ZOOMING USER INTERFACE IN PRESENTATIONS FOR LEARNING

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***Abstract**: The paper describes interactive environment for creating and using in learning multimedia presentations of compound visual structure with linking arrows due to zooming user interface. Therefore the environment can be viewed as hypermedia one. The article contains the analyses of appliance well established principles of modern instructional theories as well as hypotheses in application hypermedia in learning.*

***Keywords**: cognitive load theory, cognitive theory of multimedia learning, zooming user interface, hypermedia.*

***ACM Classification Keywords**: K.3.1 Computer Uses in Education*

Introduction

Many studies describe the usage of presentation in learning. This part of using Information and communications technology (ICT) is important because every teacher is able to create presentations. The main features of presentation are usually associated with MS PowerPoint capabilities. Theoretical findings also have appliance in practical guidelines for traditional presentation creation [Atkinson & Mayer, 2004]. Taking into account theoretical principles we try to find a different approach to the subject. We use Zooming user interface as the main idea of our system and support this idea by set of tools following the findings of theories. Students of Perm State Pedagogical University (Russia) make presentations in our system in the topic of physics. These presentations can be used in different activities such as lectures, individual studies or team work. We assume that interactive whiteboard should be used in a classroom environment for the best result.

Theoretical foundation

There are few of the most influential theories in the area of instructional design and computer-based training: The Cognitive load theory (CLT) [Sweller et al., 1998] and The Cognitive Theory of Multimedia Learning (CTML), [Mayer et al., 2000].

Cognitive load theory is mainly concerned with the learning of complex cognitive tasks, where learners are often overwhelmed by the number of information elements and their interactions that need to be processed simultaneously before meaningful learning can commence [Paas et al., 2004]. From CLT point of view the learning can be considered as schema construction and automation [van Merriënboer and John Sweller, 2005]. Schema is one of the concepts for representing mental structures.

Sweller et al. [1998] proposed several instructional design techniques based on Cognitive Load Theory. These instructional principles are identified as the *goal-free effect, worked example effect, completion problem effect, split-attention effect, modality effects, redundancy effect,* and *the variability effect*. All of these effects except *variability effect* are meant to reduce extraneous cognitive load, which is not necessary for learning but demands mind resources.

We give description of the effects that can be implemented in our environment following van Merriënboer and John Sweller [2005] :

Goal-free effect: Replace conventional problems with goal-free problems that provide learners with an a-specific goal.

Worked example effect: Replace conventional problems with worked examples that must be carefully studied.

Completion problem effect: Replace conventional problems with completion problems, providing a partial solution that must be completed by the learners.

Split attention effect: Replace multiple sources of information (frequently pictures and accompanying text) with a single, integrated source of information.

Modality effect: Replace a written explanatory text and another source of visual information such as a diagram (unimodal) with a spoken explanatory text and a visual source of information (multimodal).

Redundancy effect: Replace multiple sources of information that are self-contained (i.e., they can be understood on their own) with one source of information.

One more effect was found later:

The expertise reversal effect: Instructional methods that work well for novice learners may have neutral or even negative effects when expertise increases.

The Cognitive Theory of Multimedia Learning [Mayer, 2001] which is partially derived from Dual Coding Theory [Paivio, 1978] draws a quite conclusive picture concerning learning with visualizations. The theory assumes that there are two ways of processing information and hence two kinds of mental representation in the cognitive system. In the verbal system, information of a sequential structure such as written texts or spoken words is processed. In the non-verbal system, spatial information and pictures are processed. Connecting these two cognitive representations properly should improve learning results. [Hoffler, 2010].

The cognitive theory of multimedia learning applies some basic assumptions to the design of multimedia learning environments that are similar to CLT. In addition, this theory defines several types of sequential processes that are required for active learning [Kalyuga, 2011].

