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L. F. Fatikhova
Ufa, Russia
E. F. Sayfutdiyarova
Birsk, Russia

REHABILITATION OPPORTUNITIES OF COMPUTER TECHNOLOGIES AT SPECIAL SCHOOL BIOLOGY LESSONS

Abstract. The article considers the use of computer technologies at special education institutions and highlights the advantages of their application. The article presents an authored educational technology based on 2D and 3D graphics for developing natural science knowledge of the topic "Human being" (section "Human skeleton") in students with intellectual disabilities. The authors argue that the computer technology under description would allow increasing the efficiency of acquisition of the learning material by students with intellectual disabilities. In order to confirm the hypothesis posed by the article, the authors developed pedagogical tests based on the materials of the topics already studied. The tests included multiple choice and multi-select tasks, as well as matching and classification tasks. Testing on the same topic was conducted twice: the primary testing was held at the end of the lesson, and the secondary (delayed) testing was conducted at the beginning of the next lesson. The results of statistical data processing allowed the authors to conclude that the use of the developed computer technology makes it possible to increase the retention of learning the educational biological material by students with intellectual disabilities. The developed computer program with 2D and 3D graphics serves as a supplement to the traditional means of teaching students with intellectual disabilities; it is designed taking into account the peculiarities of perception of the children of this category, allows to compensate for the shortcomings in their educational and cognitive activities, and increases their learning motivation.

Keywords: oligophrenopedagogy; children with intellectual disabilities; information technologies; methods of teaching biology at a special school; methods of teaching biology; biology lessons; learning-cognitive activity.

About the author: Fatikhova Lidiya Favarisovna, Candidate of Pedagogy, Associate Professor.
Place of employment: Department of Special Pedagogy and Psychology, M. Akmullah Bashkir State Pedagogical University (Ufa, Russia).
About the author: Sayfutdiyarova Elena Favarisovna, Candidate of Psychology, Associate Professor.
Place of employment: Department of Social Pedagogy and Social Work, Birsk Branch of Bashkir State University (Birsk, Russia).

Introduction

Rehabilitation tasks of the special school teacher working with pupils with intellectual disability are various and determined by the specificity of psychological disorders of children of the given category singled out by the leading Russian specialists in defectology (L. V. Zankov, N. G. Morozova, V. G. Petrova, S. Ya. Rubinshteyn, Zh. I. Shif, etc.). These disorders include:

1) disorders of cognitive activity, fragmentary and limited scope of perception, poor generality and differentiation, low capacity to understand the learning material;

2) inadequate cognitive activity, low interest to the content of the learning material;

3) stereotypicality, rigidity of the mental process, its poor flexibility;

4) pronunciation impairments, agrammatical speech, poor vocabulary, coherent speech underdevelopment;

5) low memory and long-term information storage capacity, malformation of the skills of using the stored information in activity;

6) incompleteness and distortion of ideas about the surrounding wprld [5; 10; 11; 12; 16].

In order to overcome these disorders having a negative impact on the learning-cognitive activity of the pupils with intellectual disability, the special school teacher uses various methods and means. Computer technologies are efficient learning tools for the children of this category. Their arsenal is being constantly extended. The opportunities of their active use in school practice are being enhanced both due to better equipment of the Russian schools (including special ones) and raising the teachers' competence in the sphere of computer technologies in education.

Literature review

Let us now characterize computer technologies worked out for learning and rehabilitation activity of children with intellectual disability and actively used in educational practice of the Russian special schools.

Classroom multimedia technologies used at lessons in various disciplines [1; 4; 8; 13; 15] are worked out both by specialists in the field of programming and by the teachers themselves with the help of standard tools offered in the software package *Microsoft*. According to researchers, these technologies have many advantages: presentation of text, graphic, audio and video information, inclusion of animation, music, speech and other audio information. Researchers note that multimedia presentations allow learning a greater volume of material than at traditional lessons. In addition, multimedia presentations make it possible for the teacher to take into account the specific pecu-

liarities and level of perception of pupils with intellectual disability.

Program complex in the subject modules "Grammar", "Reading" and "Mathematics". The complex represents a set of game-based tasks aimed at reinforcement of the knowledge on a certain topic in accordance with the academic program for special schools for pupils with intellectual disability [2; 14]. The complex ensures activization of the process of formation of the relevant learning functions – reading, writing and arithmetic; and the uniform program algorithm allows teachers to prepare children for acquisition of the learning material at transition from one school discipline to another.

