Educational Computer Software "Inheritance Mechanisms" in Biology Lectures

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Abstract **- The author's interests are connected with the introduction of the new Infocommunication Technologies in biology educatione. Computer application in educational system should include thoroughly designed complex procedure which is eminently realised in all parts of educational system. The process of designing and applying educational computer software should be particulary emphasized. In the aim of enhancing lectures and overcoming mentioned drawbacks we created a software for learning the contents from lecture topic "Inheritance mechanisms" for the 4th grade of grammar schools. Educational computer software "Inheritance Mechanisms" in Biology lectures represents a new generation of educational technology, which is based on computing science and resources. This software is made for teaching and learning procedure, tests, assessments and exercises.**

Keywords: **biology educational, educational computer software, new information and educational technologies, Inheritance Mechanisms.**

1. Introduction

The priorities of contemporary education are enhancing the quality and efficiency of educational work and finding adequate methods and forms of work that make learning and acquiring knowledge more efficient. Insufficient activity of students, lack of progress in individual pace with accordance to previous knowledge and objective capabilities of students in the process of acquiring new knowledge, insufficient interaction among the students, and between students and teachers, present great drawbacks that significantly influence (decrease) the interest and motivation of students. Hence new solutions that would lead to the increase of the efficiency and quality of educational and learning processes should be found. This is the reason for which the Biology lectures should be made contemporary and interesting for students. Modernization of teaching and learning in modern age implies enhancement of work in education based on fitting into the framework of technological surroundings of IT society.

The more and more increasing role and significance of information and communication technologies in human society is one of the most important characteristics of today's world. One of the possibilities to achieve this is introduction of educational computer software in conducting educational content from Biology and other natural and social sciences into primary and secondary schools. "Software in the field of education presents intellectual technology and is called educational computer software (ECS) that includes programming languages and tools, specific organisation of lectures, learning and studying, and it is based on logic and pedagogy" [12]. Educational Computer Software (in further text ECS) presents a computer programme specifically intended for the content of lectures, projected in the aim of enhancing the quality of lectures and development of students' learning individuality. Under the term of educational computer software almost all existing computer programmes are implied, which can be used within the lecturing content, as well as programmes that help and direct individual potential of students in educational process. "By the use of ESC in lectures we encourage: motivation of students, individuality and differentiation of learning process, self-evaluation, acquiring new knowledge and achieving exercise, use of information databases and theInternet access and more efficient time consumption in the learning process" [13].

The latest PISA research, done in 2006, showed that our students lack with applied knowledge. According to the results of that study in the field of natural sciences, out of 57 countries, Serbia positioned 41st. The biggest number of our students are at the first and second level of achievement, which practically means they are capable of solving tasks where reproductive knowledge is needed, while the percentage of success at the levels that require capabilities of application and practical use of acquired knowledge is extremely low.

The educational contents in Biology lectures in the countries that have clearly defined strategy and educational aims are of extremely large range. The basic source of contemporary educational content of Biology is Biology as a central natural science and all

its achievements in the era of scientific and technological expansion. New discoveries from Biology are implemented into the educational content of Genetics, Molecular Biology, Cytology, Ecology and other disciplines of Biology. This integration in Biology lectures is done with a due respect to all didactical principles. Adequately methodologically formed contents of Biology science are more approachable and more acceptable with the students.

The application of Informatics and Information Technologies within the lectures of all the school subjects is one of the most important steps in the aim of development and enhancement. It is expected that contemporary educational system should form a student as an individual, flexible person, who will with easiness accept contemporary social changes and adapt to them. The application of contemporary information technologies as a support to traditional educational process can produce significant results. Some newer researches in the USA (Stanford University), and in Learning Research and Development Center in Pittsburgh, have shown that lectures that include computers make students advance faster and that their acquired knowledge lasts longer. This way of organising educational process is gladly accepted by youngsters. "Computer is not a 'subjective' teacher. There are no errors of central tendency, errors of contrast, halo effect. All the students are equal to it. There are no favourites and those who are not. In traditional lectures students are often scrupled in asking a question if something is not clear, because they are afraid they will be laughed at and underestimated. In lectures and studying by the use of computers there are no such things" [3].

