5 **pages maximum (with abstract and references)**

PREPARING TOMORROW'S SCIENCE TEACHERS TO USE NEW TECHNOLOGY

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Abstract: The impact of digital technologies on science teacher education is more pervasive than any curricular or instructional innovation in the past. The impact can be felt on three fronts. First, as with the hands-on science movement, digital technologies are changing the ways teachers interact with students in the classroom. Psychological theories (Borich & Tombari, 1997) based on the importance of language to learning, the ways organizing and relating information facilitates understanding, and the influence of social factors in the classroom are all impacted by digital technologies.

Science education has generally involved teaching not only a body of knowledge but also the processes and activities of scientific work. This view has linked the scientific uses of technology with hands-on experiences. The term "hands-on science" was descriptive of the major curriculum reform projects of the 1960s and became a label for a revolution in teaching science through the next two decades (Flick, 1993). So-called "hands-on science" instruction impacted teacher education as new curricula made its way into preservice courses. Teacher education was also influenced by teaching methods, such as the learning cycle (Lawson, Abraham, & Renner, 1989), based on theories of student learning that implied the necessity of interacting with physical materials. Science and technology education have enjoyed a meaningful partnership across most of this century. The work of scientists embraces an array of technologies, and major accomplishments in science are often accompanied by sophisticated applications of technology. These elements have traditionally been a part of teacher education in secondary science.

Key words: Biology, teaching methods, technology education, natural sciences, cell.

1. Introduction

The need to analyze, revise and modernize the conditions in teaching in the frames of our educational system has lately been closely connected with the tendencies to improve elementary education in our country, in accordance with the dynamic social and economic relations. Likewise, in times of communication revolution it is necessary that ICT be the catalyst of reforms in education, but it is not the key for changes in education. For these reasons it became obvious that changes in our educational system (introduction and application of the new conception of nine-year elementary education, development of the new curricula and innovated teaching programs) must be preceded by expert and organizational preparations directed to didactic-methodic goals, which in schools will create conditions for successful introduction of major changes in the most important segment – teaching.

For this purpose it is necessary to improve the quality of teaching, increase job skills among students, increase access to computers and integrate the use of ICT in all subjects, with special emphasis on science. In this way students will be able to think critically, which in turn will help them achieve success in the global knowledge-based economy and support professional development of teachers.

1.1. QUALITY TEACHING

Modern pedagogical theory and practice start from the thesis that school was created for children, not vice versa. This thesis conditions the teaching to be based on knowledge, interests and experiences of children that are amended and improved along with their development in school.

Today in the theory of sciences dealing with teaching real the prevalent attitude is that real, stable knowledge cannot be learned in a final form. In modern teaching, the focus of work shifts from the learning of ready knowledge towards the process of knowledge acquisition. The role of the teacher is more responsible than in traditional teaching, because of the fact that he/she must find out what the interests of students are and then monitor and properly direct them. Instruction must be directed to the student's activity, while the teacher has to "teach as little as possible" and act so that "the student discovers as much as possible."
To achieve this in natural sciences (biology), teacher and student must follow the schedule of procedures:

- Observation and recording
- Open (interactive) communication and cooperation

- Monitoring, researching, realizing, experimenting
- Application of the acquired knowledge and experience in new situations
- Creation of conditions for independent learning.

These procedures, among other things, provide proper mental development (cognitive, emotional) and proper socialization of the student.

Traditionally, teachers have emphasized lecture, text, and demonstration, with the intent that students would comprehend and recall this information at the conclusion of a unit or chapter. However, teachers practicing reforms-based instruction place less emphasis on these traditional approaches and greater emphasis on fostering inquiry in student centered ways. Reforms-based instruction is based on flexible curricula, providing students with opportunities to construct scientific understandings through active learning. These shifts in instructional approaches are difficult because they require dramatic changes in practices that have persisted for a long time.

In many cases, teachers do not even have a basic understanding of what constitutes reforms-based instruction (Gess-Newsome, 2003). Implementing reforms based instruction is made even more difficult by lack of content knowledge and inadequate understanding of science-specific instructional approaches (Loucks-Horsley, Hewson, Love, and Stiles, 1998). Finally, teachers often cite lack of resources, including both equipment and curriculum materials, as a barrier to implementing new instructional methods (Blumenfeld, Krajcik, Marx, & Soloway, 1994).