The educational computer program "Economic Education at Math Lessons". The program focuses on formation and development of economic literacy of the pupils. The program contains 38 tasks included in two blocks – "Problems and examples" and "Didactic games" – the content of which is connected with everyday life situations [3]. Apart from its urgency for the pupils' socialization, this program enhances the learning motivation of children to acquisition of rather difficult material by inclusion of interesting exercises and game-based tasks.

Computer games realized in the visual programming environment "Delphi 7". The games are targeted at formation of oral count skills ("Chamomile"), skills of writing business papers ("Address the envelope"), reinforcement of the spelling of the active vocabulary words and enrichment of vocabulary ("Active vocabulary", "Recollect the rule"), interactive knowledge control in various disciplines ("Right answer", "Choose a picture") and practicing oral count skills ("Insert a mathematical sign") [7]. The advantage of the programs consists in the fact that they solve many different problems, allow the teacher to activize various psychological functions and learning skills of the pupils and presuppose not only reinforcement of the acquired knowledge and skills but also control of the quality of material acquisition.

Computer-assisted testing technologies. These technologies are used for current, topical and final control in various disciplines and allow the teacher to evaluate the level of acquisition of the learned material by the pupils, as well as to see their own success or failure in teaching [6; 14]. The latter makes it possible for the teacher to correct his activity and to improve his ICT competence.

Materials and methods

School subjects differ both in the content of the lesson and in the character of presentation of information to the pupils by means of computer technologies, as well as in the place these technologies may

take in the process of explanation of the topic of the lesson and control of knowledge acquisition. In recent years, computer technologies using the opportunities of 3D graphics which allow observing three dimension objects and enhance the observer's sense of reality have become very popular both in mass culture and in the sphere of education. We posed a hypothesis that the use of 3D graphics in the educational process of a special school may have a positive effect on the level and quality of acquisition of the learning material by pupils with intellectual disability due to the fact that this computer-assisted tool makes it possible to compensate for the drawbacks of their academic-cognitive activity, i.e. it has high rehabilitation potential. Lessons of biology (topics "Plants", "Animals", "Human being"), geography, vocational training, and social-everyday life orientation can be referred to such school subjects.

In order to test our supposition we worked out a computer technology intended to be used at biology lessons while studying the topic "Human being" and including, apart from objects presented in the 2D graphics format, objects studied with the help of 3D graphics. The section "Human skeleton" was used as learning material on the basis of which the hypothesis was tested.

According to the work program, the given topic included the following topics:

1) "Support and movement. Role of the musculoskeletal system";

2) "Composition and structure of bones";

3) "Skeleton of the head";

4) "Skeleton of the body";

5) "Skeleton of the limbs".

3D objects were created for each topic on the basis of such technologies as 3D modeling, 3D animation and rigging. The resulting 3D object was not only a three dimension one but rotated around its pivot up to 360^{o}. In accordance with the fact that one of the tasks of the given technology was to acquaint the pupils with new material, the fragments of the 3D object have labels which are pronounced when the cursor points at them. In order to avoid mistakes in the learning material comprehension by the pupils and to attract their attention to this material, the soundtracked object is also highlighted. Figures 1-4 show variants of menus including the objects under study (the skeleton and its parts) created using 3D graphics technologies.

Apart from the fact that the given technology can be used for explanation and learning new material, it has a potential for revision and reinforcement of the material already learned and for control – i.e. checking the quality of the material acquisition. Thus, the functions "Label" and "Pronunciation" can be

disabled, which allows using highlighting for the parts of the 3D picture during frontal test (see Fig. 5).

