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PROPOSAL OF A MODEL FOR CREATING INTERACTIVE MULTIMEDIA WEB EDUCATION

PRIJEDLOG MODELA ZA IZRADU INTERAKTIVNE MULTIMEDIJSKE WEB NASTAVE

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Abstract

The increased use of multimedia web education (MWE) in distance learning, brings up questions related to the selection of suitable methods of designing this kind of learning. The paper suggests a possible model of creating interactive multimedia web education (IMWE) and compares this model with the classical teaching face to face (F2F).

The proposed model (IMWE) is based on: the experiences of Croatian teaching practice based on the cognitivistic and constructivistic approach, Merrill's basic principles of instructional design, Gagne's recommendation to activate the internal learning process, Meyer's principles of design of multimedia, and Horton's models for structuring educational web content.

The conclusion of this paper is that the IMWE teaching provides the same or even better results in learning compared to traditional F2F teaching, which is confirmed by experimental research performed with hundreds of students on the Polytechnic of Zagreb.

Keywords: *model, web, learning, multimedia, design*

Sažetak

Sve veća primjena multimedijalne web edukacije (MWE) kod učenja na daljinu, stavlja u prvi plan pitanja koja se odnose na odabir prikladnih metoda za oblikovanje ovakve vrste učenja. U radu se predlaže jedan mogući model oblikovanja interaktivne multimedijske web edukacije (IMWE), koji se komparira s klasičnim oblikom poučavanja metodom licem u lice (F2F).

Predloženi model (IMWE) utemeljen je na: iskustvima hrvatske nastavne prakse zasnovane na kognitivističkom i konstruktivističkom pristupu, Merrillovim osnovnim principima instrukcijskog dizajna, Gagneovim preporukama za aktiviranja internih procesa učenja, Meyerovim načelima oblikovanja multimedije te Hortonovim modelima strukturiranja web obrazovnog sadržaja.

U zaključku rada pokazano je da IMWE nastava daje iste ili bolje rezultate u učenju u odnosu na tradicionalne F2F nastave, što je potvrđeno i eksperimentalno kroz istraživanje provedeno sa stotinjak studenata Tehničkog veleučilišta u Zagrebu.

Ključne riječi: *model, web, učenje, multimedija, dizajn*

1. Introduction

1. *Uvod*

The development of information and communication technology enhances the traditional methods of teaching and learning by computer, including new paradigm of learning based on Internet technologies. These technologies enable sending and receiving of learning content via the WWW (World Wide Web), which has enabled distance learning over the Internet.

Content for learning provided over the web integrated picture, sound, animation and video, enabling better use of computers in education. This way of displaying multimedia information over a computer increases the level of attention, understanding and remembering the message at recipients. This paper is a resultant between research methods and tools for the development of educational multimedia content and the author's experience in this field.

The focus of this work is the model for designing educational multimedia contents that is distributed over the web. This model is called interactive multimedia web education (IMWE). The paper

presents a theoretical paradigms and practical recommendations for creating interactive multimedia web education (IMWE) in accordance with modern theoretical models of learning and Croatian educational practice. The starting point of this work is based on elements of psychological and pedagogical paradigms of learning and instructional design models that have an impact on the model for design of multimedia educational web content that is suggested in this paper.

The idea for the experimental part of this paper was created and based on the work of Chen & Shaw, named Online Synchronous vs. Asynchronous Software Training Through the Behavioral Modeling Approach: A Longitudinal Field Experiment, which can be found in the proceedings under the editorship of Mahbubur Rahman Syed [1]. Their paper describes a model approach to teaching and shaping the e-learning content of the online course for Microsoft SQL Server 2000 that was conducted in the Taiwan College. In their experiment conducted with 96 students, they found that there was no significant difference in learning outcomes achieved between lectures conducted face-to-face and online asynchronously and synchronously. Their model was based on the Behavioral Modeling Approach.

This work has had different starting points, based on psychological - pedagogical paradigms like [2]:

- Merrill's model of instructional design based on cognitivistic-constructivist approach and Gagne's recommendation to activate the internal learning process
- Mayer's principles of design of multimedia messages
- Horton models structuring web content.