In interactive learning with the application of multimedia, the computer is used as "a machine for studying", the material is exposed visually with multimedia approach. The student is in the center of attention. With this model of learning a full interactivity is achieved, the student in certain measure changes the process of learning , the roles of student and teacher are changed. Hyper textual and hyper media systems enable teachers to create materials for learning, through which students move in accordance with their own abilities and interests. In such an environment students can create materials even by themselves and connect them with materials created by a teacher, which surely presents the highest level of interactivity. Interactive learning developed interactive studying and lecturing by the use of computer networks, on-line services and especially the Internet.

It is extremely important to mention that Biology programmes at all the levels of education are very suitable for presenting by the use of a computer. In developed countries the use of computers is widely present within university education, in teaching and learning. Brant, Hooper and Sugrue in 1991 [2] were examining the use of simulation in Genetics. French and Rodgerson in 1998 [19] made computer simulations for exercises and university lectures, but also for Biology lectures in primary and secondary schools. Apkan, 2001 [1], created simulation programmes that replace real dissecting of animals. Franklin and Peat at the University of Sydney have conducted online learning with the first year Biology students [17] and have conducted the researches of strategy efficiency for computer based learning and student progression [18]. The same authors in 2001 examined the possibilities of virtual environment for learning Biology contents. Potirala K. (2003) [15], [16], at Krakow University, conducted a research on the efficiency of interactive learning with the use of ECS in Genetics, Ecology and Taxonomy. All listed authors emphasize the advantage of the use of computers in relation to application of other forms and methods of work in Biology lectures. The efficiency of these kinds of lectures and enhanced motivation of students is especially emphasized.

Jung-Bin (1992) examined the effect of learning style and instructional solutions with educational software for DNA and protein synthesis. The results have shown that the aimed achievement in post test, time needed and frequency of entered information choices are interactions between styles and instructional strategy. Comparison of active and passive students lead to a result that active students significantly sacrifice more time for the tasks, study more information, and have better results in final tests [14].

2. General postulates of ECS modelling

The application of educational software in lecturing provides elevating of motivation with those students where all other methods showed no success, or were less successful. In papers of psychologists and those of didactic scholars we come across critical analyses concerning the use of new educational technologies within the classic educational environment [6]. The specificity of ECS lies in the fact that it enables interactive learning - immediate error correction and affirmation of acquired knowledge. By the use of ECS in lecturing and learning there is a tendency towards authentic individualization of lectures. By use of specific techniques the controlling function of lectures is achieved, the process of learning is regulated and the inner motivation for learning is encouraged. Didactically devised programmes enable gradual progression in accordance with students' abilities, luring at each level the feeling of adequacy. Each student progresses in accordance to individual abilities and capabilities. More capable students can leave some parts of material out, those which seem

familiar, or easy, and less capable students have to acquire that knowledge in order to comprehend further information. ESC can provide individualization in relation to various types of thinking, different capabilities in task solving, various cognitive learning styles. There are also great possibilities to go back, revise or stay with certain parts of the programme, as well as with the browsing speed and getting wanted information. [4].

In software modelling the ideas from Ganjeev's theory are accepted, that as conditions for successful learning emphasize: continuity, revision, strengthening or forms of learning (verbal, revealing) by which the concepts, principles and rules are learned. The principle of cumulative learning has also found the application in software, according to which all learning at schools is upgrading of new contents onto previous. Galjperin's cognitive theories start from the premise that learning and cognitive processes can be modelled as directed process. The theory of forming cognitive actions in stages is especially important, it tries to establish the stages of forming mental actions. Galjperin with this tries to establish the methods of learning that would present the rational way for forming the actions and notions. Galjperin also tried to determine the relation between learning and cognitive development. He reveals those types of learning where "the acquisition of knowledge happens together with intellectual development"

In developing lectures and theory of learning, Lande starts from the fact that the thinking process has its own knowledge components and operations that are in functional relationship. The attitude of this theory is that thought processes should be branched into structural elements, so we could get to know them and then manage them.