Recent investigations point to the potential of computer technologies in facilitating reforms-based instructional practices (Kim, Hannafin, and Bryan, 2007; Sandholtz, Ringstaff, and Dwyer, 1997). Digital images and video, computer probe ware, online data access, and computer simulations have all been shown to help both students and teachers develop scientific conceptions of standards-based content (Bell, Gess-Newsome, and Luft, 2008; Flick and Bell, 2000). Furthermore, computer simulations have been shown to facilitate inquiry learning. For example, in a recent study of pre-service teachers' conceptions of lunar phases, researchers reported pre- to post instructional gains in scientific conceptions of more than 80% for participants who used an astronomy simulation in the context of inquiry instruction (Bell and Trundle, 2008). In another recent investigation, Winn et al. (2005) found simulated data collection to be just as effective as field-based data collection in learning oceanography concepts. Furthermore, the computer simulation provided a model-based experience that offered visualization opportunities not possible in actual field work.

Despite the advantages that computers have to offer, research has consistently shown that few teachers use computers as instructional tools. The researchers concluded that computers, while frequently used, had not significantly impacted classroom instruction and learning. Similarly, in his visits to schools across the nation, Pflaum (2004) found that computers were rarely used to facilitate and enhance instructional practice and more often were used for student and teacher productivity.

In fact, preliminary investigations have shown that teachers who had access to computer projectors often used the technology for instructional purposes to promote student engagement and inquiry, even in a whole-class setting (Irving, 2003; McNall, 2004; Smetana and Bell, 2009). However, additional research is needed to characterize the instruction of teachers in single-computer classrooms, especially when these teachers' preparation has been designed to facilitate their growth in ICT and to use technology for instructional purposes in whole-class settings.

Flick and Bell (2000) proposed a set of guidelines for teacher education that reflect both science education reform documents and facilitate the development of TPCK. These guidelines include the following:

1. Technology should be introduced in the context of science content.
2. Technology should address worthwhile science with appropriate pedagogy.
3. Technology instruction in science should take advantage of the unique features of technology.
4. Technology should be used in ways that make scientific views more accessible.
5. Technology instruction should develop students' understanding of the relationship between technology and science.

These guidelines place science content at the heart of learning to teach with technology, first emphasizing that teaching and learning the features of technology applications should be embedded within the context of meaningful science content. Second, activities incorporating technology should make meaningful connections to student experiences and foster student-centered, inquiry-based learning.

Specifically, the study addressed the following questions:

1. Will these pre-service biology teachers use the ICT for instructional purposes?
2. If so, in what ways will they use the ICT?
3. Will their use of an ICT reflect reforms-based instructional practices?

1.2. Operational lesson plan

At the Faculty of educational sciences at the University "Goce Delchev", Stip, the students majoring in elementary school education have the teaching subject Fundamentals of science in the first year. Although ICT finds its application in almost any subject, in science subjects it can be best incorporated for specific contents. That is why this type of research was made where students were divided into 4 groups.

Topic: Morphology of cell

STUDY UNIT: Similarities and differences between animal and plant cell

- Objectives and tasks of the lesson
- The student should be enabled to recognize and name plant and animal cells
- Name parts (cell organelles) of plant and animal cell
- Explain the functions of cellular organelles of plant and animal cell
- Draw a plant and animal cell and mark its constituent parts (core, cytoplasm, cell membrane)
- Develop a Venn diagram with similarities and differences between a plant and animal cell.

2. MATERIAL NEEDED

- Ready models of animal and plant cell
- Drawings of cells (posters, slides)
- Encyclopedias, biology atlases
- Computer, **white board**, Internet
- Paper and drawing utensils

3. INTRODUCTORY PART OF THE LESSON

The students are shown a drawing of a plant cell. Students identify and name the parts and functions of cell organelles, especially the nucleus with its constituents - chromosomes. They are shown an animal cell and the students observe and compare.

