DETERMINING THE IMPACT OF INFORMATION TECHNOLOGY TOOLS ON THE TRAINING OF COGNITIVE SKILLS IN GENETIC ENGINEERING AND BIOTECHNOLOGY

[a]Katarzyna SOCHA & [b]Barbara ZĘBALSKA*

[a] Pedagogical University of Cracow, Institute of Biology, Poland, k.socha@gmail.com
[b] Pedagogical University of Cracow, Institute of Biology, Poland, zebalska@ap.krakow.p

Abstract

The main target of the project was to determine the influence that the use of information technology tools in genetic engineering and biotechnology lessons has on the level of students' cognitive skills. The method of pedagogical experiment was used in the study. For this purpose two groups were used, an experimental group (E) and a control group (K), and the pretest and posttest were conducted on their basis. The pretest results were used to examine the significance of differences concerning the level of knowledge of genetic engineering and biotechnology between the groups.

After the initial research a natural training experiment was conducted. In the experimental group lessons in the fields of genetic engineering and biotechnology were conducted, in which pupils were taught cognitive skills. On the other hand, in the control group lessons were conducted without the use of information technology, although both groups followed the same curriculum. In order to compare and examine the two groups the same test was conducted in both groups covering the skills to be mastered by students such as drawing graphs.

The results of the study indicate that the level of cognitive competence in the experimental group is higher than in the control group where the tools of information technology were not applied .

Keywords: genetic engineering, biotechnology, IT tools

INTRODUCTION

The analysis of the teaching material of cytology and genetics in the entire twentieth century allows to draw the conclusion of a gradual reduction in the classical Mendel curriculum content in favour of the information on molecular genetics, cytogenetics and genetic engineering (Potyrała, 2004). The growing importance of teaching biotechnology and molecular biology is the proof of progress in these areas; it also necessitates updating the process of teaching biology. Every day biotechnology is becoming more and more important in the life of every human being. People will have to be knowledgeable and familiar with problems in this area in order to make more informed choices. Introducing elements of genetic engineering and biotechnology to the contents of school education involves the need to make these elements available, and thus it is important to introduce new forms and methods of teaching and learning. Niemierko (2002) claims that it is necessary to practice cognitive skills such as focusing attention, organizing information, analysis, synthesis,

inferring, hypothesis testing and evaluation of solutions. In the sphere of education actions which increase the efficiency of education are of primary importance (Pomykało,1997). In Poland efforts are taken to popularize multimedia information tools. At the same time direct instruction methods are dominant. It is feared that the mere application of IT measures will not result in greater effectiveness of biology education. (Obrebska,2008)

METHOD

In the conducted research studies the main objective is to determine the effect of the use of information technology tools on shaping students' cognitive skills in genetic engineering and biotechnology lessons. The object of the scientific study was the measurement of selected cognitive achievements covered by computer-assisted instruction and not covered by computer-assisted instruction. In connection with the intended objective of the study the following research problem was formulated: What is the relationship between teaching computer aided genetic engineering and biotechnology and the students' cognitive skill level ? Then a hypothesis was formulated. It is assumed that there is a positive relationship between computer assisted teaching of genetic engineering and biotechnology and the skill level of students, which means that students subjected to computer-aided teaching achieve a higher skill level than the students taught without computer assistance.

The study was based on a group of 60 secondary school students in Poland. The method of pedagogical experiment was used in the study. For this purpose two groups were used, an experimental group (E) and a control group (K), and pretest and posttest were constructed on their basis. The pretest consisted of 16 questions on basic knowledge of genetics, genetic engineering and biotechnology. After the initial research a natural training experiment was conducted. In the experimental group lessons in the field of genetic engineering and biotechnology were conducted, in which pupils were taught cognitive skills such as drawing graphs, analyzing information, drawing conclusions and arguing the use of information technology tools. In the control group lessons were conducted without the use of information technology, although both groups followed the same curriculum. In the course of lessons with the use of information technology tools computer programs, the internet, and the Power Point software forms and methods of education were used, such as Ball Bering, jigsaw, conceptual maps, modeling, didactic games , teaching projects, which required the students to process information by themselves, formulate problems and draw conclusions thus helping to develop cognitive skills. In order to compare and examine the significance of differences in the level of cognitive skills achieved the same posttest was conducted in both groups, and the results were analyzed statistically. The test covered skills to be mastered by the students, such as drawing a graph, using information from various sources, analyzing schema patterns, inferring, arguing.