Applications of this theory are theory-based principles for how to design electronic learning environments, which themselves can be tested in research studies. As part of his evidence-seeking efforts for the science of e-learning, Mayer [2001, 2003] presents nine major effects which were developed out of dozens of studies. These replicated effects are: *modality effect, contiguity effect, multimedia effect, personalization effect, coherence effect, redundancy effect, pre-training effect, signaling effect,* and *the pacing effect*. An explanation of part of these effects concerned with using the environment, lead to principles [Moreno & Mayer, 2000], follows:

The Contiguity Principle states that better transfer occurs when corresponding narration and animation are presented simultaneously, both temporally and spatially. Temporal contiguity means that corresponding words and pictures should be presented at the same time, while spatial contiguity means that corresponding words and pictures should be presented near rather than far from each other on a page or screen.

The multimedia principle states that better transfer occurs from animation/pictures and narration/words than from words alone. When words and pictures are both presented, learners have the chance to construct verbal and visual cognitive representations and integrate them.

The redundancy principle states that better transfer occurs when animation and narration are not combined with printed text. When pictures and words are both presented visually, it can overload visual working memory capacity.

The pacing principle states that better transfer occurs when the pace of presentation is controlled by the learner, rather than by the program. Learners vary in the time needed to engage in the cognitive processes of selecting, organizing, and integrating incoming information, so they must have the ability to work at their own pace to slow or pause the presentation if necessary. If the pace of the presented material is too fast, then these cognitive processes may not be properly carried out and learning will suffer.

These principles are general enough and can be well applied in particle designs. But we try to develop educational environment which enable implementation of these principles more natural way. On the other hand we try to use findings from different less established fields. One of them is Hypermedia environment research, which is more arguable and has pros and cons. One of hypermedia aspects is learner control, which can be also associated with form of interactivity and can be discussed from CTML point of view. Scheiter and Gerjets [2007] note that learner control in hypermedia context is supposed to aid learning, because respective environments (1) mirror the human mind, (2) increase interest and motivation to learn, (3) enable instruction adapted to learners' preferences and cognitive needs, (4) provide affordances for active and constructive information processing, and (5) foster the acquisition of self-regulatory skills.

It is also mentioned in this work that the potential effectiveness of self-controlled learning with hypermedia is hampered by (1) usability problems (i.e., disorientation, distraction, cognitive overload), (2) moderating learner characteristics (i.e., prior knowledge and general abilities, self-regulatory skills, cognitive styles and attitudes towards learning), (3) a lack of conceptual foundations, and (4) methodological shortcomings of hypermedia research.

Usability problem is a separate area and its description is out of bounds of this article, but some aids will be presented further. Some studies of learner characteristics and cognitive styles are of interest. One of these studies investigated the effect of two segmented and holistic, on the progression over time of learners' mental models toward that of an expert with the moderator of cognitive flexibility [Aubteen Darabi et al. 2009]. Authors suggest that efficient choice of segmented and holistic strategy is closely concerned with cognitive flexibility, one of cognitive styles characteristics. This conclusion is consistent with Swanson and Law's [1993] whole-part-whole instructional model. That assumes through "first whole" the model introduces new content to learners by formatting in their minds the organizational framework, then "parts" learned separately, and after learners have successfully achieved the performance criteria for individual "parts" within the whole, the instructor links these parts together, thus forming the second whole.

Zooming user interface

A ZUI is a dynamic interface. It provides user a canvas that is larger than the viewing area, on which items are placed: The items placement is arbitrary and may be determined by the users, by the system, or by both. User can scroll their viewing window across this canvas to view different items. The ZUI difference from a normal canvas is that the user may zoom in or out onto a particular item, like a telescopic lens on a camera [Salmoni, 2004].

In application of presentation construction ZUI means that there are no separate slides more. They turn to frames – dedicated parts of large canvas that can be placed arbitrary, can have arbitrary scale. Smaller frames can be combined in a larger one. And all of them can be linked by pointing arrows (Fig. 1, 2, 3). Thus, all of presentation content can looks like concept map and represent connections between parts. This approach assumes, that titles of frames are large enough to be readable in low scale, when presentation or its part presents structure of the content only.

