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"MATHEMATICS, INFORMATICS AND PHYSICS"

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BOOK 5

"MATHEMATICS, INFORMATICS AND PHYSICS"

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Physics

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COGNITIVE APPROACH TO DEVELOPING LEARNING DESIGN FOR INTERACTIVE MULTIMEDIA TRAINING

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Abstract: *This article was prepared with the financial assistance of the European Social Fund: project BG051PO001-3.3.06: "Supporting Academic Development of Scientific Personnel in Engineering and Information Science and Technologies". The article presents a cognitive approach and main methodological guidelines for the development of interactive learning design and related practical activities.*

Keywords*: multimedia, presentation, feedback, training, strategies*

INTRODUCTION

The current article looks through the specific phases planning, presentation and practice in the development of interactive multimedia educational design, approaches to creating appropriate presentation and related practical activities that are oriented to learners' sensory, operational and long-term memory.

Variables that need consideration during the creation process of advanced educational resources come from *science*, *logic* and *feedback*.

Science. It may give ideas, but different strategies should be used. As a basis for their decisions course designers use mainly behavioral and cognitive psychology's scientific knowledge. But this information only provides guidelines. Every single educational setup is unique. Each educational project should provide various types of content, different learners and various learning spaces.

Logic. Educational design is a set of quality learning solutions, their testing and the ability to modify the instructions into an appropriate direction. Does design really help the student to absorb information efficiently and effectively? Instructions are pointless if not following these objectives.

Feedback. Creation of electronic educational resources requires time and energy expense by both the designer and the learner. In this sense loss of time is not acceptable. Collection of evidence by the author is necessary to demonstrate that training has given its results and has improved learners' knowledge and skills.

The above principles define basic approaches to creating electronic educational resources. In the following lines these principles are supplemented by three basic phases of educational design: (1) planning, (2) presentation, (3) practice.

Planning

This is a process of systematization of each of the actions in the creation of design, so that any decision to be determined by a previous one. For example, once defined educational needs, the next step is learning objectives to be clarified and articulated. These learning objectives are the unambiguous statement of what the learner will be able to do after the training. Likewise, terms of the tasks need to reflect on the implementation of learning objectives. Educational design must not be concrete and coherent only, but also suitable and convenient. In order to be convincing and appropriate, educational design must first be properly categorized.

Presentation

Most learners need assistance in acquiring information. Type and amount of assistance that trainer may provide to learners are presented as learning strategies. Whatever tool (platform) is used for providing information the author must have specific strategies for presentation. He has to know how to organize, arrange and present content to the learner, to decide which definitions to use, which examples will best illustrate the thesis and what graphics will reinforce his message [9].

Practice

One of the most important principles in educational design is the necessity of learner's activity. There is no certainty in the results that students achieve if it is not provided evidence of their skills. Learning is mostly hierarchical - new skills build on old ones.

The only way of defining whether learners have assimilated the information, is by involving them in performance. The more opportunities for performance and feedback learners receive, the better.

1. MODEL OF EDUCATIONAL DESIGN

By the planning phase are defined objectives that afterwards have to be canalized into a system that provides results. Model of educational design provides such system and is based on studies of information processing by humans that consists of three main phases/types: (1) sensory memory (sensory or short-term); (2) operational (working) memory and (3) long-term memory (Ashcraft, 1989) [2].

Sensory memory gives a person the opportunity to communicate with environment by using his senses. It is characterized by person's ability to choose or pay attention to a certain amount of incentives compared to the vast amount of information that reaches the senses.

Working (operational) memory is where conscious thought occurs. This type of memory is characterized by its relatively small capacity. Miller's study, G. A., [8] confirms that operational memory is limited to approximately seven units and offers the idea of mental load, basis of cognitive psychology.

Cognitive load refers to the capacity and capabilities of operational memory. This hypothesis is supported by evidence of reduction or decreasing of mental load in the context of improving learning process (Hogg, 2006) [5].

Long-term memory has unlimited capacity. Major challenge to educational methods in the context of long-term memory is integration of new learning material in learner's neuronal structures (Ausubel, 2000 [3], Zull, 2002 [12]). It is these memory structures that define previously described strategies of presentation and practice.

Generally speaking, *presentation strategies* create artificial conditions that support learning while *practical activities* aim to remove that artificial support. Both together form a complete educational event.

1.1. Planning

Education is often seen as a quality event, but actually represents a system of events. Educational design is a cyclic process that analyzes needs, develops solutions, tests these solutions, and revises them. Generally, educational design is a method for planning, management and product development. In this article the model of educational design consists of three major phases: (1) planning, (2) presentation and (3) practice (evaluation).

By the planning phase it is defined what kind of problems should be examined, as well as what tasks should be included in resolving these problems. Learner's objectives should be described. Every single objective should be classified. Classifying objectives according to the educational model reduces the number of teaching strategies that need to be examined in the presentation and practical phases.

Presentation phase includes creation of practical sequences that instruct learners.

Evaluation phase includes assessment of learners and collection of test data to determine the value of the educational product [13].

Each one of these phases must be in accordance to the other phases, ensuring coherence between them.

