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The Role of Computer-Based Adaptive Objective Testing in Evaluating Pipils' Knowledge

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ABSTRACT

In work is shown experimentally research effects applications model computer-based adaptive testing (CAT – Computer Adaptive Testing) in relation to on classical testing in middle school professional education , with special in retrospect on subject Serbian language . Research is conducted in secondary vocational schools - Electrical Engineering field in Belgrade , at representative sample out of 237 students different classes and educational profile . Developed is original software model adaptive testing – Test Learning System (TLS), which is applied in teaching process for valuations student's achievements . Research is implemented in two Phases : first everything carried on comparison results classical and CAT testing within one subject (Programming), while is other encompassed different teaching subjects in more class . By analysis results obtained in both phases established is yes CAT-TLS model brings to better ones achievements student , senior number high assessment and reductions number insufficient . Obtained data indicate on importance applications contemporary technology and personalized valuation approaches knowledge , as well as need for further implementation of e- Tests in education practice .

Keywords: computer-based adaptive test , e- Test , evaluation , education , learning , testing , students , secondary school

I. INTRODUCTION

Considering the importance of learning and education, not only during formal education through primary, secondary school and/or college, but also throughout life (lifelong learning) with the aim of career advancement and continuous improvement of knowledge and skills, there is a permanent effort to monitor technical and technological innovations in this field.Analyzing the education system and the process of educational work, we come to the conclusion that the education system has not changed adequately, and that changes are necessary. In the traditional educational process, the role of the teacher is mainly reduced to the frontal form of work, presenting the teaching content and evaluating the results of the students' work. Communication is, for the most part, one-way, "downstream" in each lesson, i.e. information flows from the teacher to the student.

There is little "upstream" communication, where information flows from students to teachers, and almost no horizontal communication, where students exchange information with each other. The teaching approach does not apply individualization according to achievement levels, i.e. the ability levels of students.The use of computers in the process of testing (examining) students has long been present in practice. Several different models have been developed around the world that support computer adaptive testing (CAT), which allows testing to be adapted to the current knowledge of students. Computer adaptive testing as a model seeks to assess the knowledge and skills of students based on a relatively small number of questions.

By studying current CAT models used in the world and considering their advantages and disadvantages, this paper describes the original model of computer adaptive testing (Test Learning System - TLS), which is based on proven theoretical assumptions and a research model, applied in practice to students of secondary

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vocational schools - Electrical Engineering. Based on this model, a specialized application was created that was used in the methodological research conducted in this paper, and whose task was to justify or refute the hypotheses defined in the research process at the very beginning of the work.

Research methodology

The subject of this research is the conception, modeling, implementation of the model and verification of the e-Test (on a representative sample of 237 participants - students in the experimental group) for the objective evaluation of the results of their work, with special emphasis on computer adaptive testing (CAT). Considering that in an adaptive test, the question that follows is conditioned by the results of the previous question, after which the control expression forms the further course of execution, i.e. asking questions. From the above, it can be concluded that with this type of knowledge testing we include a personalized model of knowledge testing.The aim of this research is primarily to create a software solution for objective evaluation of student work results using CAT testing. The idea is that during the preparation phase, the software solution will enable teachers to define questions as simply as possible, both in terms of form and content. From the knowledge base (question base), a method of asking questions will be created based on algorithmic models so that in the end the most objective grade is obtained as a measure of work evaluation.

Plan for implementing the research procedure
The experiment consists of two parts on a representative sample of **237** students.

The first part was conducted on a sample of **6** classes, a total of **146** students of the **second** grade of secondary vocational schools, field of study "Electrical Engineering", educational profile "Electrical Technician of Information Technologies". The students took the final test, planned by the curriculum and syllabus for the subject "Programming" in two ways, classic testing and the application of computer adaptive testing.