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FINDINGS

The first stage of the research

In order to determine the significance of differences between the groups concerning the level of knowledge in the field of genetic engineering and biotechnology the Pretest results were used. In order to check the significance of differences between the two groups the Mann-Whitney test was used. The test value calculated on the basis of the research results was p= 0,7788.

Table 1. Data for statistic analysis

Average	Standard deviat.	Min	Lower quartile	Median	Top quartile	Max
Descriptive statistics						
10,30	1,69	7,00	9,00	10,00	12,00	14,00
10,07	1,74	7,00	9,00	10,50	11,00	13,00

Figure 1. Distribution of the significance of differences between the groups concerning the level of knowledge in the field of genetic engineering and biotechnology.
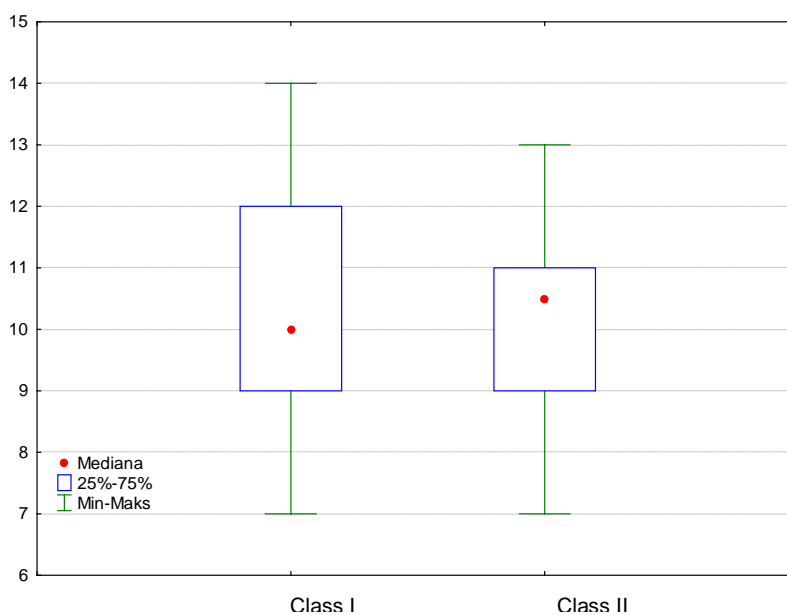
The results were illustrated in the diagram (Fig 1): an equal length of the whiskers allows for the conclusion that there are no significant differences between the experimental group (class I) and the control group (class II) in terms of genetic engineering and biotechnology knowledge, which means that students from both groups are from the same population and were properly selected for the experiment.
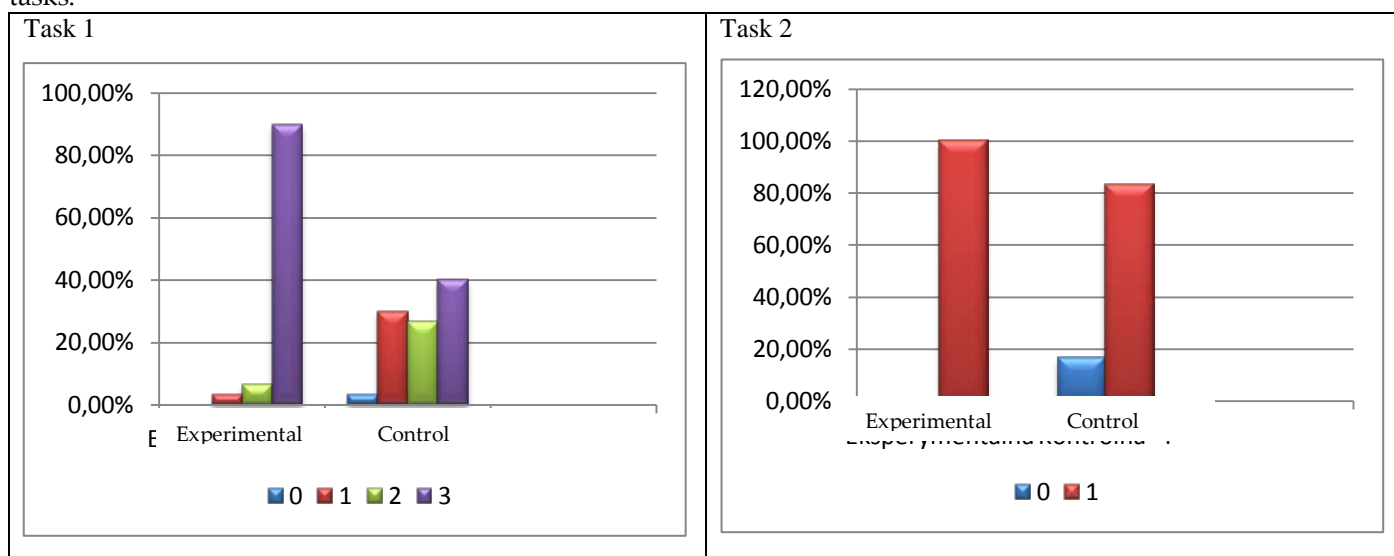
The second stage of the results