Each of the mentioned theories gives its contribution to the efforts of learning and cognitive process modelling in didactic software. "It is undoubted that the quality of lecturing and learning via computers in the future will significantly be dependent on what measure didactic software is projected on the basis of knowing learning psychology and students' cognitive operational structure..." [4].

Two basic principles with designing ECS that should be referred to in order to enhance the activity in learning are: widening the prospects and increasing interaction. In order for software to enable more successful and active learning it is obligatory to divide the material into smaller units and to enable the transition onto the next lesson only after the material from previous lesson is learned, with solving some practical tasks. If a student has a certain previous knowledge, it is sufficient to meet the criteria set in a form of a practical task, without the need to go through the material already known to him/her. In order to increase the interaction in ECS, it is necessary to create a module for interaction that could be conducted in a form of exercise, interactive quiz or in some other way, but always in accordance with the contents of the software.

V. A. Suhomilski emphasizes that as a difference from usual learning and lectures, that are overburdened with subjectivity and vagueness, which considerably makes the learning and lecture process control difficult, suitable educational computer software ensures fast, direct and quality analysis of every conducted lecture and enables high quality of learning and lecture. With this he points to the fact that without well-organized control there is no quality lecture.

The basic hypothesis of Richard Mayer and his associates' multimedia learning research of many years is that there is a great probability that comprehensive learning will appear if multimedia instruction, found in ECS, is designed in accordance with the characteristics of human learning [8] [9] [10] [11].

It has been proven that it is more important to design the material well than the sole technique, but also it is important to ensure the conditions so that the multimedia surroundings support the creativity and productive learning. The educational computer software has to be projected in a way so it meets the needs of all the participants in educational process. The participants have to be provided with the easiness in software use, as well as a high level of evidential lecturing material that is presented in this manner.

The content of Biology lectures is practically predisposed for ECS application. The largest part of theme units and lesson items from Biology curriculum at all levels of education can be presented with pictures, texts, adequate video sequences and simulation applications. For certain fields this is the way to achieve maximum effects.

3. Developmental environment and the display of educational computer software "Inheritance Mechanisms" in Biology lectures

According to the current Biology curriculum for the 4th grade general vocation of grammar schools, the following teaching units are studied: The basics of molecular biology (10 lessons), Biology of animals' development (14), Inheritance mechanisms (15), Ecology and environment protection and improvement (16) and The basic principles of evolutional biology (9). In conducting them and in teaching practice in most of the schools in Serbia there is traditional lecture with frontal teaching method and verbal-textual teaching methods. The main request in Biology lectures in Serbia is for students to acquire as larger number of facts as possible. Learning comes down to piling up the knowledge, lectures to verbalism and students are overburdened with the material, and unfortunately incapable of applying acquired

knowledge due to non-understanding. This traditional Biology lecturing does not take into consideration equal respect and development of educational, forming and functional tasks of lectures. In this kind of lectures forming of attitudes, scientific point of view and enabling students to learn, think and prepare for permanent education is forgotten. In the aim of enhancing lectures and overcoming mentioned drawbacks we created a software for learning the contents from lecture topic "Inheritance mechanisms" for the 4th grade of grammar schools.

The software "Inheritance mechanisms" is made in Adobe Captivate 5.5 programme. Adobe Captivate 5.5 presents currently leading e-learning software in the world. When this programme first appeared is served mainly as a tool for creating software simulations. Today it is just one of the options that is offered by this programme.

For the presentation of the content Captivate offers possibilities of complex slide branching, and for this purpose there is a whole line of system variables that can be defined by the user, and a lot of advanced actions that determine the behaviour and further flow of presentation. Managing audio and video files, as well as animations, is utterly simple and at the same time offers a bunch of useful options.

Captivate offers possibilities of simulations - software, hardware, business and production processes. These simulations make the need for training in early phases with the equipment, which is often very expensive and dangerous for handling, entirely unnecessary.