Zoom environment has good consideration with the Whole-part-whole learning model: the "first whole" is introduced in low amount of scale, then "parts" are surveyed closely, and then each "part" finds it's place in the "whole" again.

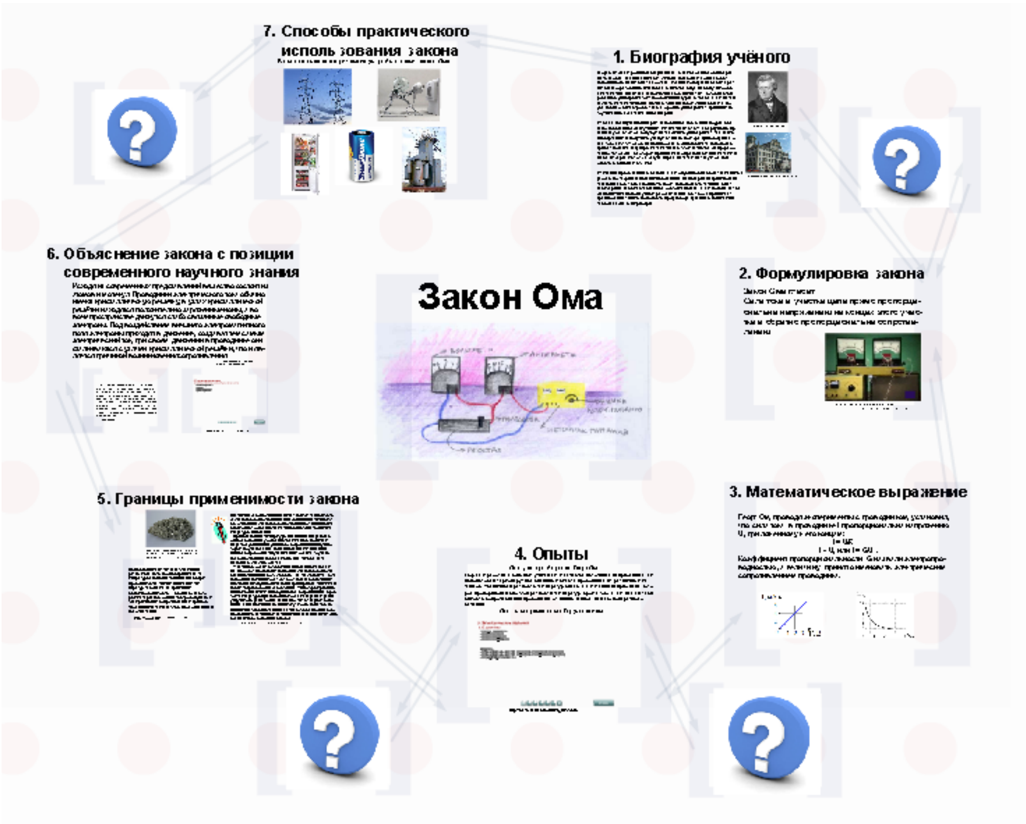

Fig.1. View of Zooming Presentation about Ohm’s Law by Mila Khrenova, student of PSPU.

