

Original paper

Student's attitudes toward application of computer-assisted interactive biology teaching in grammar school

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Summary. Computer-assisted interactive teaching is one of the more innovative models suitable for application in the natural science teaching process. Previous research showed that computer-assisted interactive methods improve teaching quality and efficiency, contribute to the individualization of teaching, enhance cooperation in teaching and enable use of various knowledge sources. This paper presents the results of a questionnaire on the application of computer-assisted interactive teaching in grammar school for realization of curriculum objectives within the subject, 'Basics of Molecular Biology'. The questionnaire was aimed at analysing student attitudes and opinions about the applied teaching model. The questionnaire was administered to a sample of 72 students/respondents. On the basis of these results, the opinions of the students were as follows: the classes were dynamic ($M = 3.95$), this model of learning is good and useful ($M = 3.93$), this approach to biology teaching enabled them to learn more in a shorter period ($M = 3.77$) and the application of computer-assisted interactive teaching in biology provided easier learning of biology content and better understanding ($M = 3.69$). The obtained results recommend increased incorporation of computer-assisted interactive biology teaching in grammar school.

Keywords: attitudes and opinion of students, biology teaching, grammar school, teaching with technology, traditional teaching.

INTRODUCTION

The natural sciences teaching process in schools in the Republic of Serbia has been predominantly traditional, including only passive listening, receptive learning, and learning by heart as student activities (Terzić and Miljanović 2009). Drawbacks of the traditional teaching model, which diminish student interest and motivation for learning biology include: insufficient student activity in the classroom, inability of allowing students to make progress at their own pace according to their prior knowledge and objective abilities, and insufficient student-to-student and student-to-teacher interactions. Also, such teaching methods neglect the creative thinking process and inherent creativity of the students. This has been confirmed by the low scores of our secondary school students at the Programme for International Student Assessment (PISA) survey test, as well as of our

primary school students at the Trends in International Mathematics and Science Study (TIMSS) survey test in biology and ecology, which are below average among the sample of the countries included in the research (Ševkušić et al. 2005; Drakulić et al. 2011). Moreover, our secondary school students generally perform mediocly at the biology entrance exam for enrollment in biology, medicine and stomatology study programmes (Miljanović 2002a; Miljanović 2003). In contrast to the traditional teaching approach, the priorities of modern education are defined by the basic principles of the current educational reform and Education Strategy Development in Serbia for the year 2020, with the goal of improving the quality of education by combining innovative methods and forms of teaching that should make learning and the knowledge acquisition processes more efficient (Official Gazette of the Republic of Serbia, No. 107/2012).

To improve the quality and efficiency of the teaching process, it is necessary to continuously search for innovative models of the teaching process that will be accepted by students. One of the ways of overcoming the disadvantages of traditional teaching is the application of Information and Communications Technology (ICT) in teaching. It significantly improves the quality of the teaching process, which becomes enriched and versatile: enhancing student independence during the learning process, contributing to individual learning, providing feedback about students' achievements, enhancing cooperation between teachers and students in the teaching process, and enabling use of huge databases and information (Vilotijević 2009). Besides the actual application of computers in teaching, there is also a significant contribution from interactive teaching methods in general, which also improve the teaching process, especially in combination with computer-based applications. Current didactical and methodical literature suggests that computer-assisted interactive teaching is one of the most favourable didactical models of contemporary teaching. Moreover, student knowledge obtained in this way is more focused on practical applications, which is considered to be the highest possible level of knowledge that can be achieved (Branković 2007).

