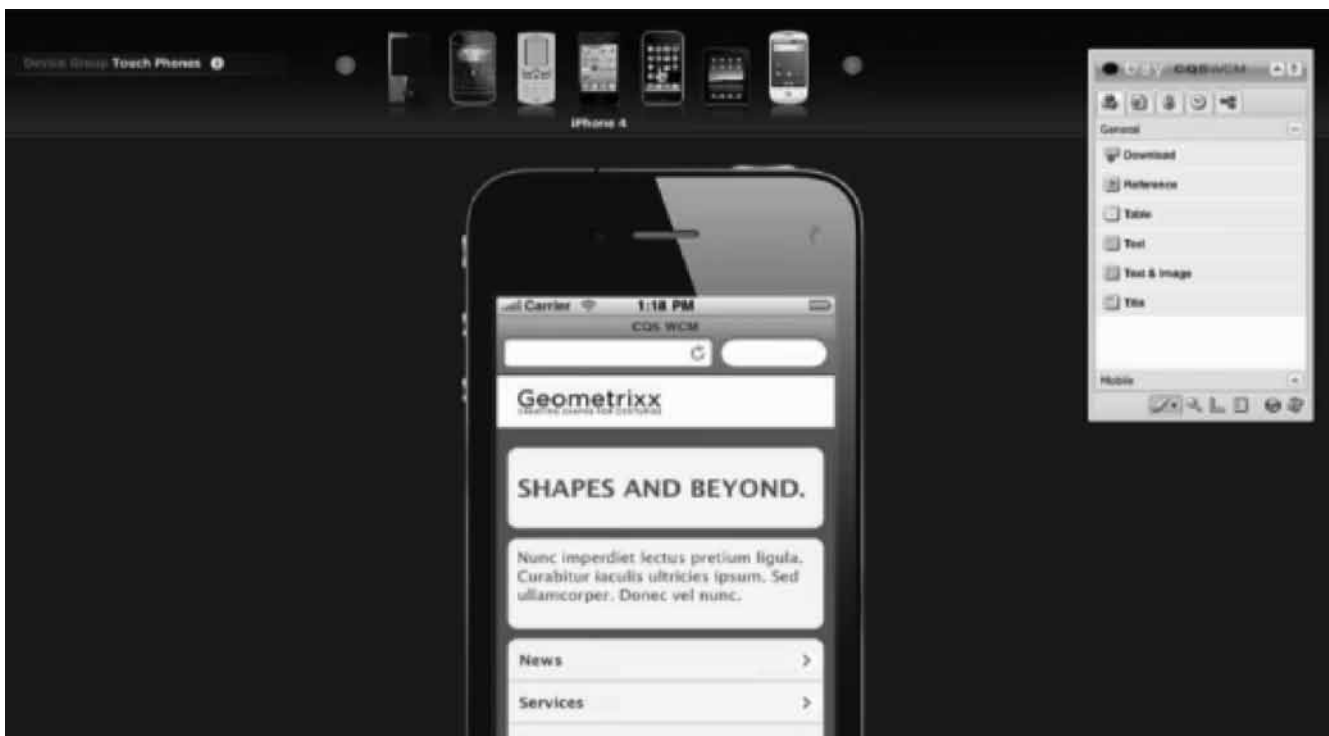


Figure 4: Choosing an output device without changing the content.



Figure 5: Possibility of changing the order of chapters.

own needs, principles, and behavior patterns. The functional and visual standards of designing e-resources must be observed. This is yet again not the resource author's job, but needs to be provided as an option (e.g. 508 Compliance in the USA).

- It is necessary to consider the fact that user experience is strongly affected by the speed of the connection as well as hardware and software. Keeping content in as "raw" mode as possible ensures automatic transfer of higher quality multimedia content when it becomes available or possible to be used.
- The option of the e-resources being translated into other languages, minority groups' languages (in Slovenia for example, Italian and Hungarian) must be considered.