Hypothesis (H) of this work was [2]: "The use of interactive multimedia web instruction (IMWE) statistically gives equal or better learning outcomes compared to traditional frontal classroom teaching face-to-face (F2F)".

2. The Basics Theories of Learning and Instruction Design

2. *Osnovne teorije učenja i instrukcijskog dizajna*

Learning theories provide instructional experts strategies and techniques for facilitating learning. There are many theories of learning, some of which are significant Behaviorism, cognitivism, constructivism [2] [3] [4].

Behaviorism is a learning theory that focuses on objectively observable behaviors and outsides mental activities. Behavioral theorists define learning as acquisition of new behavior, or a change / modification of existing [2] [3].

The behavioral approach to learning is based on an objective study and measurement of external visible changes in behavior. According to this theory of learning are important external visible changes in behavior, while internal processes are irrelevant to the study of learning, because they cannot be observed or measured directly [2] [3].

Cognitivism is opposite of behavioral theory which focuses on internal mental processes, which involves how people perceive, think, remember, learn and solve problems. Cognitivism is related on intelligence, according to contemporary research works often links cognitivism to the view that people process information as computers do. Cognitivism influenced the education system at its most effective [2] [3].

Constructivism is a meta-concept about how somebody thinks, it is a theory of communication which suggests that each recipient will use own learning contents and communication process on different ways. From the perspective of constructivists, learning is an active process, unique to the individual, and consists of constructing conceptual relationships and meaning from information and experiences already in the learner's repertoire [2] [3].

2.1 First Principles of Instruction Design by David Merrill

2.1 *Merrillova osnovna načela instrukcijskog dizajna*

David Merrill gives a model called First Principles of Instruction Design. According to Merrill most effective learning environments are those which are based on the real problem and active participation of students through four different stages of learning (Figure 1) [5]:

1. Activation of prior experience
2. Demonstration of skills
3. Application of skills
4. Integration or activation of these skills in the real world.

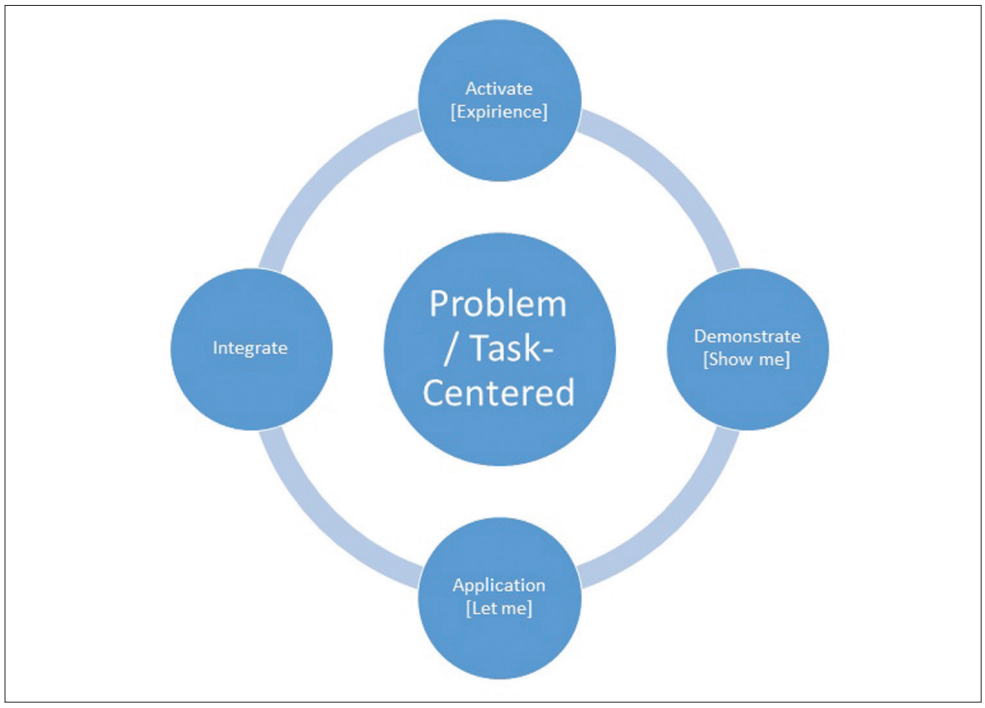

Figure 1
Merrill's Phases for Effective Instruction [5]

Slika 1
Merillove etape instrukcijskog dizajna [5]

These five first principles stated in their most concise form are as follows [5]:

1. Learning is promoted when learners are engaged in solving real-world problems
2. Learning is promoted when relevant existing knowledge is activated as a foundation for new knowledge
3. Learning is promoted when new knowledge is demonstrated to the learner
4. Learning is promoted when new knowledge is applied by the learner
5. Learning is promoted when new knowledge is integrated into the learner's real world.