In the final measurement of students' cognitive skills various tests were used to analyze particular tasks: the chi2 test or the chi2 test with Yates's correction, and instead of it Fisher's exact test. Other tests than the chi2 test were used when the observed or expected numbers were very small. Table 2 shows the test results for particular tasks which checked the selected cognitive skills in the experimental group and the control group.
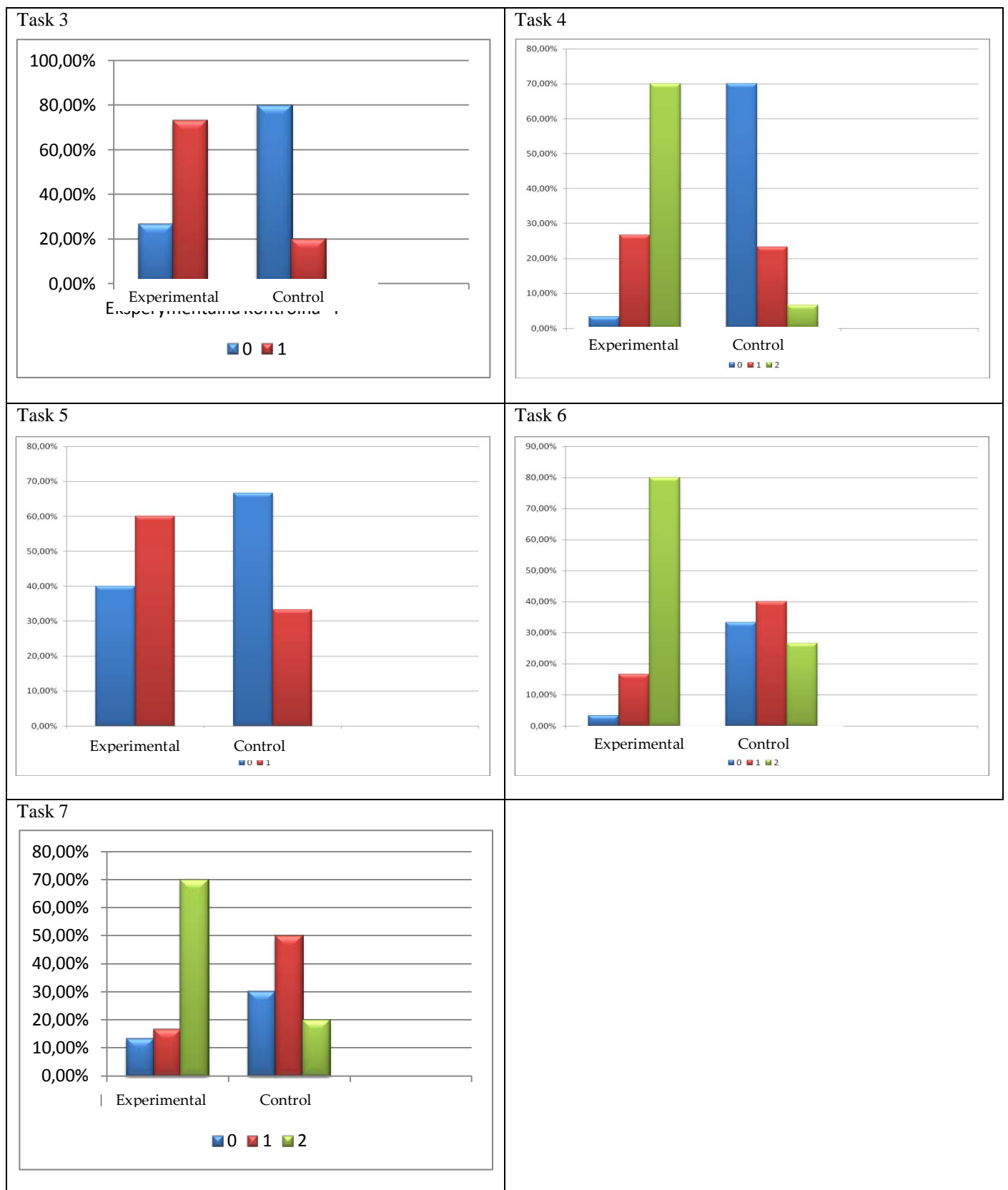
Table 2. Test results for particular tasks checking selected cognitive skills.

