Creating a Virtual (Digital) Educational Environment for Teaching Biology in the Conditions of Technoparks and Quantoriums at School and University

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Abstract. The article describes the features of the interaction of a general education school and a technopark of a pedagogical university in the implementation of modern biological education. The relationship of biology with other sciences is considered, the types of educational technologies used in the process of interaction are presented, the significance of the digital laboratories of the technopark are revealed. The article considers as a scientific problem the identification of promising areas of didactic research, the expansion of their research field. In the article, the provisions of general didactics are concretized in relation to new objects included in its research field, the problems of didactics of higher education are considered. Also, the article deals with virtual reality, more precisely, its concept for creating a more powerful and useful virtual learning environment than existing approaches to learning based on traditional technologies, by incorporating new technologies and new learning criteria. A method of vector modeling of virtual reality, presented for use in various types of self-education, based on information and communication technologies, educational technologies for blended teaching of biology in high school is proposed and substantiated.

1 Introduction

Today, Russian secondary school education must be flexible, transformable, to request and respond to the needs of our country. Society needs educated, morally educated people who can independently make responsible decisions, are capable of cooperation, are distinguished by dynamism, mobility, constructiveness, and have a developed sense of responsibility for the fate of the country. A rational solution for solving the problems of
these issues may be the creation and implementation of cooperation models focused on working with the university environment, the university community [6].

The renewal of biological education depends on the need to link it with the currently achieved development of the natural science block. Biology today is becoming a link between physics, chemistry and the humanities. Biological knowledge ensures that school graduates are ready to engage in environmentally qualified activities in the natural environment, recognizing the importance of protecting their own health and the health of others, on which the quality and life expectancy of modern people depends, as well as protecting the biosphere as a condition for the existence of natural, artificial and social system.

The newest and most promising form of implementation of biological education is the interaction of a secondary school and a technopark of a pedagogical university. The technology park is an innovative environment that forms inventive, creative, critical and productive thinking among students, which is implemented on the basis of organizations that provide training in additional general developmental programs of a natural science, technical orientation, which have a property complex; having a trained composition of pedagogical, engineering and other employees of the organization; implementing a complex of relations of various nature with industrial and intellectual partners; providing continuous updating and actualization of the content of educational activities [4].

In the course of biological education in the technopark of the pedagogical university, a competency-based approach is implemented; diverse knowledge techno projects and technological solutions are used, in particular, DOT, digital education; the greatest preference is given to active forms and methods of teaching: business and role-playing games, fictional stories (storytelling), mini-projects, case method, TRIZ technologies; educational interdisciplinary excursions, round tables, group training and public demonstration of prepared works, brain games [5].

Virtual Reality technology is a technology of non-contact information interaction that realizes the illusion of direct entry and presence in real time in a stereoscopically presented "screen world", while providing tactile sensations in the process of user interaction with objects of the "virtual world". In the field of education, the "Virtual Reality" technology has quite a variety of applications: modeling visual stereoscopic, audiovisual and sensory sensations of the user's direct contact with virtual reality objects; non-contact interaction with objects or processes occurring in the "virtual world" and their management; imitation of reality - the effect of "direct participation" of the user in the processes occurring on the screen, and influence on their functioning; designing a virtual biological subject area, endowed with real conditions for its functioning, adequately to a certain content-methodological approach; creation and modification of virtual spatial structures, and their adequate mental interpretation.

Possible negative consequences of the implementation of the "Virtual Reality" technology for educational purposes include: inadequacy and deformation of the student's perception of reality after a long stay in the "virtual world" due to the illusory nature and ambiguity of the observed images of virtual objects; the intensity of the emotional sphere of the student in connection with the information-capacious, visually rich representation of the objects of the "virtual world"; weakening of professional skills in real conditions when training on virtual equipment.

Along with social media (weblogs, Wikis - websites, social networks), various types of learning management systems, such as Socrative, Kahoot, Edmodo, and Nearpad, play an active role in creating a virtual educational environment. They represent an integrated platform for managing educational resources, supporting communication between teachers and students, and assessing the quality of education [5]. The active use of social media, electronic learning process management systems has led to the emergence of new concepts,
learning models, called "E-learning 2.0", "Pedagogy 2.0", "Faculty 2.0" and "Classroom 2.0", characterized by openness, personalization, collaboration, collective creative wisdom [8].

2 Materials and Methods

To solve the tasks set, the following methods are used: general scientific methods of theoretical research (analysis, synthesis, formalization, modeling, classification, generalization, literature study); methods of empirical research (study of pedagogical experience, observation, conversation, questioning, testing); methods of object-oriented design and programming; development of visual models and virtual reality tools; pedagogical experiment and statistical methods.

3 Results and Discussion

In the course of the study, a pedagogical experiment was conducted, which tasks included:
- analysis of the state of professional competence of future biology teachers;
- testing an experimental model of the process of forming the professional competence of future biology teachers through the use of a virtual educational environment in a university environment;
- establishing the degree of effectiveness of the elective course "Virtual Methods of Teaching Biology" and indicators of professional competence of future teachers.