2.2 The principles of instructional events by Gagne

2.2 *Gagneova načela poučavanja*

Instructional design as a process is the systematic development of instructional specifications using learning and instructional theory to ensure the quality of instruction. It is the entire process of analysis of learning needs and goals and the development of a delivery system to meet those needs. It includes development of instructional materials and activities; and tryout and evaluation of all instruction and learner activities.

Gagne's nine events of instruction became the standard for instructional design model. These nine instructional events are [2] [6]:

1. **Gaining attention (G1)**: This step provide stimulus to engage the learners and motivate them. It starts with a problem, new situation, uses a multimedia advertisements, and asks questions.
2. **Inform learners about goals and objectives (G2):** The step explains what learners will be able to do and how they will be able to use the new knowledge as a result of the learning.
3. **Stimulating recall of prior learning (G3)**: This step reminds the learners of the prior knowledge, in fact asking the learner what they already know (facts, rules, procedures or skills). Show how knowledge is connected, provide the learners with a framework that helps learning and remembering. The entry tests can be included here.
4. **Present the material to be learned (G4)**: The step provides and displays the new learning content (text, graphics, simulations, figures, pictures, sound, etc.). Chunk information (avoid memory overload, recall information).
5. **Providing learning guidance (G5)**: This step organizes the learning and putting it into context. E.g. presentation of content is different from instructions on how to learn.

6. **Eliciting performance – practice (G6)**: This step needs to allow the learners to demonstrate and use the newly acquired knowledge, skills or behavior.
7. **Providing feedback (G7)**: This step needs to tell the learners how they have performed and show them the correctness of the trainee's response, analyze learner's behavior, or possibly present a good (step-by-step) solution of the problem.
8. **Assessing performance (G8)**: This step is important to test the learners, and also give them general progress information about their performance.
9. **Enhancing retention and transfer (G9)**: This last step needs to allow the learners to consolidate their learning. It needs to inform them about similar problem situations, provides additional practice, and puts the learners in a transfer situation and possibly lets them review the lesson.

2.3 Cognitive Theory of Multimedia Learning and Mayer's Principles of Multimedia Learning

2.3 *Kognitivne teorije multimedijskog učenja i Mayerova načela multimedijskog učenja*

The cognitive theory model of multimedia learning is based on three primary assumptions [6] [7]:

1. Visual and auditory experience/information comes to recipients from two different ways. This information is processed through separate and distinct information processing "channels."
2. Each information processing channel is limited in its ability to process experience/information.
3. Processing experience/information in these channels is an active cognitive process designed to construct coherent mental representations.

This model is activated through five steps [6] [7]:

1. Selection of relevant words for processing in verbal working memory
2. Selection of relevant images for processing in visual working memory
3. Organization of selected words into a verbal mental model
4. Organization of selected images into a visual mental model
5. Integration of verbal and visual representations as well as prior knowledge.

According to the cognitive theory of multimedia learning and practical research, Mayer defined basic and advanced principles of multimedia learning. Multimedia principles can be integrated in the design of multimedia content and can be covered by all nine Gagne events

Mayer described seven basic principles of multimedia learning (BPM) these are [2] [6] [7]:

1. **Multimedia principle (BPM1)**: People learn better from words and pictures than from words alone. On screen animation, slide shows, and narratives should involve both written and oral text and still or moving pictures. Simple blocks of text or auditory only links are less effective than when this text or narration is coupled with visual images.
2. **Split-attention principle (BPM2)**: People learn better when words and pictures are physically and temporally integrated on the screen. When presenting coupled text and images, the text should be close to or embedded within the images. Placing text under an image (i.e., a caption) is sufficient, but placing the text within the image is more effective. The text and images should also be presented simultaneously. When animation and narration are both used, the animation and narration should coincide meaningfully.
3. **Modality principle (BPM3)**: People learn better from graphics and narration than from graphics and onscreen text. Multimedia presentations involving both words and pictures should be created using auditory or spoken words, rather than written text to accompany the pictures.
4. **Redundancy principle (BPM4)**: People learn better when the same information is not presented in more then one format. Multimedia presentations involving both words and pictures should present text either in written form, or in auditory form, but not in both.
5. **Segmenting, pre training and modality principles (BPM5)**: People learn better when multimedia messages are presented in learned-paced segments rather then as continuous unit, people learn better from multimedia messages when they know the names and characteristics of the main concepts and people learn better

from multimedia message when the words are spoken rather then written.

6. **Coherence, signalling, spatial contiguity, temporal contiguity and redundancy principles (BPM6)**: People learn better when extraneous material (words, pictures, and sounds) are excluded rather than included, when cues are added that highlight the organization of the essential material, when corresponding words and pictures are presented near rather then far from each other on the screen or in time, and people learn better from graphics and narration than from graphics and narration and onscreen text.
7. **Personalization, voice and image principles (BPM7)**: People learn better when the words of multimedia presentation are in conversational style rather then formal style and when the words are spoken in standard-accented human voice rather then a machine voice or foreign-accented human voice; but people do not necessarily learn better when the speaker's image is on the screen.

Mayer also gives nine Advanced Principles of multimedia learning (APM) [2] [6] [8]:

1. **Guided-discovery principle (APM1)**: People learn better when guidance is incorporated into discovery-based multimedia environment.
2. **Worked-out example principle (APM2)**: People learn better when receive worked-out examples in initial skill learning.
3. **Collaboration principle (APM3)**: People can learn better with collaborative online learning activity.
4. **Self-explanation principle (APM4)**: People learn better when they encouraged to generate self-explanation during learning.
5. **Animation and interactivity principles (APM5)**: People don't necessarily learn better from animation than from static diagrams.
6. **Navigation principles (APM6)**: People learn better in hypertext environments when appropriate navigation aids are provided.
7. **Site map principle (APM7)**: People learn better in an online environment when the interface includes a map showing where the learner is in the lesson.
8. **Prior knowledge principle (APM8)**: Instructional design principles that enhance multimedia learning for novice may hinder multimedia learning for more expert learners. Design effects are stronger for low-knowledge learners than for high knowledge learners and for high spatial learners rather than from low spatial learners. The aforementioned strategies are most effective for novices (e.g., low-knowledge learners) and visual learners (e.g., high-spatial learners). Well-structured multimedia presentations should be created for they are most likely to help.
9. **Cognitive aging principle (APM9)**: Instructional design principles that effectively expand working memory capacity are especially helpful for older learners.

2.4 The models of structure Web content and learning activity by Horton

2.4 *Hortonovi modeli strukturiranja Web sadržaja i aktivnosti*

Web lesson is a collect of activities and presentations that accomplish one of the sub-goal of the course. A lesson is a miniature course requiring its own objectives, introductions, assessments and feedback. The structure of multimedia web lessons is a series of small web sequences [9].

Progress through the lesson, or through small web sequences is usually determined in advance. Horton models generally suggest the idea how create a sequence of instruction (Table 1). If use them we have starting point for our own solutions, and each model can be customized and formatted as required [10] [11].

The originality of this paper is reflected in by introducing Gagne nine events of instruction in these models [6].

This paper describes structure of the classic tutorial (the basic model). It is familiar to learners and teachers. The model for creating interactive multimedia web education that is proposed in this paper has a simple structure and familiar to traditional F2F teaching and Croatian educational practice according to Poljak articulation of teaching [12] [13]. It is also easy and flexible and can be used and customized for many purposes including Web-based training. In this model we can easily incorporate Gagne's nine events of instruction (Figure 2).

On the other side in this model multimedia sequences have to be designed according to Mayer's basic and advanced principles of design of multimedia. Designing of multimedia sequences Mayer's basic principles is mandatory, while the advanced Mayer principles optional (Figure 3).