Fig. 1. Section menu “Skeleton”

Fig. 2. Subsection menu “Bone joints. Semi-mobile joints”

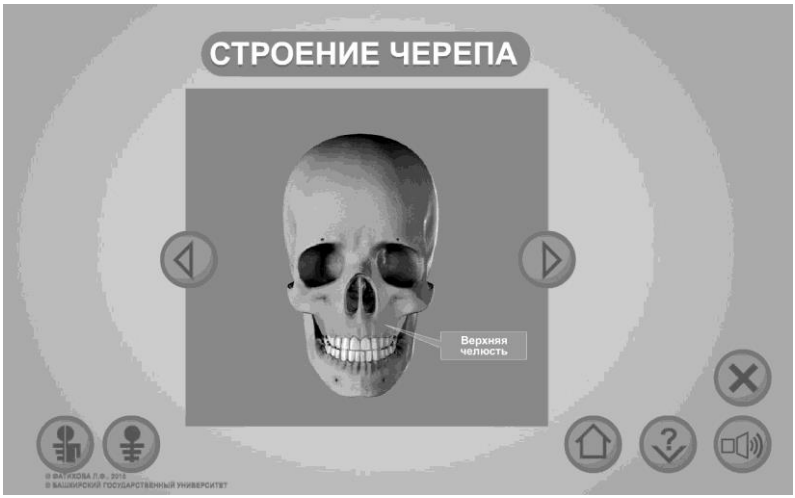

Fig. 3. Subsection menu “Skeleton of the head”

Fig. 4. Subsection menu “Skeleton of the upper limb”

Fig. 5. Subsection menu "Skeleton of the lower limbs"

During experimental testing of the created computer educational technology, we also conducted lessons with the learning material not supported by 3D graphics. These were lessons on the following topics:

1) "Structure of the cell";
2) "Chemical composition of the cell";
3) "Tissues. Organs";
4) "Systems of organs. Organism".

Comparison between the quality of learning material acquisition at the lesson with 3D graphics and the quality of acquisition at the lesson without it allows assessing the effectiveness of application of 3D graphics at special school lessons for pupils with intellectual disability while mastering natural-scientific knowledge.

Pedagogical tests including the following tasks were used as assessment tools:

1) multiple choice tasks (with the chance of choosing one, the only correct answer to the question);
2) multi-select tasks (presupposing two or more correct answers to the question);
3) matching exercises;
4) classification tasks.

Each test included 5 tasks, and the maximum number of points that could be scored in each of them was 8. Testing on one and the same topic was held twice:

1) immediately after acquisition, i.e. at the end of the lesson;
2) delayed in time – at the beginning of the next lesson.

To our opinion, this approach

does not only allow checking the level and quality of knowledge acquisition but also its stability.

Results

Figures 6 and 7 show the results of comparative analysis (median, minimum and maximum score) of testing pupils after the lesson and delayed testing in 9 topics of the course "Biology".

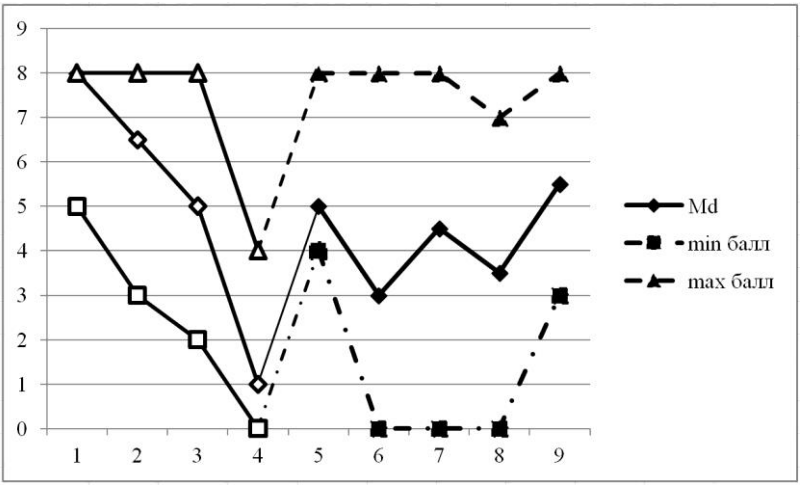

Fig. 6. Dynamics of test results of acquisition of learning material in the section "Biology" immediately after acquisition (after the lesson) by pupils with intellectual disability

Note: Md — median, min score — minimum test result, max score — maximum test result; topic numbers: 1 — "Structure of the cell", 2 — "Chemical composition of the cell", 3 — "Tissues. Organs", 4 — "Systems of organs. Organism", 5 — "Support and movement. Role of the musculoskeletal system", 6 — "Composition and structure of bones", 7 — "Skeleton of the head", 8 — "Skeleton of the body", 9 — "Skeleton of the limbs".