Captivate has the option for creating knowledge tests. Along with classical tests where the user has to choose or enter a correct answer, there is a possibility of knowledge check through simulations where it is necessary to successfully execute certain routines expected in real situations.

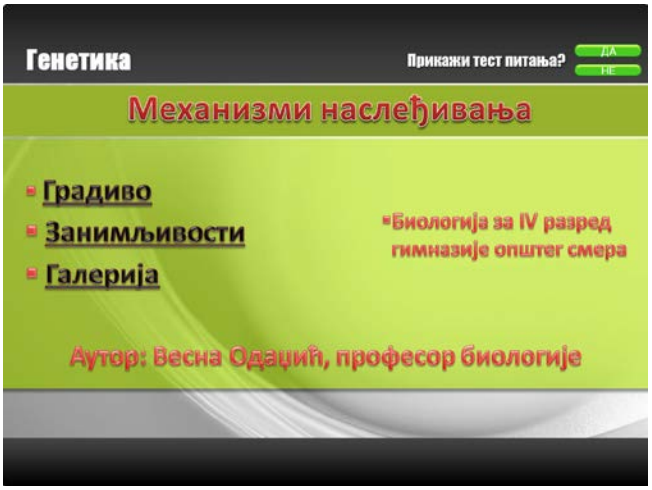
The programme supports export of projects into Flash CS5 where it can be additionally enhanced. This is possible due to the fact that Adobe Captivate is practically based on programming language Action Script 3 that uses Flash. By using these two programmes alongside, impressive results for a really short period of time can be achieved.

The project can be used in various formats:

Flash (swf)
Windows Executable (*.exe)
MAC Executable (*.app)
MP4 Video (*.mp4)
Export to PDF

For the needs of this presentation *.exe option is used, which enables the programme to start on every computer that operates under some kind of Windows operating system independently.

On picture 1. the cover page of educational software "Inheritance mechanisms" is displayed.



Picture 1. The cover page of educational software "Inheritance mechanisms"

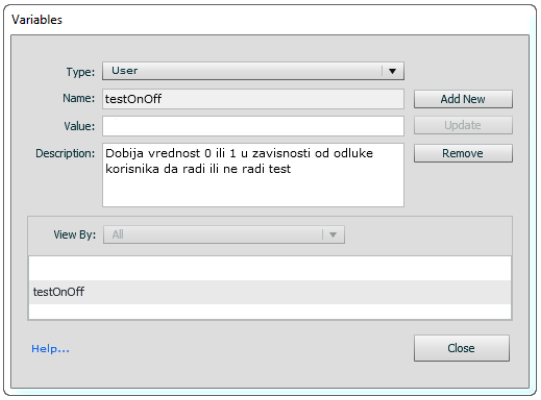
The cover page provides basic information about the presentation and the author, and there are also the links for logical units such as:

- Teaching material
- Interests and
- Gallery.

By clicking some of these hyperlinks the wanted unit is opened.

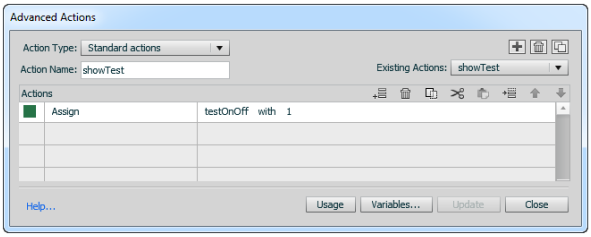
In the upper right corner a user is offered the choice of doing test questions. If he/she clicks the button "yes", after each unit test slides will follow, and in a case of choosing "no", test slides will become invisible for the user, offering him/her the possibility of focusing entirely onto the teaching material.