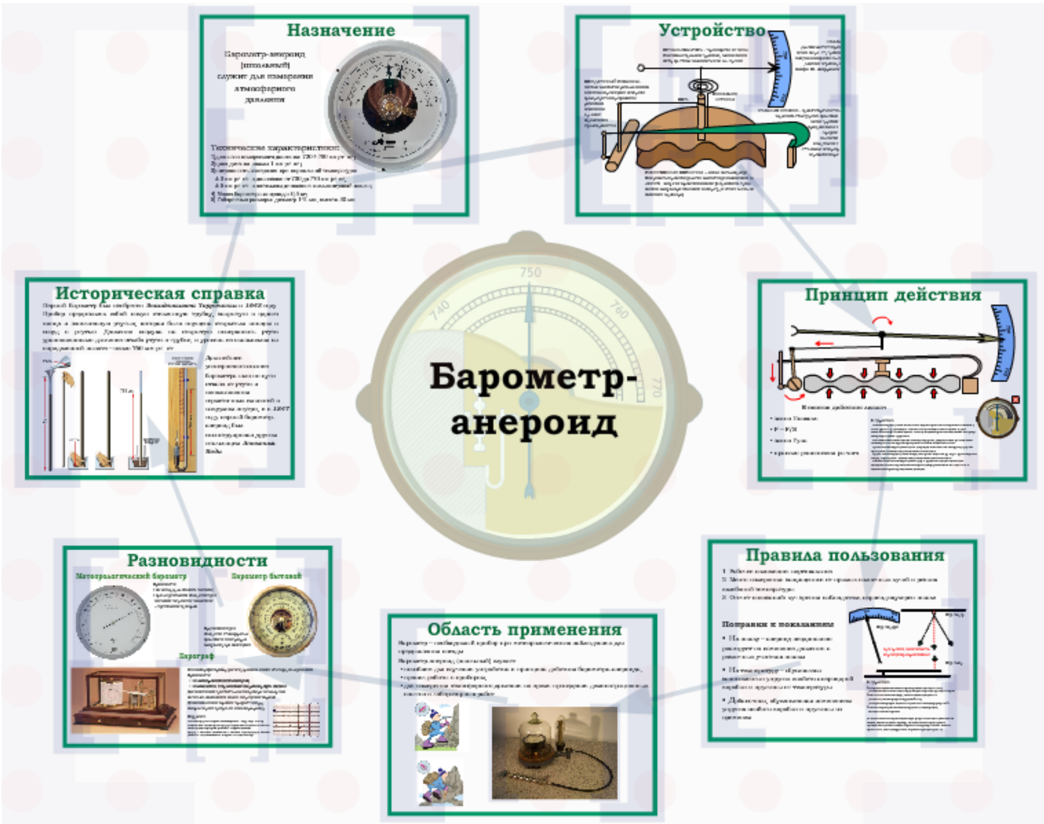

Fig.2. View of Zooming Presentation about aneroid barometer by Stas Subbotin, student of PSPU