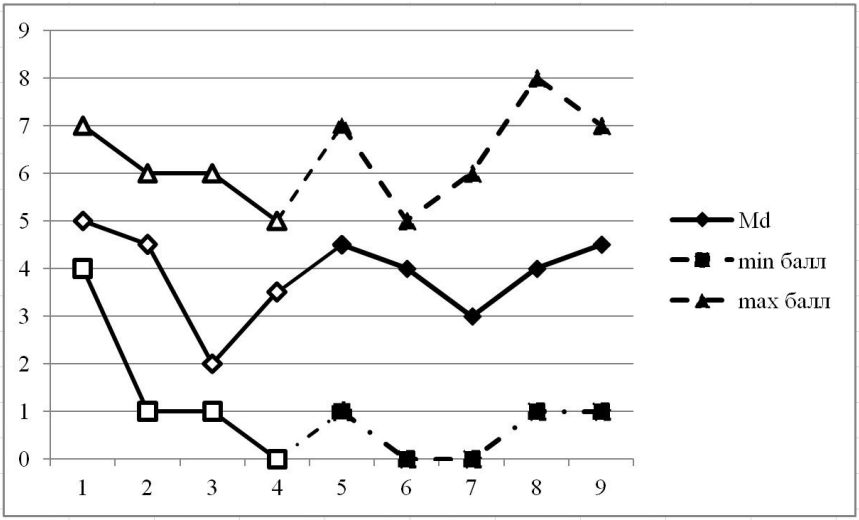

Fig. 7. Dynamics of delayed test results of acquisition of learning material in the section "Biology" (at the next lesson) by pupils with intellectual disability

Note: See note to Fig. 6.

The results presented in the graphs demonstrate the differences in the dynamics of acquisition of the learning material by the pupils immediately after the lesson and delayed in time (at the beginning of the next lesson while checking the effectiveness of reinforcement of the material learned at the previous lesson). In order to illustrate the effectiveness of acquisition of the learning material we presented the test results of the pupils in both cases on the topics not employing computer-based technology with 3D graphics (Lessons 1-4) and on the topics using 3D graphics (Lessons 5-9). Graphical data demonstrate gradual decrease of test results at the traditional lessons, whereas the lessons using the computer technology worked out by us show increase of all test results beginning with the very first lesson (Lesson 5) – of the median, minimum and maximum scores. It should be noted that the effectiveness of test tasks completion is higher according to the results of testing held immediately after the lesson, which corresponds to the specificity of cognitive development of the pupils with intellectual disability: they are characterized by a low level of long-term memory. The median tendency of the test results is characterized by significant fluctuations from increase to decrease and vice versa at

each sequential lesson. In addition, we observe a considerable variety of the minimum (0-5 points) and maximum (4-8 points, with prevalence of 8 points) scores in test results shown in Fig. 6.

The results of delayed testing (Fig. 7) of pupils with intellectual disability are characterized by lower indices of the median; the variety of the minimum (prevailing score is 1 point) and maximum (prevailing scores are 6-7) scores become more stable. The average values of test results are characterized by an insignificant tendency towards increase. Everything mentioned above testifies to the fact that the use of 3D graphics computer technology at the lessons (on the section "Musculoskeletal system. Skeleton) facilitates improving the effectiveness of acquisition of the learning material by the pupils with intellectual disability – in terms of its remembering and stability of acquisition.

In order to reveal the differences between immediate testing results just after the lesson and delayed testing on previously learned material we used the *Mann–Whitney* U test (Table 1). We supposed that the presence of differences between immediate testing results just after the lesson and delayed testing results shows the lesser degree of effectiveness of material acquisition by the pupils as it would bring about fast loss of the acquired knowledge, and short term character of remembering the material learned at the lesson. The absence of significant differences will mean, on the contrary, that computer technologies facilitate better, i.e. more stable acquisition of the learning material.

The results presented in the table made it possible to reveal differences in testing results of the pupils with intellectual disability on the lesson topics which were conducted without using the 3D graphics computer-assisted technology – "Structure of the cell" ($U = 7.5$; $p < 0.01$), "Chemical composition of the cell" ($U = 20.0$; $p < 0.05$), "Tissues. Organs" ($U = 18.0$; $p < 0.01$), and "Systems of organs. Organism" ($U = 15.5$; $p < 0.01$).