This has been achieved by using variables and advanced actions. First the variable testOnOff was defined, as seen on picture 2:



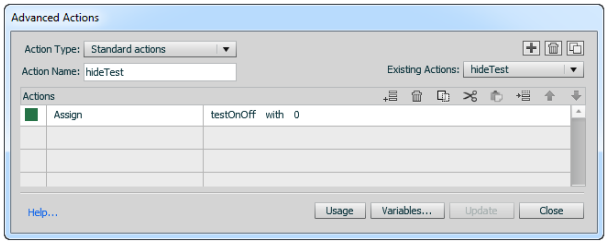
Picture 2. Defining variable testOnOff

As can be read from the variable description, its value depends on the user's action. By pressing the button "yes" variable testOnOff gets value 1, which is conducted via action showTest, presented on picture 3.



Picture 3. Display of action showTest

By pressing the button "no" variable testOnOff gets value 0, which is conducted via action hideTest, shown on picture 4



Picture 4. Action hideTest

Action showTest and hideTest fall into the category of so called standard actions because of using Assign features, allocating values respectively. Standard actions offered in the programme are:

Continue
Go to Previos Slide
Go to Next Slide
Go to Last Visited
Jump to Slide
Show
Hide
Enable
Disable
Assign
Open URL/File
Open Other Project
Send Mail
Execute JavaScript
Expression
Apply Effect

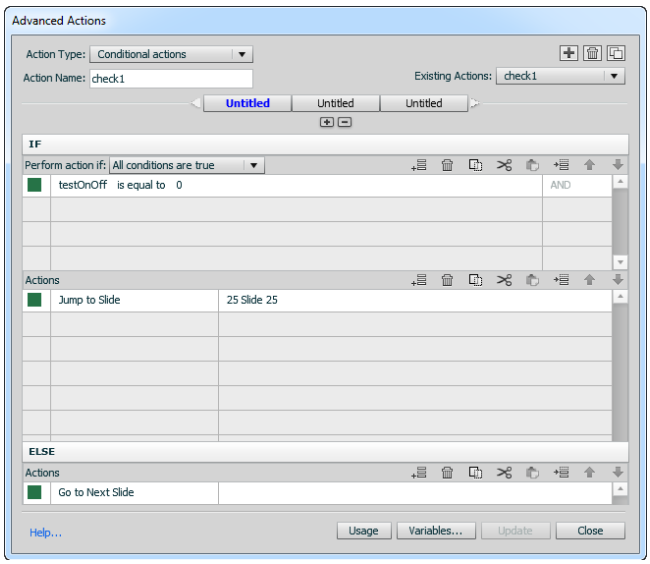
Attention should be paid on the possibility of user not to press any of the buttons but to continue further on with the presentation, and for this reason it was allocated that the starting value of variable testOnOff is 1. In this way the display of test slides after each lesson is provided, for the user has not chosen otherwise.

Conditional actions that are based on basic principles of logic exist, and they are the consequence of choices made during the presentation.

check1: IF (testOnOff is equal to 0) Jump to Slide 25
ELSE Go to Next Slide

The logic of this action is following: if a variable testOnOff equals 0, it means that the user decided to switch off the test questions, and the action Jump to Slide 25 is executed, and the user is presented with slide 25, shown on picture 5. In this way test slides for the first unit are skipped and the user continues with further teaching material.

If testOnOff is different from 0 (in our case it is value 1), it means that the user decided to do the test and Go to Next Slide is executed, the user is presented with the next slide that contains a question.



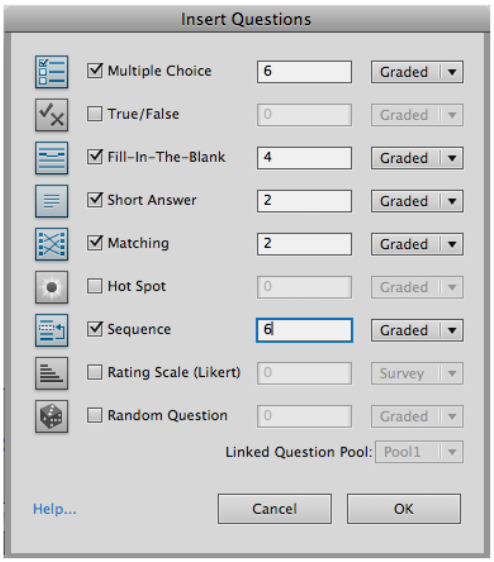
Picture 5. Executing action Jump to Slide

Other conditional actions are named check2, check3...check11 and are executed identically as above described with one difference of "jumping" to various slides.