Operational activities lead to results and interventions that cause them are necessary. Objectives in education could be achieved mostly by trainer's instructions [1].

Use of systematic approach in creation of educational design suggests that the first strategic choice not always determine the final result. The initial choice of design strategies should come from carefully catalogued range of options taken from both science and experience. These strategies should be tested on a certain amount of students who have similar characteristics as a target audience. The results of such a sample are the best source for a feedback.

- **Needs analysis** is the first step that should take place in the planning process. At this stage it is to be determined what is the need for training.

Originally, skills are arranged in hierarchical structures. These structures are organized in areas of study. It is assumed that in order to practice a profession associated with these areas, the learner must master interrelated skills and knowledge (Van M., 1999) [11].

- Once needs that could be determined by instructions are identified, follows **tasks analysis** associated with their satisfaction.
- **Establishing objectives** is a process of creating detailed definitions of what would be learners' abilities at the end of training; what is expected from them to know and be able to do. These objectives give both trainers and learners, guidance for their actions. Educational strategies are directly related to learning objectives and follow them. These strategies can be many and various, but they are undertaken only after learning objectives have been identified and classified (Mager, R. F., 1961) [6]).
- **Classification of objectives**. Educational design is based on the fact that there are different types of training and different strategies for it (Gagne, R. M., 1985) [4]. This leads to one of the most significant problems of educational design. Categorization of individual objectives supports operation with them as they turn into classes with similar characteristics. The Merrill system, emphasizing on the cognitive aspect of the intellectual skills, suggests that education objectives should be classified as assimilation of facts, concepts, principles or procedures [7].
- **The establishment of verification elements** is the last step in the planning process. A clear link between education objectives and verification elements must be created.

1.2. Presentation

Normally, learners' first interaction with study materials is through presentations. The presentation should provide the learner with clear and straight information and also should be accurate, understandable and appropriate for the audience.

Design of a presentation is a decision-making process that **manipulates information** so that it is accurately presented and consistent with short-term, operational and long-term memory. This requires the usage of a carrier-media.

Media has its own components: (1) mechanism, (2) modality and (3) level of abstraction. Whenever information is presented to learners, decisions in regard to each of these components should be taken.

Presentation **mechanism** is media's physical technology (television, radio, internet, face to face communication etc.) and every mechanism has its own characteristics.

Presentation **modalities** include methods as text, audio, video, animation, images and illustrations. Educational interventions include verbal description, visual expression, as long as usage of symbols. The most common are verbal descriptions. Verbal information is a powerful form of information delivery, but has its own limitations. For example, symbols are appropriate for presenting abstract information; illustrations, tables, diagrams are more suitable for interconnections presentation etc. Most often presentation of study material should include all these modalities, as the information is miscellaneous. After precise analysis of learning needs, the designer should successfully connect modalities and content.

Level of **abstractedness** is the next assessment level. All modalities can be included in presentation in levels from abstract to concrete. In order to estimate what levels of abstraction and which modalities to be chosen, learning objectives should be precisely clarified.

Educational strategies help for the correct focus of attention of learners, for the effective use of their mental capacities and for generalization and content transfer into a new situation.

For every learning interaction it should be estimated whether to **directly** teach new knowledge or to use **discovery** strategy.

Discovery strategy is more rarely used. Its advantage is in increasing motivation for learning but it requires more time and may lead to improper assimilation of information. Both strategies-direct and discovery- require trainer's guidance.

When teaching, it must be carefully estimated how learners' **attention should be focused** so that knowledge that they receive is embeded in their long-term memory. Learners' attention must be navigated at any time. For accomplishing this it is needed: 1) learners to be informed about learning strategies; 2) learners to be informed about objectives classification; 3) important thing in the presentation to be emphasized; 4) presentation's time and space to be manipulated (for example accelerate or slow down animation).

One of the most important texts about **management of mental load** in cognitive psychology is Miller's text, G. A. [8], where the author claims that human memory can hold 5 to 9 units of information at the same time. This theory stands in the basis of management of cognitive load which means that if a learner is loaded with more units of information, there is a chance he becomes confused or overwhelmed.

That's why always when possible designer of study content must decrease the number of study units in his presentation. There are four major methods to do this: 1) improving clarity by eliminating side information; 2) reducing the size of the study content, and the study units as well; 3) preparing learners to create categories or classes; 4) use of media resources to create context and occasion for associative thinking.

In order to think of an educational event as successful, we have to be sure that the information taught is sealed in learners' long-term memory. This is a challenge because each learner has an individual set of neural connections. However, this process can be well assisted by demonstrating links with other educational material: 1) creating a knowledge structure map (conceptual map); 2) identification of the most important moments; 3) providing a wide range of examples.

Prior knowledge. Ausubel [3] declares that: *The most important variable in learning is when learners find that they already know something and they need to learn it*.

1.3. Practice

Educational design should be created so as to document and assess the activity and progress of learners. Feedback is an important component of education. Of particular importance is learners' activity, and it shows itself through consistency in practice. Through a sequence of practical activities, information-based learning model turns into interactive.