Molecular biology is a subdiscipline of biology that deals with biology on the molecular level. Most teachers consider this topic difficult to present to their students in traditional teaching form, and the subject itself is also difficult for their students to grasp (Marbach-Ad and Stavy 2000; Templin and Fetters 2002). The content of this teaching topic frequently remains abstract and beyond the understanding of students even after explanations are provided in class. Therefore, it is necessary to alter the form of teaching by introducing innovative models of teaching that would enable students to better understand the most difficult content and learn more efficiently. One such model is computer-assisted interactive teaching which has been researched and presented in this paper. The students from three fourth grade classes in grammar school realised the teaching topic Basics of Molecular Biology through computer-assisted interactive teaching. Teaching was conducted in the classroom for informatics and the students worked in pairs. Ten teaching lessons were used, covering the following teaching topics from molecular biology: Topic and significance of learning molecular biology; The molecular basis of biological processes; The interdisciplinary character of molecular biology; Nucleic acids and their basic structure; Structure and function of DNA as a molecular basis for storing and transferring genetic information; DNA replication; Structure of RNA; Types and functions of RNA; The biological role of nucleic acids; Proteins – structure and role; Genome (structure of human genome) and gene (a unit of inheritance); Transcription; Translation; Regulation of

gene activity; Genetic engineering; Possibilities of intervention and changing inheritance material (Official Gazette of the Republic of Serbia - Education Gazette No 7, 2011).

The teaching topic Basics of Molecular Biology was introduced to the students with 10 presentations using Prezi presentation software. The teaching content in the presentations was prepared according to the textbook Cvetković et al. 2011. Each presentation was structured to lead the students first through the teaching material, then the additional information and finally, the students were asked questions in the form of a problem task to engage them in additional thinking processes. Four out of the total of ten presentations included an animation of complex biological processes: replication, transcription, and regulation of gene activity. The complex processes were explained to students in this simpler way since the teachers found it difficult to explain them verbally. The students could view the animations several times.

Additional or bonus information in the presentations was in the form of short information aimed at raising the students' interest, in order to gain deeper knowledge in molecular biology. Interesting discoveries, such as Chargaff's rules and Dolly the cloned sheep, were described in several sentences. This part of the presentation was intended for all students as a stimulus for the development of a positive attitude toward biology as a science.

Due to the time restriction of one teaching hour (45 minutes), each presentation ended with a problem question or a task. Solving of the problem question or task demanded not only reproduction of the content learned, but involvement of the students at a higher level, i.e. practical application of knowledge. Some of the tasks were also experiments that helped to achieve important discoveries in biology.

The students worked in pairs on computers and watched 10 presentations during their biology classes on the topic, Basics of Molecular Biology. All the classes included multi-dimensional communication: student-to-student, student-to-teacher and student-to-computer communication. The level of pedagogical communication in biology classes created conditions for teaching improvement and more efficient realisation of biology teaching goals. While working in pairs, the students helped and supported each other, devoting special attention and concentration on all of the elements of the presentations: text illustrations and animations of complex biological processes; and later on, answered the teacher's questions and passed a test to show that they understood and acquired the teaching material.

Multimedia presentations were made using the software Prezi, and recommendations included in Prezi with respect to adequate learning theories (constructivism, cognitivism, and behaviorism) were taken into account, which also had a positive impact on the design and quality of the presen-

tations (Milanović 2006). The demands of constructivism were satisfied by efforts to make learning an interesting and active process in which the students are at the centre of the learning process and have control over the process itself. To achieve meaningful learning, the presentations offered examples that were familiar to the students, and included activities that required application of obtained knowledge in real-life situations. By working in pairs, students were able to cooperate (interact) with their fellows, exchange opinions, observe presentations, read interesting information and solve problem tasks. Moreover, this stimulated additional thinking activities, conversations, and analyses of the material they learned together. According to the suggestions concerning cognitivism, strategies that catch the attention of the students and enhance perception were used in the preparation of the presentations. The information in the presentations was centrally positioned on the screen and the key words were emphasised (colours, font size, etc.). Every screen offered a limited amount of information, which was grouped in a logical order (from easier toward more difficult, from known toward unknown, from theory toward practice) and helped students to gradually master the teaching content. The difficulty of the information and complexity were adjusted to the cognitive level of the students' development. Individualisation of the teaching process was achieved by the use of additional material: problem tasks, bonus information, tests, etc. According to behaviourism, modelling of multimedia presentations provides the students with information about the goal and outcomes of the learning process, which further enables them to control their learning process and estimate the results of their work. After certain parts of the teaching material had been presented, the students were given interactive tests, obtained feedback on their performance on the tests, i.e. the level of their achievement and whether they achieved the planned goals and outcomes of the learning programme. The tests were used for self-assessment of student knowledge and feedback about the results had an additional impact on their motivation for further learning in biology classes. The applied model of teaching biology in the fourth grade of grammar school produced better results than the traditional teaching method (Pribičević et al. 2017).