Table 1 *Horton's models structuring web content* [9] [10] [11]

Tablica 1 *Hortonovi modeli strukturiranje web sadržaja* [9] [10] [11]

Structure	Description	Using
Classic tutorial	After an introduction, learners proceed through a series of topics, each teaching a more difficult concept or skill. At the end of the sequence are a summary and a test. Within the topics, teaching skills and concepts are examples and practice activities.	To teach basic knowledge and skills in a safe, reliable, and unexciting way.
Book-like structure	The lesson is organized as a hierarchy of general and specific areas. Learners can navigate the lesson sequentially as if turning pages, drill down to a specific topic, or consult an index or table of contents (main menu).	For subjects with a clear, accepted structure, especially if the lessons will be used for refresher learning or just-in-time learning.
Scenario centered lessons	The lesson centers on a major scenario about a problem or project. After an introduction and preparation, the learner engages in a variety of activities all relating to accomplishing the goals of the central scenario.	To teach complex concepts, emotional subjects, or subtle knowledge that requires rich interaction with the computer or other learners
Essential learning tutorials	After an introduction, learners proceed through a series of tests until they reach the limits of their current knowledge. Then they are transferred into the main flow of a conventional tutorial, which ends with a summary and test.	To let impatient learners skip over topics on which they are already knowledgeable.
Exploratory tutorials	Learners find knowledge on their own. Learners navigate an electronic document, database, or Web site in which they accomplish specific learning goals. To aid in this task, they may use a special index and navigation mechanisms. Once learners have accomplished their goals, they view a summary and take a test.	To teach learners to learn on their own by developing their skills of navigating complex electronic information sources.
Subject specific structure	A free-form structure where each topic, activity, or page can potentially lead to any other. In practice the structure is organized by the logical organization of the subject or the flow of a scenario.	For subjects that have a distinct organization you want to teach. And for simulations when other structures would interfere with learning.

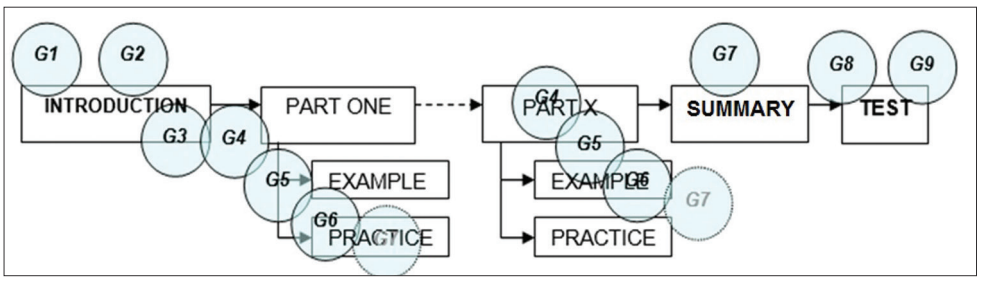

Figure 2 *Horton's basic model of the training tutorial (the lesson blocks) with Gagne's instructional events* [2] [6]

Slika 2 *Hortonov osnovni model tutorijala (blokovi lekcije) s Gagneovim načelima poučavanja* [2] [6]