Table 1

Statistical data of differences between testing results of pupils with intellectual disability after the lesson and delayed testing (*Mann–Whitney* U test)

Lesson topics	**Rank Sum (testing after the lesson)**	**Rank Sum (delayed testing)**	**U test**	**p-level**
1. Structure of the cell	147.50	62.50	7.50	0.01
2. Chemical composition of the cell	135.00	75.00	20.00	0.05
3. Tissues. Organs	137.00	73.00	18.00	0.01
4. Systems of organs. Organism	70.50	139.50	15.50	0.01
5. Support and movement. Role of the musculoskeletal system	121.50	88.50	33.50	n/a
6. Composition and structure of bones	110.00	100.00	45.00	n/a
7. Skeleton of the head	119.50	90.50	35.50	n/a
8. Skeleton of the body	96.00	114.00	41.00	n/a
9. Skeleton of the limbs	127.00	83.00	28.00	n/a

Thus, our hypothesis was corroborated in relation to all topics. The differences on the topics “Structure of the cell”, “Chemical composition of the cell”, “Tissues. Organs” and “Systems of organs. Organism” indicate that the knowledge acquired by the pupils without the use of 3D graphics at biology lessons is not stable enough and is lost by the next lesson. The absence of differences between such topics as “Support and movement. Role of the musculoskeletal system”, “Composition and structure of bones”, “Skeleton of the head”, “Skeleton of the body” and “Skeleton of the limbs”, on the contrary, testifies to the fact that the learning material presented with the help of the 3D graphics technology has been acquired by the pupils substantially enough: the learning material of the lesson was hardly lost by the next lesson.

The teacher’s observation of behavior of the pupils with intellectual disability during lessons and outside regular hours also allow one to judge about rehabilitation potential of the developed technology. Thus, the pupils’ interest to the subject rose, which is demonstrated by fewer absentees at the lessons of

biology and negative attitude to those pupils who are late for biology lessons. The rehabilitation-educational effect on the cognitive activity of the pupils is seen from the fact that they began to ask the teacher questions on the topic of the lesson, to express surprise at the facts told at the biology lesson and to ask to use the given computer technology at all future lessons. The increase of the level of comprehension of the learning material by the pupils is demonstrated by their commentary of animated videos and the teacher's explanations.

Conclusion

Theoretical review of the use of computer technologies as a means of raising effectiveness of learning of pupils with intellectual disability showed that in recent years, rehabilitation potential of these technologies have not been studied to the full and need further specification. Nevertheless, a number of researchers proved that computer technologies are effective both for teaching children of this category and rehabilitation of their educational capabilities.

Intervention upon academic-cognitive activity of the pupils with intellectual disability by means of 3D graphics computer animation was undertaken with the purpose of raising effectiveness of the teaching methods aimed at acquisition of the natural-scientific field of knowledge difficult for them. Methods of teaching of any school discipline needs constant perfection. Today, application of various computer technologies to the education process, including 3D graphics tools, is one of the means of such improvement.

The computer program described in the article can optimize the process of acquisition of natural-scientific knowledge by children with intellectual disability. It takes into account the peculiarities of perception and acquisition of natural-scientific knowledge by children with intellectual disability and complements the traditional means of explanation of the learning material by the teacher at the lesson. The given computer technology is correlated with the program content of the discipline "Biology" (the topic "Human being") and is fully controllable by the teacher.

With the help of the computer technology worked out by us to ensure the acquisition of knowledge at the lessons of biology on the topic "Human being" by children with intellectual disability we proved the effectiveness of inclusion of such technology as 3D graphics in the education process of a special school. Thus, the analysis of the dynamics of acquisition of the learning material in the course "Human being" by the pupils with intellectual disability using the given technology showed that they demonstrate improvement of not

only the level but also the quality of acquisition of the learning material, and, consequently, our hypothesis that the use of 3D graphics in the special school education process while learning school disciplines raises the level and the quality of acquisition of the learning material by the pupils with intellectual disability has been validated.

We believe that further investigation in this field is perspective in terms of checking the effectiveness of inclusion of 3D graphics in the lessons of geography, vocational training, etc. in the education process of a special school.

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