The second part was conducted on a sample of **4** classes, from all grades (I_1, II_1, III_1 and IV_1) one class each in different subjects:

- I_{1st} grade final test in "Mathematics", **24** students took it;
- II_1 grade – final test in "Electronics", **22** students took it;
- III_1 grade - final test in "Web programming", **24** students took it;
- IV_1 grade – final test from "Database", **21** students took it;

The total sample of students on whom the entire research was conducted is **237** students. The research procedure is carried out based on the designed and formed phases:

I. The phase is represented by **the classic way of testing** ;
II. The phase is represented by a method of **computer adaptive testing;**

Implementation of the first phase of the experiment – part I of the research

Students were tested in the first phase through a standard method of knowledge assessment, using an appropriate test and a pen/pencil. The form of the test questions was of different weights, on the basis of which the method of evaluation (scoring) was formed. For the sake of easier generation of final grades, and in accordance with the Rules on Evaluation, the sum of the points of all questions is exactly 100 points. All students received 15 identical questions, with 5 questions carrying 5 points each, 5 questions carrying 8 points each, and 5 questions carrying 7 points each, for a total of 100 points. Negative evaluation of the work results was excluded.

The time articulation was planned for 45 minutes. After that, the review of the papers and the formulation of the final results were started, which consumed another 6 to 7 hours of active review. In addition to the concentration for reviewing the papers, it is necessary to enter each achieved

Implementation of Phase II of the experiment – Part I of the research

The same students were tested using computers, in computer laboratories, using a computer adaptive model. Knowledge testing was conducted in computer laboratories. All students used in the research phase were trained and previously prepared for this type of knowledge testing, familiarized with the working environment, user interface, in order to avoid unnecessary stress and fear of the difficulties of knowledge testing and "unknown situations". This type of adaptation also depends on the age of the students. The younger the age, the longer the adaptation.

The initial probabilities were taken from the values obtained based on the testing results after the first phase of the experiment (based on classical testing). After the completed CATAfter testing, a new evaluation of the model

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was automatically performed, i.e. new probabilities were calculated.

Analysis and interpretation of research results

Experimental results – Part I of the research

Table 1 shows the structure of the final grades of second grade students on the final test in "Programming", after **classical testing** , and Chart 1 shows the distribution of those final grades. The average grade after the testing is: **satisfactory (2.43).**

Table 1: Grade structure after **classical** testing

Rating	**Number of students**
insufficient (1)	**38** students
sufficient (2)	**46** students
good (3)	**33** students
very good (4)	**18** students
excellent (5)	**11** students
Total:	**146 students**

The results of **the classical** testing of Part I of the experiment are shown in Chart 1.

Chart 1 : Distribution of grades after **classical testing**

Table 2 shows the structure of the final grades of second grade students on the final test in "Programming", after **the CAT-TLS testing** , and Chart 2 shows the distribution of those final grades. The average grade after the testing is: **good (3.03).**

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Table 2: Score structure after **CAT-TLS** testing

Rating	**Number of students**
insufficient (1)	**21** students
sufficient (2)	**36** students
good (3)	**47** students
very good (4)	**27** students
excellent (5)	**15** students
Total:	**146 students**

The results of **the CAT testing of** Part I of the experiment are shown in Chart 2.