MATERIALS AND METHODS

The present research was conducted at the beginning of the second semester during the 2016/2017 school year. Student respondents had average grade of 4.37 in biology and a total average grade of 4.28 at the end of the first semester. After the teaching topic Basics of Molecular Biology had been realised over 12 teaching hours by application of a computer-assisted interactive biology teaching model, the students completed a questionnaire about their attitudes and opinions

on the innovative model of biology teaching applied in this research. The research sample consisted of 72 students from three fourth grade classes in grammar school, natural science majors in the Grammar School, "Jovan Jovanović Zmaj" in Novi Sad, the Republic of Serbia. The questionnaire consisted of 12 questions: 10 closed type questions (4 questions, five-point Likert scale) and 2 open-ended questions. The questionnaire comprised: the time students spend using computers at home and school; attitudes of students towards biology as a school subject and learning biology; their opinion about multimedia presentations that were delivered to them using the Prezi presentation software; what appealed to them the most and the least in the applied model of biology teaching. The results of the questionnaire were processed using SPSS Statistics 19.0, and presented with statistical indicators: percentage (%), average scale value (M), standard deviation (SD), and Chi-squared test (χ^2).

RESULTS AND DISCUSSION

To consider the attitudes of the students in detail, every question from the questionnaire was separately analysed.

The answers to the question How much time a day do you spend using the computer in your free time? were the following: over 120 minutes (31.0% students) then 60 to 90 minutes (25.4%), from 90 to 120 minutes (16.9%), from 30 to 60 minutes (14.1%) and less than 30 minutes (12.7%).

The answers to the question How often do you use a computer at school? showed that the students use computers rarely (64%) or sometimes (34.7%) at school, and mainly for certain classes such as informatics. The answers to the first two questions indicate that the students use computers more frequently in their free time (for games and entertainment) than for learning at school. This may be the result of the fact that most of the students have computers at home, whereas in our schools we still do not have enough computers.

The following five-point Likert scale questions asked about students' opinions on learning biology, the quality of the multimedia Prezi presentations, the application of computer-assisted interactive teaching and the effects of its application on biology teaching.

The attitudes of students on learning biology are presented in Table 1.

According to the analysis, the students' responses showed a positive attitude towards learning biology ($M = 3.09$, $SD = 0.33$). The chi-squared test tested the impact of total average grade and average grade in biology on their attitudes towards learning biology. The obtained results showed that there is no statistical significance between the total average grade of the students ($\chi^2(6) = 4.91$, $p = 0.555$) and their average grade in biology ($\chi^2(6) = 6.77$, $p = 0.342$)

Table 1. Attitudes of students on learning biology.

Statment	M
1. I easily achieve good success in biology	3.81
2. It is not difficult for me to study biology	3.71
3. Biology content is interesting and useful to me	3.79
4. Biology content is often abstract and unclear to me	2.37
5. Biology is hard to learn	2.64
6. Biology is boring to me	2.20

Average scale value M of five-point Likert scale (1-5).

and students' attitudes toward learning biology. Overall the respondents had a positive attitude toward learning biology in the fourth grade of grammar school.

The analysis of the students' responses on the question about the quality of multimedia presentations prepared in Prezi software is presented in Table 2.