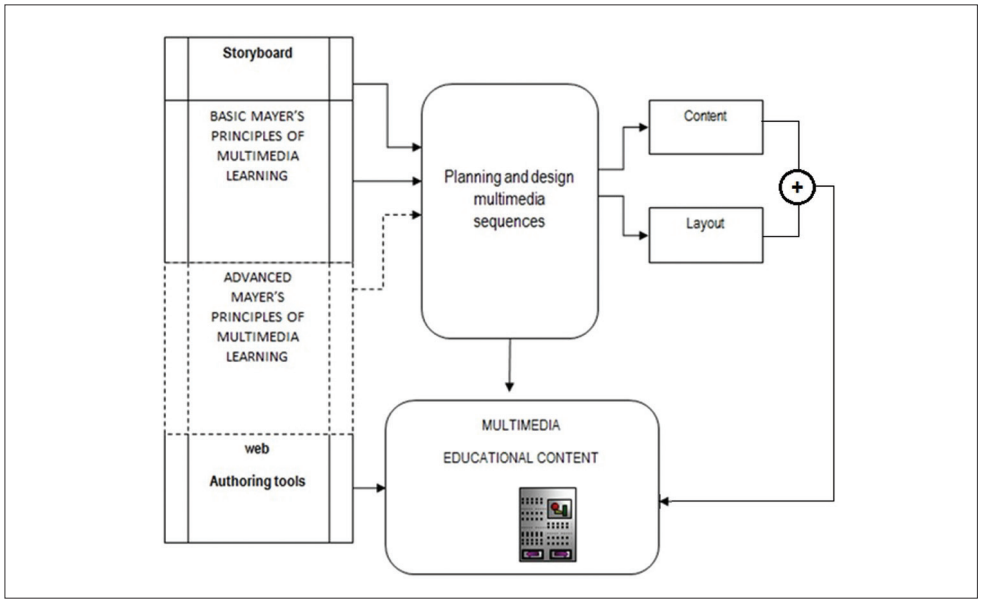

Figure 3
Model for the planning and design of multimedia sequences [2]

Slika 3
Model planiranja i oblikovanja multimedijskih sekvenci [2]

3. The Statistical Analysis of Results and Verification of the Model

3. *Statistička analiza rezultata i verifikacija modela*

Conducted research within of this work is motivated by the desire for practical verification of the proposed model compared to traditional classroom teaching face-to-face (F2F). The proposed model for the design of educational multimedia content presented in this paper is based on a synthesis:

a. Pedagogical-psychological paradigms based on the cognitivist and constructivist way of learning
b. Structuring of web content and defining a sequence in accordance with the proposed Horton models structuring web content
c. Introducing Gagne's nine teaching events in Hortons' models like outside influences for affected and triggered activation internal cognitive processes of learning
d. Merrill's First Principles of Instruction Design based on active resolving practical problem tasks
e. Design of multimedia elements according to Mayer's principles of multimedia learning.

The proposed model represents an interactive way of learning within the defined structure of web space for accommodating the multimedia educational content, which means the maximum active relationship between student and course content.

Verification of the model that proposes to create multimedia web educational content verified by experimentally comparing results of knowledge tests, after the completion of course performed by IMWE and F2F method. The tests measured the amount of memorized material and the success of solving practical tasks. The research had been done with students of the Polytechnic of Zagreb.

Through the teaching from three different modules (three experiments), students were divided into three groups. In each experiment, was treated one unit (lesson) that has been designed in two ways, as a classic F2F teaching and as IMWE.

Three groups (the control groups: A, B, C) have had classic F2F teaching with instructor and ppt presentation. Other groups have had teaching through online IMWE (B-s, C-s; A-s, C-s; A-s, Bs) (Figure 4). At the end of each teaching unit all the students have handled the test. At the end all of this tests of all groups was examined and assessed by the instructor.

The success of the groups that participated in all experiments (all observed statistically events) are expressed on the basis of the mean [14]:

$$\overline{X} = \frac{\sum X_i}{N}$$

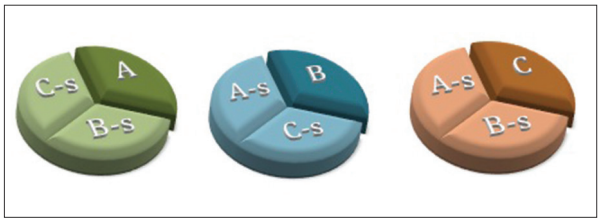

Figure 4 *Three sequences of experiments* [2]

Slika 4 *Tri sekvence eksperimenata* [2]

$\overline{X}$ – The average value of tests in the group (arithmetic mean)

N – the number of assessed tests

$\sum X_i$ – the total of assessed tests in group.

In checking hypotheses were used methods [14]:

a. checking the variance using the F-test
b. checking the arithmetic means using Student's t-test.

The obtained results by the groups are presented in table (Table 2) and chart (Figure 5) and as such are compared and discussed below.