4. Test slides

One of the main reasons of Adobe Captivate's great popularity as a programme is complete easiness in test creating, so very easily simple presentations are transformed into interactive applications for learning and evaluation of acquired knowledge.

It is important to mention that until a few years ago this was impossible to achieve without proficiency in programming, which was surely the main obstacle for wider use. Today, on the other hand, everybody can learn this programme and use it successfully. The curve of learning is considerably more difficult than with the similar programmes, but the end results are incomparably better. On picture 6 we see the types of questions that the programme supports:



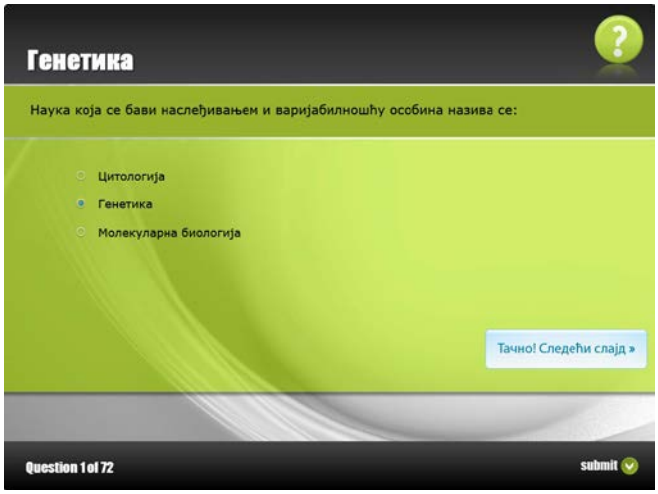
Picture 6. Types of questions

Test slides can be integrated anywhere within the presentation, and the option of automatic change of provided answers order is especially suitable, so each time the programme is switched off, new variations are offered. In this way a more quality experience of testing is provided and memorizing correct answers is avoided, or at least made difficult. Each question can carry certain number of points, depending on the complexity, but there are situations when questions are not evaluated but serve solely for the purpose of polls and studies.

Test slide designs within the presentation are minimally modified in relation to the slides that contain the material for easier visual recognition. In upper right corner a symbol of a question mark is added, and in the lower left corner there is information on which question is active and how many questions there are altogether.

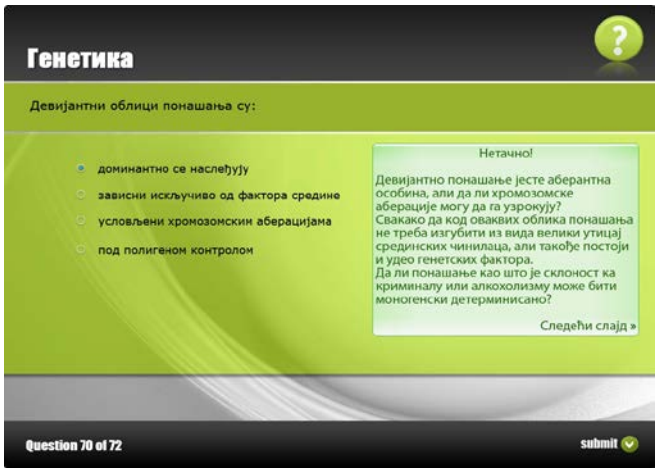
The most used type of question is true/false with multiple offered choices. Fill in the blank (type the answer) as well as matching (connecting correct answers) are also used.

After the question is answered and the button submit clicked, a user gets a certain feedback that depends on the correctness of chosen choice. By clicking the button submit before choosing an answer, the programme will inform you that you have to answer the question in order to continue further on with the presentation. If the user provides a correct answer the application will confirm that as shown on picture 7.



Picture 7. Application with the right answer confirmation

In case the answer was incorrect, (as seen on picture 8), the message can contain a short explanation so the error could be memorized and understood. This is a way more practical solution than to have all correct answers offered at the end of a test, because the user is at a given moment focused only on one question.