Table 2. Opinions of students about the quality of multimedia presentations in Prezi software

Statment	M
1. Presentations were easy to use	4.39
2. Design and organisation of the presentation and slides appealed to me	4.27
3. Studying the units was easy since the material was divided into smaller logically connected parts	4.03
4. Problem tasks were challenging and interesting to solve	2.93
5. I liked the numerous schemes, illustrations and animations in the presentations	4.17
6. Assessment tests were very useful	3.80

Average scale value M of five-point Likert scale (1-5).

Students' opinions on the quality of the multimedia presentations used in the biology classes were highly positive (average scale value $M = 3.93$, $SD = 0.55$). The Chi-squared test did not reveal any statistically significant impact of the total average grade of the students ($\chi^2(9) = 6.73$, $p = 0.665$) or their grade in biology ($\chi^2(9) = 13.74$, $p = 0.132$) on their opinions about multimedia presentations. The obtained results indicated that the students were highly motivated to actively participate and broaden their knowledge when the innovative model of teaching was applied.

Analysis of the students' responses to the question about learning biology by application of computer-assisted teaching model is presented in Table 3. The results of the questionnaire demonstrated that the opinion of the students about learning biology by application of computer-assisted interactive biology teaching was positive and moderately strong (average scale value $M = 3.54$, $SD = 0.55$).

To obtain a complete picture of the effects of the applied

Table 3. Opinions of students on learning the topic Basics of Molecular Biology by application of computer-assisted interactive biology teaching model.

Statment	M
1. Biology classes are dynamic	3.95
2. This type of teaching biology enabled the acquisition of more knowledge in a much shorter period of time	3.77
3. This model of learning is very good and useful	3.93
4. Computer-assisted biology learning was difficult and exhausting	2.16
5. Application of this model in teaching biology helped me to learn easier and better understand the content	3.69
6. I would like to learn other topics in biology in the same way	3.71

Average scale value M of five-point Likert scale (1-5).

teaching instruction, the impact of average grade in biology and the total average grade of students on their opinion about learning biology by application of computer-assisted interactive teaching method was examined. The chi-squared test showed that there is no statistically significant difference between total average score and their attitude toward learning biology ($\chi^2(6) = 12.24$, $p = 0.057$) and their grades in biology ($\chi^2(9) = 3.05$, $p = 0.962$). The students, regardless of their total average grade or average grade in biology, positively evaluated the introduction of computer-assisted interactive instructions in teaching biology in grammar school. According to data from the present study, the students eagerly accepted the introduction of the innovative model in teaching biology. They eagerly accepted increased activity and independence in biology classes and the opportunity to adjust learning to their abilities.

The results of the questionnaire about the effects of computer-assisted interactive biology teaching are presented in Table 4.

The obtained results showed that the opinion of the students about the effects of the application of computer-assisted interactive biology teaching was positive (average scale value $M = 3.50$, $SD = 0.47$). The chi-squared test did not show a statistically significant impact from total average grade ($\chi^2(6) = 4.12$, $p = 0.661$) or average grade in biology ($\chi^2(6) = 7.11$, $p = 0.311$) on their opinions about the effects of the application of computer-assisted interactive biology teaching.

After the completion of the teaching topic Basics of Molecular Biology, which is one of the most difficult topics within the biology programme for grammar school (Marbach and Stavy 2000; Pribičević et al. 2017), most of the students (94.7%) expressed their opinion that the content of

Table 4. Opinions of students about the effects of the application of computer-assisted interactive teaching.