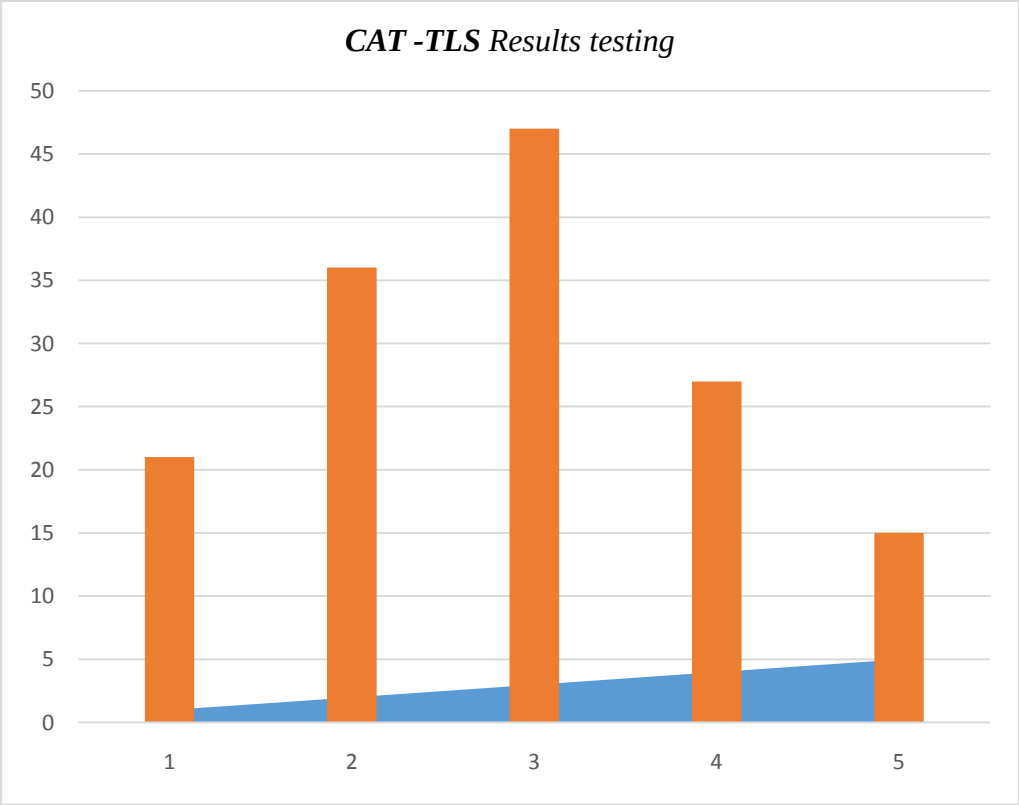

Chart 8.2: Distribution of scores after **CAT-TLS testing**

Table **3 shows** a comparative view of the grade categories after each of the experimental phases. It can be concluded that during the CAT-TLS testing, **50%** of students achieved level II. Most students achieved success, receiving level II grades.

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Table 3: Comparative view of rating categories after testing

Category (levels)	rating	Number of students tested on the final test			
		Classical testing		CAT testing	
And	1	38	**26%**	21	**14%**
	2	46	**32%**	36	**25%**
II	3	33	**23%**	47	**32%**
	4	18	**12%**	27	**19%**
III	5	11	**7%**	15	**10%**