Picture 8. Application with incorrect answer explanation

This testing system is extremely functional and widely used in western countries as one of the more efficient tools in learning, in education, and business environment.

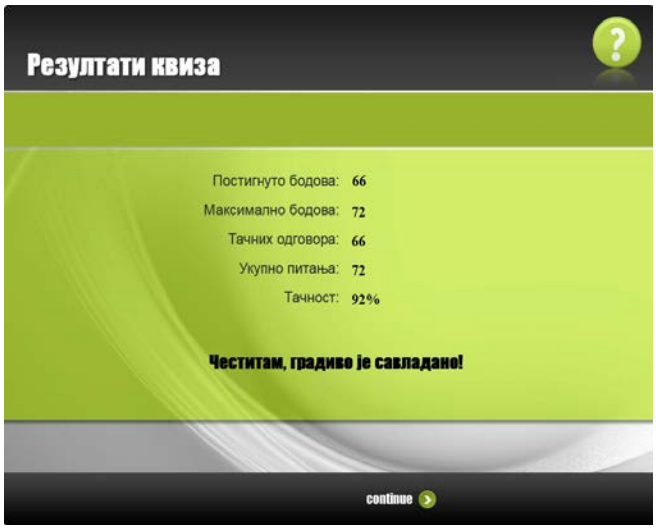
People who create presentations now have the possibility to design in a short time period powerful interactive presentations, without previous knowledge of programming.

Testing results:

After answering the last question the slide with results follows (picture 9) and it contains following information:

Number of achieved points.
Maximum number of points.
Number of correct answers.
Overall number of questions.
Success in percentages.

The border for passing is determined by the presenter and in this case it is 60%



Picture 9. Testing results

Teaching software "Inheritance mechanisms" is compiled for 4th grade students of grammar schools as a substitution for the book during the elaboration of Biology materials. Next to the basic part, the software contains exercises as well as the final test from Genetics. The contents of teaching units are given in the programme:

- Introduction to Genetics (the significance of genetic research);
- The basic rules of inheritance;
- Types of inheritance;
- Chromosome basic inheritance
- Recombination
- Mutations, chromosome aberrations
- Population genetics;
- Artificial selection and animal and plant breeding;
- Genetic development control;
- Human Genetics;
- Genetic predisposition of human behaviour.

When starting the programme there are links for the units contained in the software: Teaching material, Interests, Gallery.

Teaching material - has its own cover slide and contents towards hyperlinks of each lecturing unit. By clicking a certain hyperlink the wanted lecturing unit is opened. Within the teaching material animations that show dihybrid inheritance are shown. After each lecturing unit the test follows. The test contains various types of questions and problem tasks: multiple choices questions, fill in the blanks, matching. After the student answers the question there comes a feedback about the correctness of the answers. If the answer is incorrect the student gets additional information that will help with coming to the right answer. A special convenience in the tests is possibility for automatic change of offered answers array, because the programme each time gives new variations of answers. In this way mechanical learning and copying are prevented (each student in his/her computer has various answer combinations). Each question, depending on the complexity, carries a certain number of points. There are 72 questions altogether.

Interests contains 13 slides that can serve for widening basic knowledge from Genetics.

Gallery contains 129 pictures and schemes. Along with the pictures within the software there are other pictures, unknown to students, that relate to lecturing units.

Genetics tests:

Comprise entire teaching material from lecturing unit "Inheritance mechanisms". It contains 16 questions and tasks. Types of questions are: multiple choice questions, choose the right answer and enter the correct answer. A student cannot pass to the next page of the test if the right answers are not given for all the questions. On the last test page there is an option see the result. Results notify a student on the test success percentage and analyze the mistakes in the answers. The test is designated for individual knowledge evaluation. If a student is not satisfied with the achieved results, he/she can go through the teaching material (parts of lectures) and do the test again afterwards.

Exercises:

The exercises are designed as interactive animations with a tutorial and tasks that a student should solve. If a student makes an error he/she gets automatic information about the error and additional directions that will help in solving the problem correctly.