Statment	M
1. At classes I was more relaxed	3.80
2. I learned easier and faster and better memorised the content	3.69
3. pair-work was more suitable than individual work	3.56
4. I participated more actively in classes	3.09
5. It was difficult for me to master the content that was presented during one class	3.04
6. Possibility of working at my own pace while learning the content	3,91
7. I learned more than in previous biology classes	3.12
8. Constant communication with the teacher and the student from my pair helped me to better understand the content	3.80

Average scale value M of five-point Likert scale (1-5).

this topic was useful and interesting. This further indicated the possibility that computer-assisted interactive teaching supports students' motivation for learning the most difficult content in biology. Presentation of such difficult content in an appropriate form enables students to acquire and grasp the meaning of such content within biology as a science.

The answers to the question about prior use of the Prezi programme in teaching were mostly negative (92.1%). The positive impact of applied teaching instruction during the research period was observed in the growing interest of the students in the Prezi programme in which the presentations and tests were designed. Most of the students (89.4%) replied that they were interested in learning about the Prezi programme and presentation design for biology classes. Students' knowledge of informatics and the English language would facilitate use of the Prezi programme and the preparation of presentations. Moreover, the obtained data highlighted the interrelation of sciences and school subjects and the possibility of intensifying the interrelations in teaching different school subjects.

To more completely portray students' opinions on computer-assisted interactive biology teaching, students were given additional opportunities to express their observations via their responses to the following questions: What did you like the most?, and What did you not like in the applied model of biology teaching? during realisation of the teaching topic, Basics of Molecular Biology. The prevailing answers were positive opinions: "This was a good way of learning new, very difficult content in biology"; "The content was more interesting, animations in the presentations helped me to understand the process of DNA replication, transcription and translation"; "I liked the different approach to teaching:

use of computers, content divided into smaller units and the most important information presented without the details described in the textbook"; "I liked the communication with my pair, I studied more easily from the presentations than from the textbook"; "I liked that we first watched the presentations in pairs and learned individually the new content, and then heard explanations from the teacher about the parts we did not understand"; "I liked the concise and clear presentation of the content, especially animations of the processes of replication, transcription, and translation, that helped me understand them easily"; "I liked the interactive tests on the computer that helped me to check how much I learned in class"; "The Molecular Biology content in the textbook is too detailed and difficult to learn, but in class we focused only on the content from the presentations".

The insufficient ability of the students to understand the essence of the teaching content and to connect the new content with previously learned material is normally one of the main obstacles to learning. Therefore, in this research, the students were given tests with several (6-7) questions to assess their knowledge at the end of each class. This activity was also positively evaluated by the students. Most of the students expressed a positive opinion towards an innovative model of teaching biology, quality of multimedia presentations in the Prezi programme and effects of their application in biology teaching. The students highlighted the most important elements of computer-assisted interactive teaching: joint activities, mutual communication, and help in the activities, good communication with the student from the pair and with the teacher, which is also important for contemporary teaching. Also, the students' responses demonstrated their higher interest and motivation for biology learning by application of computer-assisted interactive learning compared to the previous, traditional model of teaching. The best description of the value of computer-assisted interactive teaching is given in the answers that the students themselves provided. The most prominent answers were: intensified activity of the students in biology classes; appealing, concise, systematic, interesting and creative presentation of the teaching content in the Prezi programme; positive attitude towards the use of computers in biology classes; learning at one's own pace; contribution of presentations and animations to better understanding of the teaching content; carefully selected animations; well-devised problem-based tasks; good communication with other students and the teacher during biology classes; interesting programme for presentations; better organisation and connection of the content compared to the textbook, which attracted increased student attention.

The most frequent negative student remarks were: "We had little time for the most difficult units"; "Certain units

demanded more than one class for a thorough understanding of the difficult content”; “I do not like learning the content using the computer, I am used to learning by listening to the teacher’s lectures first, and then to learn from the book”; “At the beginning I only listened to the explanations of my colleague from the pair, and later on I actively participated and we learned together”. The remarks from the students on the concept of computer-assisted interactive biology teaching did not dispute its advantages, but they pointed out the difficulties in accepting the new in the teaching process, due to deeply rooted habits of our students to get the teaching content “served” in ready to use form by their teachers (Miljanović 2002b, p. 160).