**RECOMMENDATION 2:** Resources should be modular.

Explanation:

- It is only possible to reuse resources when they are constructed out of several smaller blocks, which can be used within different contexts. A building block should be a complete unit and logically indivisible, e.g. an image, an animation, a question, etc.
- Modular composition enables the adaptation of the textbook to the didactical learning situation and individualization. Teachers are therefore able to take a part of the textbook and combine it with the resources they use already. Here an analogy with the present situation is apparent; teachers nowadays often use several different traditional textbooks and/or web based resources at the same time. These changes can be very simple, but often powerful.

For example a simple approach with the possibility of changing order of chapters can already be seen (see Figure 5: Possibility of change) on Flat World Knowledge portals<sup>4</sup>.

- This choice increases the flexibility of e-textbooks and enables better framework to support cross-curricular teaching.

**RECOMMENDATION 3:** The resources should be open standards based.

Explanation:

- In order for educational resources to be useful within the educational system, it is necessary for them to be available under a suitable Creative Commons type license which is already in use for the resources that were made in the existing e-resources constructing projects<sup>5</sup>.
- The resources themselves must be created using open standards whenever possible (HTML, XML, CSS, JS). Solutions that assume transformation of the entire content into a proprietary (protected) format (such as Flash, QuickTime, SilverLight, etc.) do not enable straightforward modification and adaptation of the resource.
- The content (scenario that includes interactive functionalities of the content) itself should be in text-based format that enables effortless modification and supplementation.
- Separation of the scenario from the presentation of the content enables automatic (i.e. computer-based) management of the repository and computer-powered construction of new e-learning content based on the requirements (measured knowledge) of the learner.
- Free access into the structure of the textbook must be enabled, if possible without logging in.

<sup>4</sup> Flat World Knowledge; <http://www.flatworldknowledge.com>.

<sup>5</sup> NAUK repository of elearning content; <http://www.nauk.si>.

**RECOMMENDATION 4:** Resources should be meta-data equipped.

Explanation:

- All e-textbooks should be metadata equipped. There already exist different ontologies as well as approaches directed towards linking existing curricula and particular e-resources (Libbrecht et al., 2008; Libbrecht et al., 2011). This enables easier searching, replacing single building blocks, and use of building blocks outside the textbooks.
- Metadata should not only contain information about the authors, but also suitable licenses for the resource units acquired from other sources. E-textbooks must namely always follow copyright laws.

**RECOMMENDATION 5:** E-textbooks and their parts should be transferable into different environments.

Explanation:

- Where possible, the resources should enable export in SCORM format; elementary formats of export are also desirable (XML, HTML+CSS), due to their simplicity of use and minimal consequences for the functionality.
- It is necessary to presuppose the execution of certain scripts in at least two output models: a conventional browser and the interactive board. The resources must be suitably adapted.
- Many teachers use virtual classrooms that enable the import of different types of resources. Some teachers are able to use the collection of questions in XML standardized format directly within the virtual classroom as well as to correct them and combine them with their own resources.
- Original source files must be maintained, as they alone enable the preparation of export in different forms.

**RECOMMENDATION 6:** E-textbooks should have a single and simple user interface.

Explanation:

- It is necessary to be aware that quality user experience is crucial for the existence and use of web-based e-learning, therefore a lot of attention must be paid to that, regarding the current technological limitations. The tools and services must be based on the Web 2.0 concept, which puts the end-user, in our case the learner, into a center.
- Different presentation channels should use the same “look and feel” – to prevent confusing the learners that use the same content in different situations (e.g. in school, at home).
- Due to the aforementioned concept, the user community development (social network management) must be regarded as well as the content collection, presentation, and offer.
- The content of the textbooks should be freely universally available (at the same time adapted for vision, physically, hearing, cognitive, and verbally disabled users; the content should not contain unnecessary moving pictures, pictures should be alternatively marked, etc.), the content should conform to the W3C recommendations.