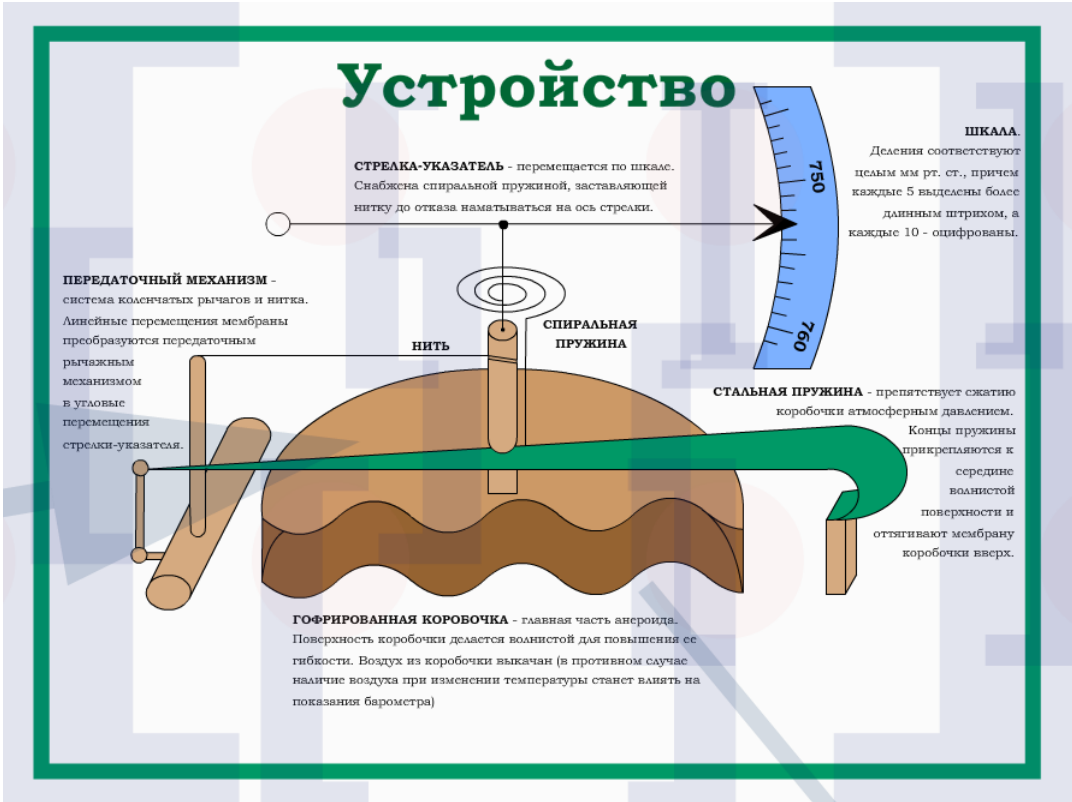

Fig.3. Zoomed fragment of Presentation about aneroid barometer

Features of the environment

First of all we should note that elements of described presentation can be in almost any media format: text, pictures, video, animations, sounds and anything that can be placed in SWF format (interactive models, 3D models, units displaying images from WEB-camera, etc). Arrows in presentation also take function of links – clicking on arrow will place pointed frame in viewing area. Thus, our environment match description of Hypermedia learning environments: “…consist of network-like information structures, where fragments of information are stored in nodes that are interconnected and can be accessed by electronic hyperlinks” [Scheiter and Gerjets , Conklin 1987; Rouet et al. 1996].

Now let us describe set of tools realized in the environment. Main from them are: *painting tool, mask layer tool* and *drag-and-drop*.

Painting tool allow presentation's author to set “drawable” property to any element of presentation (f.e. picture or movie). Then, when presentation is being viewed, user can draw marks on this element by mouse pointer just like in a graphics editor without any additional actions. In case of pictures or animations it can be explanatory statements, or, in case of clean fields it can look like a part of simple whiteboard, which allows learner to write task solution.

Any parts of presentation can be overlapped and one can hide another one. If *mask layer tool* is assigned to top element, it is possible to cut holes in this element to make the bottom element visible.

And *drag-and-drop tool* means that element of presentation can turn to "dragable" element, so a number of those elements can be reordered as a part of some learning task.

Implications of theoretical foundation

In this section we show appliance of multimedia principles in creation of multimedia presentations in our environment.

Goal-free exploring strategy in hypermedia environment is very natural, so it is closely concerned with *goal-free effect*. It is an efficient way to introduce learners in complex topic.

Besides usual way *worked example effect* as well *as completion problem effect* can be freshened up with painting tool, layered masking tool and its combination. Any part of a solution can be hidden, any part can be dedicated to be filled by learners. According to *split-attention effect* and *contiguity effect*, zoom environment allows to place any elements to single construction. Even extensive description can be integrated with images due to zooming placement. Following *redundancy principle* we should exclude printed text which is presented in narration, but in some cases due to *expertise reversal effect*, printed text can be preferable. In zoom environment that redundant texts can have low scale, so it will be unnoticeable usual way, but can be accessible on request. Also some cases *mask layer tool* can be applied well. *Modality effect* and *multimedia effect* take their place when images, video, animations and sound records are used. *The pacing effect* appears firstly due to leaner's control in hypermedia environment and secondly due to splitting sound records by elements they targeting. Usability problems (i.e., disorientation, distraction, cognitive overload) are partly resolved due to possibility to take zoom out any time and to view all system of topic knowledge and to find placement of current element.

Conclusion

The paper presents the description of interactive environment for creating and using in learning multimedia presentations. It shows how multimedia principles can be applied for creating presentations in the environment. The assessment of student's work will be discussed in a separated paper.

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