The majority of the students (94.70%) in their responses to the question What do you think about the topic content, Basics of Molecular Biology? expressed the opinion that the content was useful and interesting. That further indicated that the innovative model of teaching provided successful learning of the most difficult content from the subject of biology, and raised interest in biology among the students, as well as higher awareness about the significance of biology both as a science and a school subject.

The Prezi software has not been used for any school subject and the students were unfamiliar with it. However, 92.1% of students expressed a positive opinion on its application in teaching biology. The students also expressed their wish to learn other topics in biology in the same way. This statement in the questionnaire had an average scale value of 3.71.

A large majority (89.4%) of the students expressed interest in learning the programme and creating their own presentations.

Positive opinions about the application of innovative models in teaching biology in primary and secondary schools were found in studies reported by other authors. Miljanović (2002b) discussed students’ relationships with active biology teaching. The questionnaire was conducted on a sample of 120 students. “The results of the questionnaire showed that the students accepted this form of learning biology, which opened the door for wider use of an active teaching model in teaching biology” (Miljanović 2002b, p. 155). The student respondents highlighted the following advantages of active learning: “interesting, increased activity of the students during biology classes, joint work, a relaxed working atmosphere in biology classes” (Miljanović 2002b, p. 164). Drakulić and Miljanović (2010) analysed the attitudes of 105 students about the application of computer-assisted programmed biology teaching in the sixth grade of primary school. The results of the analysis were as follows: “higher efficiency, interest, and motivation of students in individual work and independent learning of the didactically and methodically shaped biology content presented to them through

programmed teaching educational software” (Drakulić and Miljanović 2010, p. 215). Terzić et al. (2015) analysed the attitudes of students towards the “application of electronic textbooks in teaching biology to fourth-grade natural sciences grammar school students, after it was used during the whole school year” (Terzić et al. 2015, p. 91). The analysis of student perception showed that they understood the essence and importance of the application of electronic textbooks in teaching biology. They accept the advantages of electronic textbook use in teaching biology, since they do not want to be passive observers during the teaching process, but to actively adapt the learning process to their abilities, interests and needs” (Terzić et al. 2015, p. 104). The papers mentioned above and the research presented in the present study conclude that most of the students adopted the application of the innovative model of teaching and clearly understood its contribution to improving the quality and efficiency of teaching biology in primary and secondary schools.

CONCLUSIONS

Contemporary society is commonly recognised by introduction of fast changes and high representation of ICT in all life spheres. Education, as the cornerstone of every society, should follow changes in society and be a leader in prompt training of students for all the professional and everyday life challenges that await them in the future.

Combining various forms and innovative models of teaching (application of modern teaching facilities, primarily ICT) may significantly improve both teaching and the learning processes for most school subjects. One such model is computer-assisted interactive teaching which provides: learning through research and discovery; develops independent learning, creativity, preciseness, and patience in learning; and improves social interaction among students.

Schools in Serbia are still under-equipped, and lack modern teaching facilities (primarily computers and projectors) that would help teachers explain complex and abstract content in molecular biology, biochemistry, genetics or the physiology of plants and animals. The research presented in this paper was conducted on fourth-grade grammar school students who worked in pairs. The teaching topic Basics of Molecular Biology was presented to them via a computer-assisted interactive teaching method over 12 teaching hours in a classroom for informatics. After completion of the 12 teaching hours, students were given questionnaires. The analysis revealed that the students have positive attitudes towards biology as a school subject and a positive opinion on the quality of multimedia presentations created in the Prezi presentation software: layout, design, and organisation of teaching content, the applied teaching model, and the positive effects of the computer-assisted interactive biology

teaching model. The computer-assisted interactive teaching model enhanced student motivation for learning biology and their desire to learn other school subjects by the same teaching model. The obtained results of the questionnaire recommend increased inclusion of computer-assisted interactive biology teaching in grammar school.

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