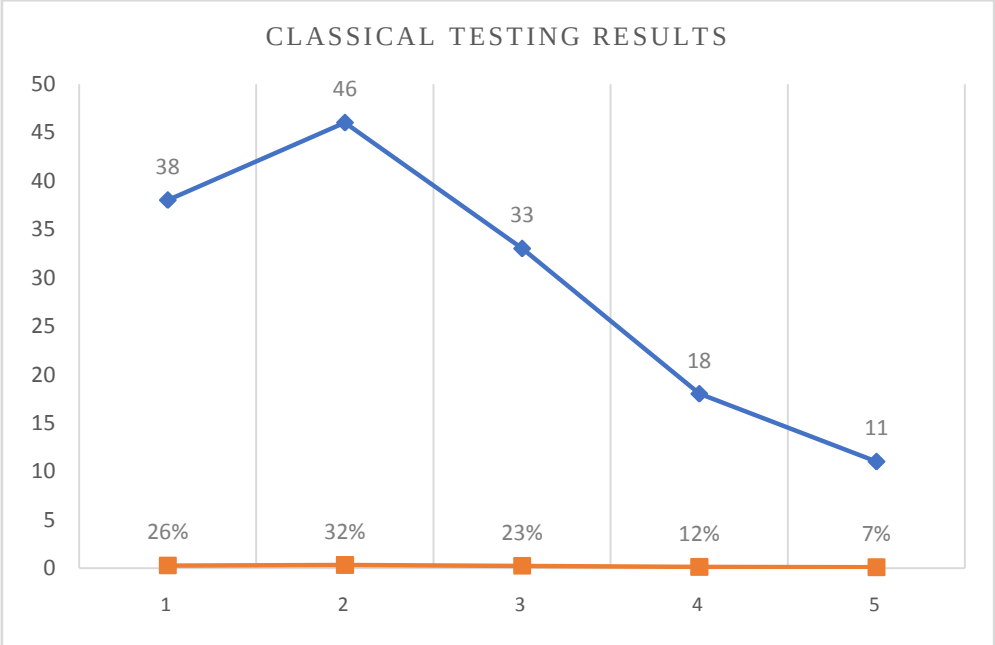

Chart 3 : Classic testing results

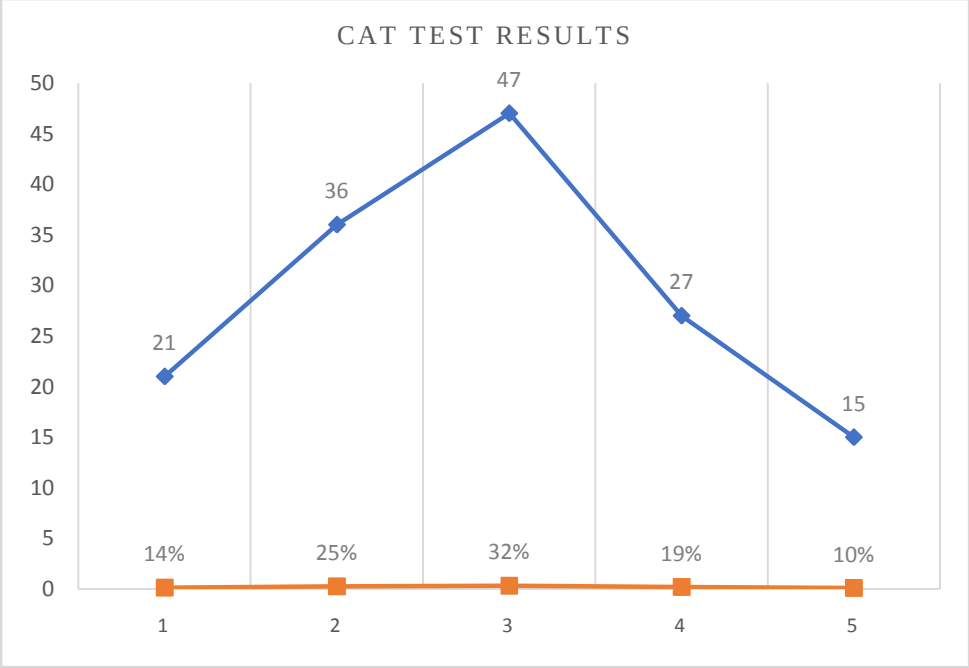

Chart 3a : SAT test results

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Experimental results – Part II of the research

FINAL TEST FOR FIRST GRADE STUDENTS – "MATHEMATICS"
- classic testing -

Table 4 shows the structure of final grades after **the classical** testing of first grade students (24 students) on the final test in the subject "Mathematics", and Chart 4 shows the distribution of those final grades. The average grade is: **good (2.50).**

Table 4: Grade structure after **classical** testing

Rating	**Number of students**
insufficient (1)	**8** students
sufficient (2)	**6** students
good (3)	**3** students
very good (4)	**4** students
excellent (5)	**3** students
Total:	**24 students**

The results of **the classical testing** of part II of the experiment are shown in Chart 4.

Chart 4: Distribution of grades after **classical** testing

FINAL TEST FOR FIRST GRADE STUDENTS – "MATHEMATICS"
- CAT-TLS testing -

Table 5 shows the structure of final grades after **CAT-TLS** testing of first grade students (24 students) on the final test in the subject "Mathematics", and Chart 5 shows the distribution of those final grades. The average grade is: **good (2.79) .**

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Table 5: Score structure after **CAT-TLS** testing

Rating	**Number of students**
insufficient (1)	**6** students
sufficient (2)	**4** students
good (3)	**7** students
very good (4)	**3** students
excellent (5)	**4** students
Total:	**24 students**

The results of **the CAT-TLS** testing of part II of the experiment are shown in Chart 5.