Practical phase is the last one in educational design. Practical activities are also based on the theory of the three types of memory as in presentation phase, but their purpose is exactly the opposite. While in presentation phase it is necessary the process of assimilation of information to be supported, at the practical part this support should be eliminated.

On the Internet, transmission of information is easier than ever. Most designers of study content are tempted to directly take this information and teach it to the learners but presentation of content is not enough. A comprehensive study event should provide students opportunities to demonstrate their knowledge in a logical sequence. It is these activities that are called practice.

Learning software, based on the information centered model, is called a "page-turner", which actually is the digital book. The main advantage of learning from a screen is interactivity, and if such is not present, this way of learning becomes completely pointless.

Quality learning should: 1) deliver information; 2) offer practical opportunities; 3) provide conditions for the learners to get to knowledge on their own (to discover it); 4) ensure proper feedback (Sivasailam, 2007) [10].

Practical sequences are something more than endless repetition of an act. These are methodical and include specific acts, followed by on-time feedback.

The establishment of the so called **practical cycle** requires an assessment of the benefit of each exercise. The goal is to select exercises which can make the learning process effective, efficient and interesting. First, these should provide practical activities, supported by the teacher through various tips and guidelines. With time, this support is gradually ceased. The level of learners' already available knowledge should also be considered to make sure they do not get bored with the exercises.

For the establishment of **consistency** (design) of practical exercises, it is necessary to carefully follow the goals and tasks of the learning process (reconcile with the goals), the learning sphere content, the specific characteristics of the study materials, and the learning interventions. The more detailed and clear these are from the very beginning, the more adequate the respective practical interventions would be.

Each "hard" material (difficulty level of the tasks) shares given characteristics, defining its level of abstractedness: 1) extent of similarity to another material; 2) number of qualities a given element has; 3) volume of the material; 4) extent to which the material is similar to already assimilated information; 5) time period between studying and actual knowledge application.

When a study material shares a number of **characteristics** with another material, the trainer should provide additional support to the learners. Apart from this, it should be considered that the more characteristics a given element has, the harder it gets classified.

Another important matter the trainer should consider is the presence of sub-classes in a given study class. The more sub-classes there are, the more difficult it is to generalize those in a large class.

The provision of **context** around a given task makes its understanding easier and more comprehensible. The study content designer can always judge how necessary such additional help is for the different cases.

Establishment of practical cycles is the strategic assignment of tasks to the learners. Whereas the goal of the study presentations is to provide help to the learners in the process of learning, such help should be ceased during the practical exercises.

In order to design a practical cycle, **attention managing tasks** should be developed, considering the following variables: 1) modality; 2) scope; 3) learner activity; 4) support.

Modality is about the type of presenting the practical activity. Practical cycles can use sound, video, animations, illustrations, and graphics, or combinations of these.

On establishing a practical cycle that starts with providing support on the **mental strain** processes, the scope of the tasks has to be considered as well. Each task can be combined with another task or can be divided into sub-tasks.

Another method for management of the cognitive strain is to foresee the expected type of reaction of the learners. Different answer types can be required from them – for identification, for choice and etc. It is very important what the learning goals are [14].

On establishing a practical cycle to support the introjection of knowledge into learners' long-term memory, the amount of provided support should be foreseen. The tips and reminders originally included in the tasks have to be gradually removed.

As each of the study design phases, practice requires clear and timely **feedback** to the learners. It is feedback that makes a practical cycle interactive. Learners should understand whether their answer is correct or not on time. With no such confirmation, they cannot change or correct their answers. The types of providing feedback also have their modality, meaning these can be diverse. The choice of feedback answer is a question of design and can be programmed. Possible ways to do this are many and diverse. What is important is that each component should stay consistent with the initially set learning goals.

CONCLUSION

Through modern electronic educational resources to a large extent may be organized the process of acquiring knowledge and skills, and learners to be able to receive various reference and academic information, theoretical knowledge, acquire skills and practical activity and individual work habits, and last but not least, to be able to control the results of their training.

Applying cognitive approach to developing interactive multimedia training products presented in the article, depends on the trainer's appraisal in the context of educational needs, as well as knowledge, skills and competencies of learners. Through implementation of specific phases in the development of learning design – planning, presentation and practice, and selection of appropriate strategies to create appropriate presentation and related practical activities aimed at the sensory, operational and long-term memory of the learners, it is aimed the raise of the quality of education.

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КОГНИТИВЕН ПОДХОД ПРИ РАЗРАБОТВАНЕТО НА УЧЕБЕН ДИЗАЙН ЗА ИНТЕРАКТИВНО МУЛТИМЕДИЙНО ОБУЧЕНИЕ

Светлозар Цанков

Русенски университет “Ангел Кънчев”

Резюме: *Настоящата статия е изготвена с финансовата помощ на Европейския социален фонд: проект № BG051PO001-3.3.06-0008* ***Подпомагане израстването на научните кадри в инженерните науки и информационните технологии****. Тя представя когнитивен подход и основни методически насоки при разработването на интерактивен учебен дизайн и асоциираните с това практически занимания.*

Ключови думи: *мултимедия, представяне, обратна връзка, обучение, стратегии*

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