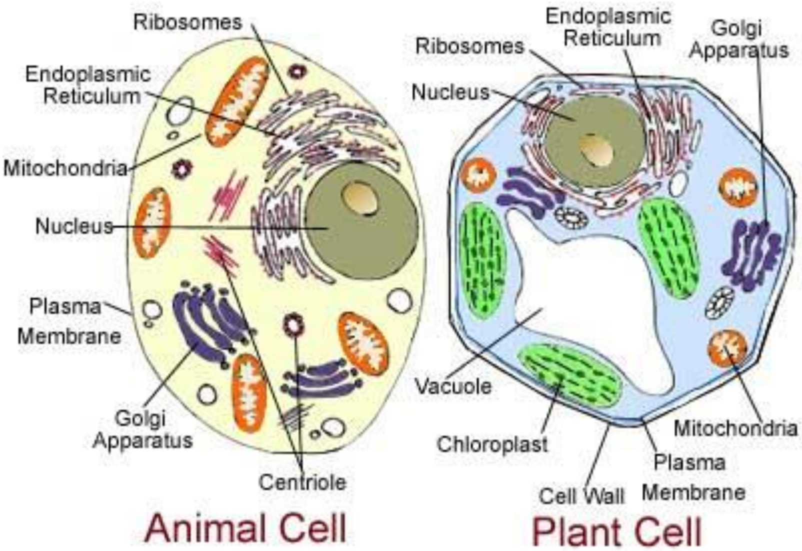

Figure 1. Plant and animal cell

3.1. MAIN PART - RESEARCH

The first group – draws a plant cell, marks, names parts and discusses the functions of the cell organelles. They draw the nucleus and the constituent parts of the nucleus.

The second group – Draws an animal cell, nucleus of an animal cell, marks and discusses.

The third group – makes a Venn diagram with similarities and differences between a plant and animal cell.

To achieve these objectives different technologies were used: PowerPoint presentations, simulations, animations, digital images, videos, digital diagrams and models, video clips, web pages, simulated labs, etc. ICT is used for lectures on various topics from biology with a wide range of technological resources.

The students were shown pictures in order to illustrate different types of cells, cell structure, including cell organelles and chromosomes as constituents of the nucleus. Instead of using only images for illustration, they used digital images to stimulate interaction with the material. Students made observations and conclusions, and images were used as a stimulus for discussion.

After a short introductory part, the teacher began the lesson on the cell and cellular organelles, nucleus with chromosomes. He said: "Today we will talk about the structure of animal and plant cell nucleus and chromosomes". He asked a few questions about what the students knew about the cell and then released a PowerPoint presentation that showed pictures of several different types of cells - plant and animal. Students asked questions about the structure and functions of cellular organelles. The teacher then used a web-animation of cell, cell division, etc.
With a white board pen they marked the cell organelles, the nucleus and the chromosomes within. The students were excited trying to pair the chromosomes, and the teacher invited different students to come to the board and drag chromosomes to their homologous pairs. Students laughed and encouraged each other while the class debated which chromosome the student at the board should choose.

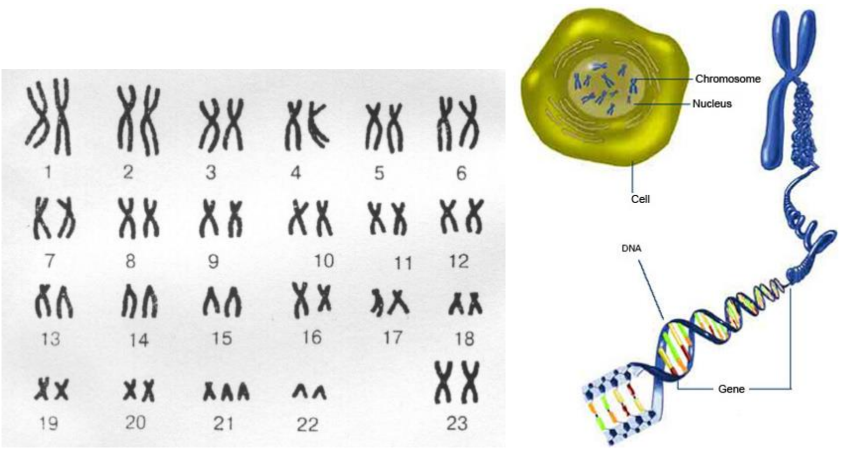

Figure 2. Karyotype, nucleus, chromosomes and DNA

The use of images of karyotypes helped students to visualize human chromosomes, the nucleus as the most important structure of both plant and animal cell. The abstract concept of the construction and structure of the cell as a structure invisible to the human eye, that it contains a nucleus, the nucleus contains chromosomes, and that chromosomes are made of genes, was made more concrete through these karyotype images. Scientists create and use karyotypes to diagnose disorders, and the use of karyotypes simulation helped students to create their own interaction with the process and to mimic the process that biologists undertake. The usage of the display system for visualization was a topic that was common in the educational experiences of all participants.