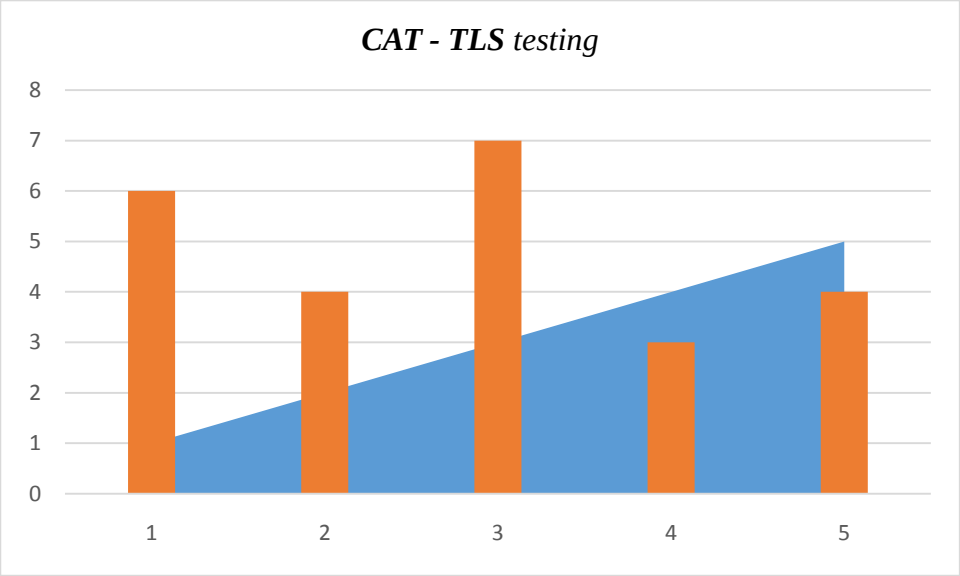

Chart 5: Distribution of scores after **CAT-TLS** testing

FINAL TEST FOR SECOND GRADE STUDENTS – "ELECTRONICS"
- classic testing -

Table 6 shows the structure of final grades after the **classical** testing of second grade students (22 students) on the final test in the subject "Electronics", and Chart 6 shows the distribution of those final grades. The average grade is: **satisfactory (2.09).**

Table 6: Grade structure after **classical** testing

Rating	**Number of students**
insufficient (1)	**9** students
sufficient (2)	**6** students
good (3)	**4** students
very good (4)	**2** students
excellent (5)	**1** student
Total:	**22 students**

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The results of **the classical testing** of part II of the experiment are shown in Chart 6.

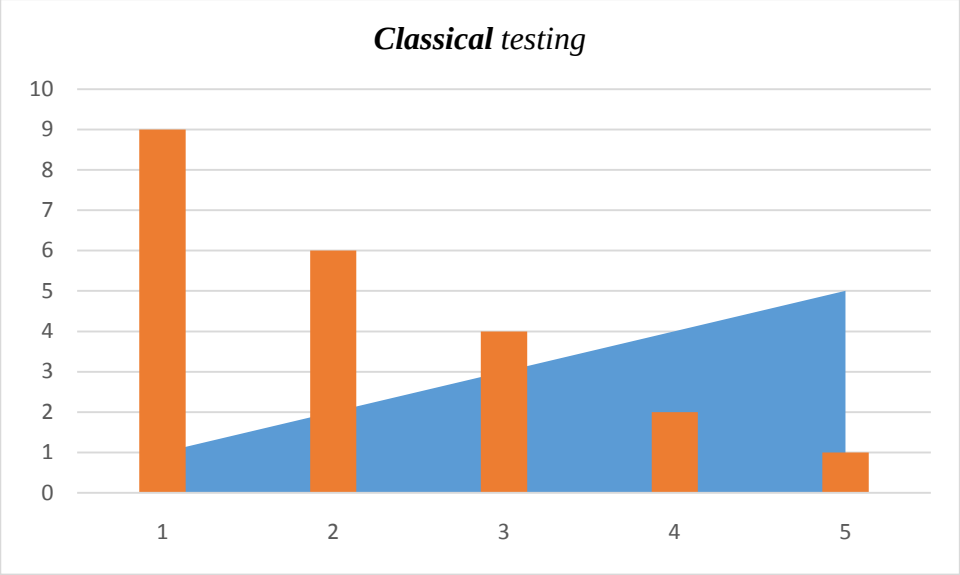

Chart 6: Distribution of grades after **classical** testing

FINAL TEST FOR SECOND GRADE STUDENTS – "ELECTRONICS"
- CAT-TLS testing -

In the TableFigure 7 shows the structure of final grades after **the CAT-TLS testing** of second grade students (22 students) on the final test in the subject "Electronics", and Figure 7 shows the distribution of those final grades. The average grade is: **good (2.68).**