**RECOMMENDATION 7:** Activities connected with the preparation of e-textbooks should be divided into the following steps:

- Development of collection of tools for the preparation of e-textbook scripts and their later-on technical execution.
- Preparation of multimedia resources and interactive scenarios for pilot e-textbooks.
- Making pilot e-textbooks.
- Improving e-textbooks.

Explanation:

- A manner of describing e-textbooks (writing standardized script or scenario) is necessary for enabling the separation of content and execution (presentation), as well as a collection of suitable tools and services that enable the authors to promptly prepare resources (such approach enables successful cooperation between the authors and technicians at first steps of e-textbook creation). Suitable tools also enable the teachers to further adapt and individualize the resources, by themselves. The tools should also enable the definition of a work-flow, community cooperation, consultants, referees, etc.
- The interactive scenario represents the actual learning path (or better, a learning network), that is, a guide how to perform the teaching of a concept with the aid of the aforementioned components. It is actually the basic non-linear learning path as imagined by the authors. On this basis, teachers could develop new versions of the scenario and construct new learning paths. The existing scenario can serve as the base for making new or improved e-resources (and can be included in several e-textbooks).
- The script needs to determine the content of the e-resource: text, pictorial and other material (map, musical score, etc.), multimedia and interactive elements. During the script design it is necessary to respect the fact that new e-resources should enable and encourage the introduction of novel and modern approaches to teaching and learning – especially a more active role of the learner and inductive learning.

**RECOMMENDATION 8:** Using e-textbooks should be fun.

Explanation:

- The most efficient (classical and electronic) learning is learning without the awareness and presence of the learning process; in short term “learning without knowing it”. E-textbook can only achieve this goal when it is fun using it. To achieve the ease of learning using e-textbooks, authors of the e-textbooks should use every possible way to present the knowledge in a friendly and fun way. Consequently e-textbooks should contain a lot of interaction, visualization and animation.
- An e-textbook must make sensible use of the ICT and Internet options available, and contain truly interactive elements (multiple choice exercises, text input boxes, connecting pictures and text, marking answers, dynamic – parameter equipped exercises, freehand drawing, matching exercises, simple insertion of special symbols, augmented reality, etc.). Similarly, colors, avatars, characters, humor, etc. should be used in a sensible way.

## 4 Conclusion

E-textbooks should not be a simple transfer of the classical printed textbooks into a more contemporary electronic format. The simple addition of multimedia elements and limited interactivity are not enough. An e-textbook should offer more. It must facilitate what a conventional textbook cannot, due to the nature of its medium. Contemporary textbooks should be prepared in such manner that will enable contextual dependence of textbook elements and thus different learning paths of reviewing & studying e-content. The process of improving the educational content should be greatly eased and therefore enable the teachers to easily and promptly adjust the learning materials with the respect to the real situation in the classroom. And what is the most important; all this should enable the learners to learn more in the same time.

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### **Izhodišča za pripravo e-učbenikov**

V okviru skupine NAUK (Napredne Učne Kocke; <http://www.nauk.si>) se ukvarjamo z razvojem tako teoretičnih kot praktičnih izhodišč na področju uporabe IKT v izobraževalnem procesu na vseh nivojih. V zadnjem času je v Sloveniji zelo v ospredju problematika elektronskih učbenikov (e-učbenikov). Rešiti bo potrebno več dilem: kakšen naj bo sodoben e-učbenik, kakšne naj bodo njegove značilnosti, kaj mora vsebovati, v čem se razlikuje od klasičnega učbenika, katera orodja in tehnologije uporabiti za izdelavo itd. V prispevku smo poskusili predstaviti nekaj priporočil, za katere menimo, da naj bi jih upoštevali vsi avtorji e-učbenikov.

**Ključne besede:** e-izobraževanje, elektronski učbeniki, e-učbeniki, e-gradiva, priporočila