The fourth group - control group in which none of the modern educational technologies applied in natural sciences classes. The traditional teaching method was used here: "Students were presented an oral presentation by the teacher". Teachers are satisfied with the traditional method because they remain in control of time and content. Oral presentation to a large group of passive students can do very little for real learning.

4. DISCUSSION

Groups discuss their research:

Groups convey their research results and ideas (with drawings and diagrams, they complement

Final part – Application:

In the structure and functions of tissues and organ systems. To understand the functional link between cells in tissues, organs and organ systems. Differentiation and specialization of cells occur in various organs and tissues in plants and animals. Students pull papers with given tasks: to draw a cell, to list the functions and to explain differences.

Research problem

- ✓ How will the use of new educational methods in teaching science affect the academic achievement of students?

Other research problem

Are there differences in academic achievements among the investigated groups?

This study was designed as an experiment that was performed in four groups of 10 students attending the subject Fundamentals of science in their first year – Department of elementary school teaching at the Faculty of Educational sciences the University "Goce Delchev", Stip.

Tools for collecting data

The purpose of this research was to try to empirically determine whether sequential use of different methods of learning was important for the progress in students' academic success. Effectiveness was determined quantitatively by a written test. The test contained 20 questions. This test was used as a pre and post-test, before and after methods-applications and repetition of the test in order to determine the level of the retained knowledge - 40 days after the lectures on the subject.

Analysis of the results obtained

Firstly a pre-test was conducted in 4 groups of 10 students. According to the test results, differences between groups were statistically analyzed using the ANOVA test (Table 1), and there was no significant difference (p> 0, 05) between them. The difference between the first, second and third group, compared with the fourth group was significant. This means that the level of retention (memory) of the students in Groups 1, 2, and 3 is significantly higher than in Group 4.

Reflections

As part of the student teaching seminar, each preservice teacher wrote four formal reflective essays over the course of the student teaching semester and at least five informal essays evaluating their lesson plans and classroom instruction. The formal reflections described the student teachers' approach to and use of inquiry, their attitudes toward and use of educational technology, their understandings and implementation of the nature of science in their teaching, and their approach to classroom management. Participants' formal and informal essays were collected to further characterize their instructional approach and use of ICT and other educational technologies.

The results of this study showed that academic achievement of students depends on how the teacher teaches specific content of natural sciences (or biology in our case). Classes beginning by using interactive methods in teaching and using ICT, Internet connection and whiteboard were more exciting and encouraging on students' reflective activities than classes beginning with lecturing. In science teaching using laboratory experiments or slides at the beginning of class attracts more attention and motivation among students. The use of an oral lecture is boring for students. The visual material includes the understanding that words cannot express and make students remember the content very easily (Odubunmi and Balogun 1991; Gentry, 1994).

Using PowerPoint presentations creates a very conducive environment for learning unlike lecturing in halls (especially for large classes) because it offers students real life situations and an opportunity to solve the problem with skills. At the same time, students have more time and opportunities for practical experience, active thinking and the reflex of knowledge. In addition, teamwork encourages students to practice their interpersonal skills, and foster team spirit and leadership. Finally, oral presentations provide an opportunity for students to strengthen their mental response and presentation skills.

According to the results of the research, the level of retention (memory) of the acquired knowledge during classes that begin with an experiment or slides was higher than during those beginning with lectures. This is because people remember 10% of what they read, 20% of what they hear, 30% of what they see and 90% of practical experience. Laboratory work is practical experience (Beydogan, 2001). This research also showed that students' understanding was increased when the class began with an experiment because these activities increased the students' interest in the topics.

Let us hope that this research will be the start of various sequential methods of teaching biology. The results of this research could be adapted to other teaching subjects.

5. Conclusion

The results of this investigation may inform the content and instructional approaches used to introduce pre-service teachers to interactive display systems in educational technology and science teaching methods courses. For example, it is important to teach specific approaches for using digital images effectively, including having students record observations about what they see and infer what will happen next (Bell and Park, 2008). Instructors should model effective use of video clips, including providing advance organizers to help students comprehend what they see and how it is connected to the content they are learning and pausing video clips to ask questions or to point out specific features.

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