Experimentally determined:

N_{IMWE}=94; $\overline{x}_{IMWE}$=78,85; S_{IMWE}=13,7; k_{IMWE} = 93

N_{F2F}=42; $\overline{x}_{F2F}$=62,4; S_{F2F}=18,04; k_{F2F}= 41

To confirm the hypothesis: $\overline{x}_{IMWE} > \overline{x}_{F2F}$ applied the statistical method of checking the hypothesis by comparing the experimental data with the theoretical values in two ways by checking [14]:

Table 2 *Spreadsheet view the results of learning [2]*

Tablica 2 *Tablični prikaz postignitih rezultata učenja [2]*

THE ACHIEVED RESULTS					
GROUPS AND STUDENTS					
GROUPS	NUMBER OF STUDENTS IN A GROUP	N	$\overline{X}$	COMMENT	Stand. Dev. σ
A	14	42	62,40%	F2F	18,04
B	14				
C	14				
A-s	17	94	78,85%	IMWE	13,69
A-s	17				
B-s	15				
B-s	12				
C-s	17				
C-s	16				

a. Variance for IMWE and F2F over the F-test
b. Arithmetic means for IMWE and F2F over the Student's t-test.

F-test

The assumption: H'0: $\sigma^2_{F2F} = \sigma^2_{IMWE}$

Then:

$$F_{exp} = \frac{\sigma^2_{F2F}}{\sigma^2_{IMWE}} = \frac{18,04^2}{13,7^2} = 1,7339$$

Theoretical values of the variables F for freedom degrees k_{IMWE}=93, k_{F2F}=41 are:

$F_{0.01}(k_{IMWE}, k_{F2F}) = 1,73$

$F_{0.05}(k_{IMWE}, k_{F2F}) = 1,47$

As the $F_{exp} < F_{0.05}$ (1,7339<1,47) and $F_{exp} \geq F_{0.01}$ (1,7339≥1,73), the hypothesis could be accepted, e.g. the variance in this case did not significantly different [14].

T-test

The assumption that the: $\mu_{IMWE} > \mu_{F2F}$ if the: $\overline{x}_{IMWE} > \overline{x}_{F2F}$ with the degree of freedom: $k_{IMWE} + k_{F2F}$=134, then:

$$t_{exp} = \frac{\overline{x}_{IMWE} - \overline{x}_{F2F}}{\sqrt{\frac{(N_{IMWE}-1)S^2_{IMWE} + (N_{F2F}-1)S^2_{F2F}}{N_{IMWE} + N_{F2F} - 2}} \sqrt{\frac{N_{IMWE} + N_{F2F}}{N_{IMWE} N_{F2F}}}} = \frac{78,85 - 62,4}{\sqrt{\frac{93*13,7^2 + 41*18,4^2}{134}} \sqrt{\frac{136}{94*42}}}$$

$$t_{exp} = \frac{16,45}{15,29+0,1856} = \frac{16,45}{15,4756} = 1,06296$$

The critical values of t_0 for the freedom degrees >120 are: $t_{.1}$=1,282; $t_{.05}$=1,645; $t_{.0025}$=1,96; $t_{.01}$=2,32.

How is the value of $t_{exp} < t_0$ (1,06296 < t_0), then the hypothesis $\overline{x}_{IMWE} > \overline{x}_{F2F}$ can be accepted [14].

On this way, statistic methods were confirmed that the IMWE teaching on average achieved better learning outcomes in relation to the F2F teaching. This also confirmed the practical applicability of the proposed model and recommendations for the designing of multimedia educational web content.