Table 7: Score structure after **CAT-TLS** testing

Rating	**Number of students**
insufficient (1)	**6** students
sufficient (2)	**5** students
good (3)	**5** students
very good (4)	**2** students
excellent (5)	**4** students
Total:	**22 students**

The results of **CAT-TLS** testing of part II of the experiment are shown in Chart 7.

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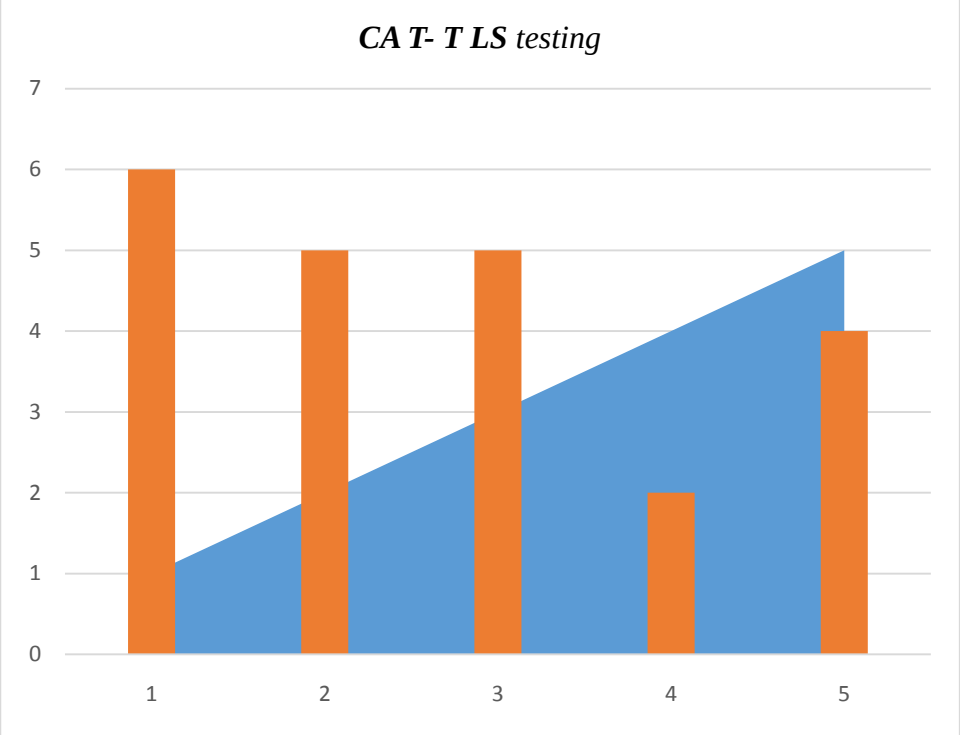

Chart 7: Distribution of scores after **CAT-TLS** testing

FINAL TEST FOR THIRD GRADE STUDENTS – "WEB PROGRAMMING"
- classic testing -

Table 8 shows the structure of final grades after **the classic** testing of third grade students (24 students) on the final test in the subject "Web Programming", and Chart 8 shows the distribution of those final grades. The average grade is: **good (2.83).**

Table 8: Grade structure after **classical** testing

Rating	**Number of students**
insufficient (1)	**4** students
sufficient (2)	**6** students
good (3)	**7** students
very good (4)	**4** students
excellent (5)	**3** students
Total:	**24 students**

The results of **the classical testing** of part II of the experiment are shown in Chart 8.