Task no	Type of skills being tested	test	Result
1	Graphing	Fisher p=0,0002	Highly significant correlation
2	Date analysis	Fisher p= 0,0260	A significant relationship
3	Diagram analysis	Ch2 Yates=15,07, df=1, p=0,0001	Highly significant correlation
4	Argumentation	Ch2 Yates = 33,94, df=2, p<0,0001	Highly significant correlation
5	organizing information	Ch2=4,29, df=1, p=0,0384	A significant relationship
6	Explaining the basis of information	Ch2=18,25, df=2, p=0,0001	Highly significant correlation
7	Understanding and application of dates	Ch2=15,26,df=2, p=0,0005	Highly significant correlation

On the basis of the analysis of test results comparing the experimental group and the control group a significant or highly significant relationship was noticed in the formation of cognitive skills using the IT tools. The experimental class in which IT tools were used obtained a higher score in comparison with the control class in each of the types of skills tested. Worse teaching results in the control class may be related with the predominance of direct teaching methods. (Fig. 2)

Figure 2. Distribution of results obtained by the experimental group and the control group in particular tasks.

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Task 3

Task 4

Task 5

Task 6

Task 7

The level of students' cognitive skills in the experimental group was significantly higher than the skills level of control group students in each type of the trained skills. It indicates a positive

relationship between the use of IT tools and the effectiveness of cognitive skills training.

DISCUSSION

The results of the experiment confirmed earlier opinions of teaching assuming a beneficial influence of using IT tools in teaching and learning of biology and other sciences. (Cipera et al., 1996,Unterbrunner,1999, Potyrała&Walosik 2001, Potyrała, 2003, Kowalik 2003, Potyrała& Wołek, 2004, Potyrała 2007, Wójcik AT All 2007). The use of IT tools contributed to raising students' cognitive competences such as drawing graphs, analyzing data, analyzing diagrams, arguing, organizing information, drawing conclusions. These skills promote scientific thinking and allow students to formulate hypotheses, conclusions and solve biological problems. In the experimental classes students can make a greater use of their knowledge, e.g. point out the benefits and risks associated with the development of genetic engineering, demonstrate sensitivity and understanding of bioethical issues and also point out the practical and cognitive aspects of human genome research. Student's school progress is inherently connected with the dynamics of the relationship existing between the two sides of the learning process (Ledzińska, 1996). Learning should be a process related to management and creating situations which allow the student to acquire specific experience. The role of the teacher is to guide their cognitive activity (Przetacznik-Gierowska, Włodarski 1994 after Ledzińska 1996). The widespread use of IT has an increasing influence on the shape of modern education. The modern school must meet the challenges of the era of information technology and prepare students for its benefits

CONCLUSION

The computer is another tool which broadens the teaching base. At the same time it is a tool of great potential which allows for sharing knowledge and skills; it is also a tool which students can use when doing exercises, collecting and compiling materials, preparing presentations, data analysis, creating generalizations and regularities, reasoning or, in other words, developing their cognitive skills.

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