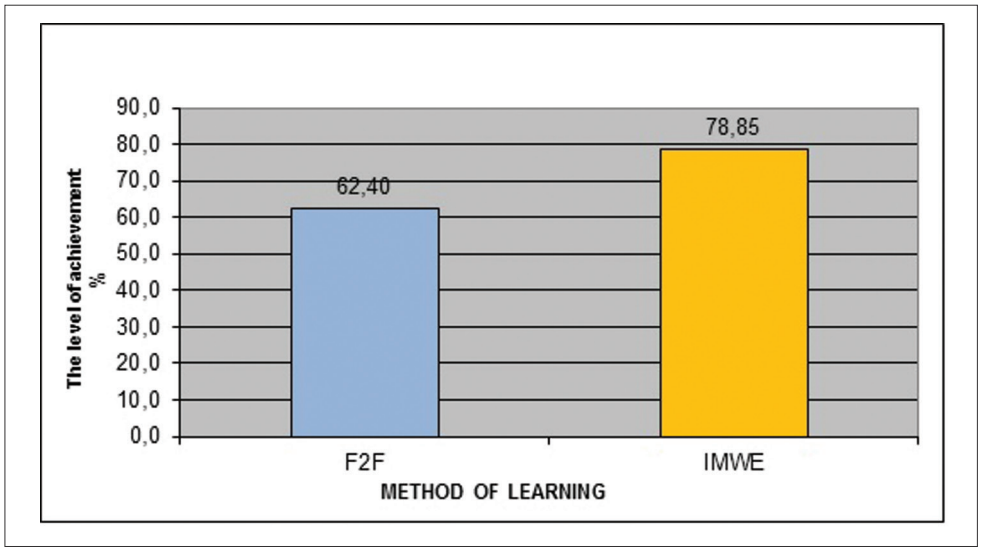

Figure 5
Graphic view of the average values of the results achieved learning [2]

Slika 5
Grafički prikaz prosječnih vrijednosti postignutih rezultata učenja [2]

4. Conclusion

4. *Zaključak*

The model for the design of educational multimedia content presented in this paper is based on cognitivist and constructivist way of learning supported by Gagne's nine teaching events in Hortons' models like outside influences for affected and triggered activation internal cognitive processes of learning. From the other side introduction of Merrill's First Principles of Instruction Design based on active resolving practical problem tasks and designing of multimedia elements according to Mayer's principles of multimedia learning, additionally and stronger are activated cognitive processes which contribute better e-learning.

The experimentally and statistically has been proven that in this case the interactive multimedia web education (IMWE) provides better results in learning compared to traditional face-to-face (F2F) teaching, which is confirmed by experimental research performed with hundreds of students on the Polytechnic of Zagreb.

5. References

5. *Reference*

[1] Charlie, C. Chen; R.S. Show; Online Synchronous vs. Asynchronous Software Training Through the Behavioral Modeling Approach: A Longitudinal Field Experiment, Strategic Applications of Distance Learning Technologies, INFORMATION SCIENCE REFERENCE, IGI Global, Hershey, p.14-27, New York, 2009.

[2] Širanović, Ž.; A MODEL FOR DESIGN OF THE MULTIMEDIA EDUCATIONAL WEB CONTENT / doctoral thesis. Zagreb: Filozofski fakultet, 2012, 228 pages.

[3] Kearsley, G.; Culatta,R.; Learning Theories, Instructional Design.org, http://www.instructionaldesign.org/theories/

[4] Peggy A.; Ertmer and Timothy J. Newby; Behaviorism, Cognitivism, Constructivism: Comparing Critical Features From an Instructional Design Perspective, PERFORMANCE IMPROVEMENT QUARTERL, 2013 International Society for Performance Improvement (http://northweststate.edu/wp-content/uploads/files/21143_ftp.pdf)

[5] Merrill, M. D.; First principles of instruction. Educational Technology Research and Development, 50(3), 2002. p. 43-59. http://mdavidmerrill.com/Papers/firstprinciples-bymerrill.pdf

[6] Širanović, Ž.; Guidelines for Designing Multimedia Learning Materials, Proceedings of the 18th International Conference on Information and Intelligent Systems, Varaždin : Faculty of Organization and Informatics Varaždin, University of Zagreb, ISBN 978-953-6071-30-2, p.79-84, Varaždin, 2007.

[7] Mayer, E.; Richard; Multimedia Learning, Cambridge University Press, Cambridge, 2001.

[8] Mayer Richard, E.; The Cambridge Handbook of Multimedia Learning, Cambridge University Press, Cambridge, 2015.

[9] Horton, W.; Designing Web_Based Training, John Wailey & Sons, Inc 2000.

[10] Horton, W.; Examples from E-Learning by Design, http://horton.com/books/e-learning-by-design/examples-from-e-learning-by-design/

[11] Horton, W.; Examples from E-Learning by Design, Chapter 12, http://horton.com/eld/Chap_12_Lessons.pdf

[12] Poljak, V.; Didaktika, Školska knjiga, Zagreb, 1985.

[13] Bežen, A., Metodika znanost o poučavanju nastavnog predmeta, Profil, Zagreb p.148-154, Zagreb, 2008.

[14] Serdar, V.; Udžbenik Statistike, Školska knjiga, p. 385-388, Zagreb, 2002.

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