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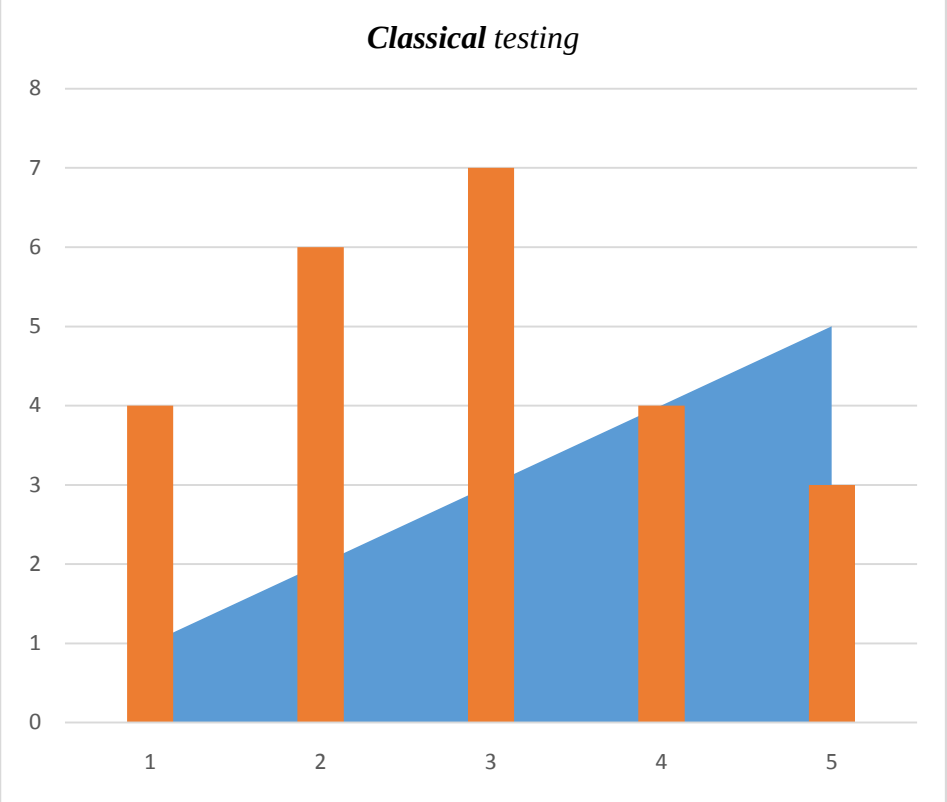

Chart 8: Distribution of grades after **classical** testing

FINAL TEST FOR THIRD GRADE STUDENTS – "WEB PROGRAMMING"
- CAT-TLS testing -

Table 9 shows the structure of final grades after **CAT-TLS** testing of third grade students (24 students) on the final test in the subject "Web Programming", and Chart 9 shows the distribution of those final grades. The average grade is: **good (3.41)**.

Table 9: Score structure after **CAT-TLS testing**

Rating	**Number of students**
insufficient (1)	**1** student
sufficient (2)	**5** students
good (3)	**5** students
very good (4)	**9** students
excellent (5)	**4** students
Total:	**24 students**

The results of **the CAT-TLS** testing of part II of the experiment are shown in Chart 9.

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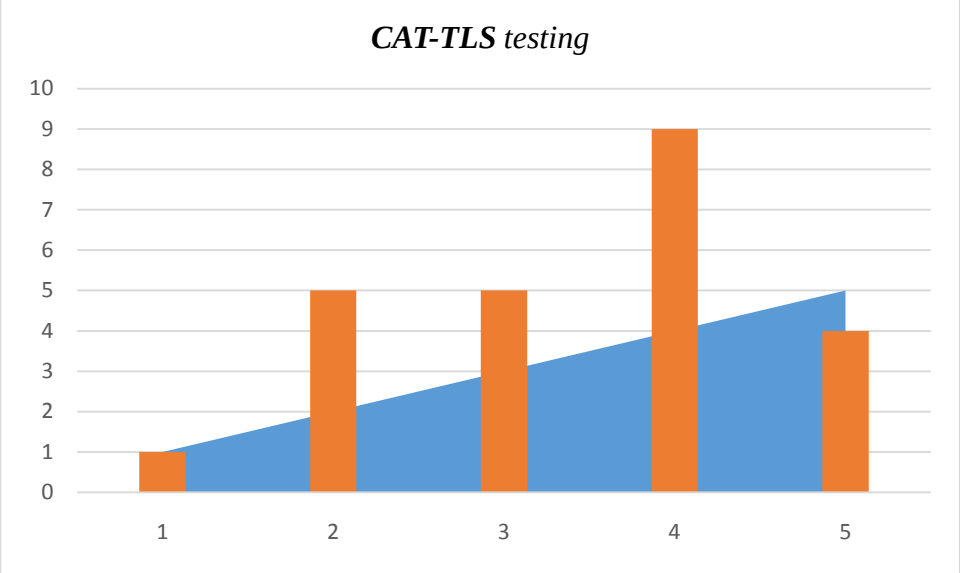