5. Conclusion

Educational Computer Software for Biology lectures on the basis of Adobe Captivate 5.5 programme has been shown in this paper. It represents currently one of the leading e-learning software in the world. Starting from the fact that Adobe Captivate 5.5 is practically based on programming language Action Script 3 that uses Flash, export of the project into Flash CS5 has been done. By simultaneous use of these two programmes, the results presented in this paper through the display of development environment and educational computer software "Inheritance mechanisms" in Biology lectures have been achieved.
This programme has been under development as an original copyright work since 2008, and has been applied in Biology lectures in Zrenjanin Grammar School.
Achieved results show students' interest for these types of lectures and learning, and output results show that the students' average grades are higher in comparison to traditional approach of learning with lecturing topic "Inheritance mechanisms". The course of further research is directed towards evaluation and software perfection.

References

[1]. J. P Apkan, *Issues Associated with Inserting Computer Simulations into Biology Instruction*: A Review of Literature, Electronic Journal of Science Education, vol. 5, No. 3, 2001.
[2]. G. Brant, E. Hooper, B. Sugrue, *Which comes first the simulation or the lecture?* Journal of Educational Computing Research, 7 (4): 232-236. 1991.
[3]. М.Вилотијевић, *Дидактика 2*: *дидактичке теорије и теорије учења*, Научна књига и Учитељски факултет, Београд, 1999.
[4]. K.Voskresenski, *Didaktika za profesore informatike i tehnike*, Tehnički fakultet M. Pupin, Zrenjanin, 2004.
[5]. R. Gagne, *Watching media learning. Meaking seanse of media education*, Falmer,London, 1987.
[6]. T. Giagkoglou, *Can Computers change the social aspect of the Classroom?* New Media in Secondary Education, 1-8, Harrov, 2002.
[7]. L. N. Landa, *The Improvement of Instruction Learning and Performance Educational Tehnology*, Englewood Cliffs, 1982.
[8]. R. E. Mayer, *Multimedia Learning*, Cambridge University Press, New York, 2001.
[9]. R. E Mayer, *Multimedia learning in B. H. Ross (Ed) The psyhology of learning and motivation*, vol.41 (pp. 85/139), Academic press, San Diego, CA, 2002.
[10]. R. E Mayer, *The promise of multimedia learning: Using the same instructional design methods accross different media*, Learning and Instruction, 12, 125-141.2003
[11]. R. E Mayer, R. Moreno, *Nine ways to reduce cognitive load in multimedia learning*, Educational Psyhologist, 38, 43-52. 2003.
[12]. Đ. Nadrljanski, *Obrazovni softver – hipermedijalni sistemi*, Tehnički fakultet M. Pupin, Zrenjanin, 2000.
[13]. Đ. Nadrljanski, *Informatička pismenost i informatizacija obrazovanja*, Informatologija 39, 4, 262 – 266. 2006.
[14]. Đ. Nadrljanski, M. Nadrljanski, D. Soleša, D. *Digitalni mediji – obrazovni softver*, Univerzitet u Novom sadu, Pedagoški fakultet u Somboru, 2008.
[15]. K. Potyrala, *Computer-aided genetics teaching In: Computer Based Learning in Science*, Vol. I: new Technologies And Their Applications in Education, C.P. Constantinou, Z. C. Zacharia (ed.), Nicosia, 2003a.
[16]. K. Potyrala, *Improvement of students' cognitive skills with the help of a computer in: Biological and Environmental Education* No. 1 (5). 2003b.
[17]. S. Franklin, M. Peat, *Online learning: the first year biology way*, School of Biological Sciences, The University of Sydney, Australia, 1998a.
[18]. S. Franklin, M. Peat, *Strategies to support learning and student progression: the first year biology way*, School of Biological Sciences, The University of Sydney, Australia, 1998b.
[19]. K. French, L. Rodgerson, *The integration of multimedia resources into the teaching of introductory biology practicals*, Ascilite, 261-266. 1998.

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