The productivity of experimental developments was determined during the stage of the pedagogical formative experiment, which was preceded by the stages of search and ascertaining.

The ascertaining experiment showed insufficient work on the formation of professional competence of future teachers. As a result of a sociological survey of biology students, including questions that allow determining the level of formation of their professional competence was determined, that allows to determine the degree of education, professional training of future teachers at the university; the degree of interest of future teachers in the use of a virtual educational environment. Data on the level of professional training of future teachers when studying at a university are presented in Table 1.

Table 1. Generalized data on the level of professional training of future teachers when studying at a university (%).

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Sufficient</th>
<th>Insufficient</th>
<th>Not prepared</th>
<th>Difficult to answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical</td>
<td>7.4</td>
<td>75.2</td>
<td>14.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Practical</td>
<td>2.1</td>
<td>77.5</td>
<td>17.1</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Table 1 shows that 75.2% of future teachers assess their professional training as insufficient in the theoretical aspect, in practical - 77.5% of students. The obtained results of the assignments confirm the critical self-assessment of future biology teachers, in terms of identifying the level of professional competencies. During the period of professional practice, 62% of students had difficulties in satisfying the need to find possible methodological recommendations on professional issues. In this regard, an elective course "Virtual methodology for teaching biology" was developed and introduced into the educational process, the effectiveness of which was determined in the course of a formative experiment.

Experimental work was carried out on the basis of the State University of Education, Moscow. In total, 40 people took part in the experiment: 35 students and 7 teachers.
The results of the survey in Figure 1 show that 12% of students do not see the need to use a virtual educational environment, while more than 75% of students want to use a virtual educational environment in learning. The result of selective observation, when performing information and communication activities of students in the educational process, showed an incomplete degree of readiness of university students for the full use of the virtual educational environment, Internet resources in their own educational practice.

![Correlation diagram of representations and real application of the virtual educational environment by students in the field of education.](image)

**Fig.1.** Correlation diagram of representations and real application of the virtual educational environment by students in the field of education.

During the experiment, in order to more fully characterize the results obtained, three levels of professional competence of future biology teachers were determined: high, medium and low, which are characterized in accordance with its criteria. In the course of experimental work, the dynamics of the development of professional competence of future teachers was observed; summarized results are presented in table 2.

**Table 2.** Indicators of professional competence of future teachers according to the criteria (1-motivational-goal-setting, 2-cognitive, 3-procedural-managerial),

<table>
<thead>
<tr>
<th>Group name level</th>
<th>EG (%)</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ascertaining experiment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td></td>
<td>51,6</td>
<td>48,4</td>
<td>49,2</td>
</tr>
<tr>
<td>medium</td>
<td></td>
<td>37,4</td>
<td>37,6</td>
<td>38,9</td>
</tr>
<tr>
<td>high</td>
<td></td>
<td>11,0</td>
<td>14,0</td>
<td>11,9</td>
</tr>
<tr>
<td><strong>Formative experiment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1,5</td>
</tr>
<tr>
<td>medium</td>
<td></td>
<td>44,6</td>
<td>43,1</td>
<td>41,0</td>
</tr>
<tr>
<td>high</td>
<td></td>
<td>55,4</td>
<td>56,9</td>
<td>57,5</td>
</tr>
</tbody>
</table>

The positive dynamics is confirmed on the basis of the revealed results in the experimental groups, it shows the effectiveness of the presented model of the process of forming the professional competence of future biology teachers and the effectiveness of the elective course "Virtual Methods of Teaching Biology".

Thus, the study confirmed the proposed hypothesis. In the course of our research, we found that the effectiveness of learning in a virtual educational environment depends on
involvement. The rapidly changing global economy has created a new context for learning and interaction that is inextricably linked to the digital world.

4 Conclusion

1. The technique of vector modeling of virtual reality promotes the development and personal freedom in educational activities, the activation of self-esteem, the use of freedom of action for the formation of professional competence.

2. Information and communication technologies with the introduction of educational information, advanced multimedia technologies, the use of information and educational tools for remote access, allow improving the professional competence of the graduate.

3. The virtual educational environment is notable for its openness and flexibility in adapting to the different abilities of students. The virtual educational environment carries out the tasks of cognitive and educational, experimental, scientific and professional activities, which are implemented through information educational technologies.

4. An empirical study has confirmed the effectiveness of learning in a virtual educational environment. This study is designed to analyze the typology of the virtual educational environment. Virtual educational environment implements the dominant method of interactive self-awareness, a method that includes constant interaction, cooperation in scientific subjects and scientific disciplines, and continuous feed.

References


5. Y. I. Shcherbakov, Interaction between the university and the school in modern conditions, World of science, culture, education, 1(44), 105-107 (2014).