Chart 9: Distribution of scores after **CAT-TLS** testing

FINAL TEST FOR FOURTH GRADE STUDENTS – "DATABASES"
- classic testing -

Table 10 shows the structure of final grades after **the classical** testing of fourth grade students (21 students) on the final test in the subject "Databases", and Chart 10 shows the distribution of those final grades. The average grade is: **good (2.51).**

Table 10: Grade structure after **classical testing**

Rating	**Number of students**
insufficient (1)	**6** students
sufficient (2)	**6** students
good (3)	**4** students
very good (4)	**2** students
excellent (5)	**3** students
Total:	**21 students**

The results of **the classical testing** of part II of the experiment are shown in Chart 10.

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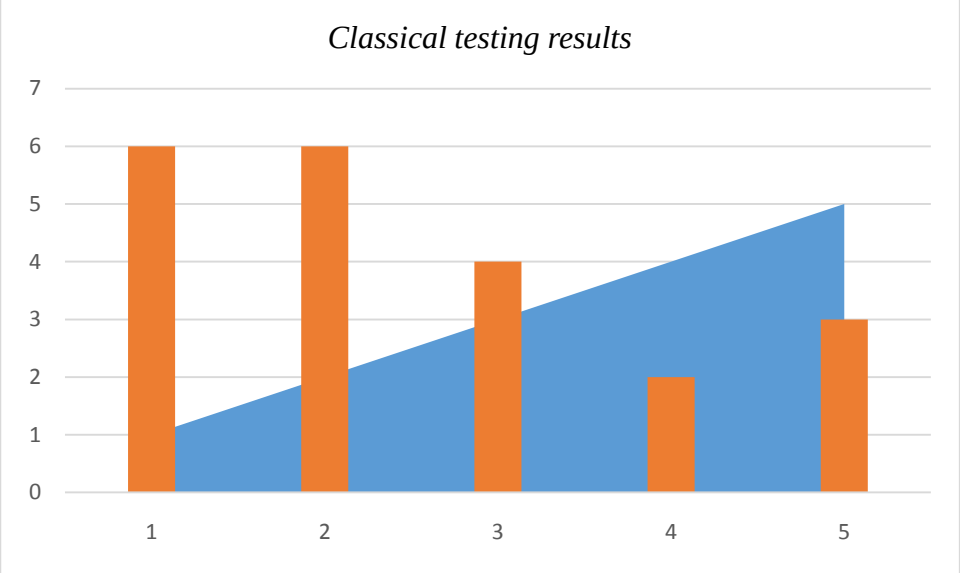

Chart 10: Distribution of grades after **classical testing**

FINAL TEST FOR FOURTH GRADE STUDENTS – "DATABASES"
- CAT-TLS testing-

In the TableFigure 11 shows the structure of final grades after the **CAT-TLS** testing of fourth grade students (21 students) on the final test in the subject "Databases", and Figure 11 shows the distribution of those final grades. The average grade is: **good (3.28)** .

Table 8.11: Score structure after **CAT-TLS** testing

Rating	**Number of students**
insufficient (1)	**2** students
sufficient (2)	**4** students
good (3)	**6** students
very good (4)	**4** students
excellent (5)	**5** students
Total:	**21 students**

The results of **CAT-TLS** testing of part II of the experiment are shown in Chart 11.

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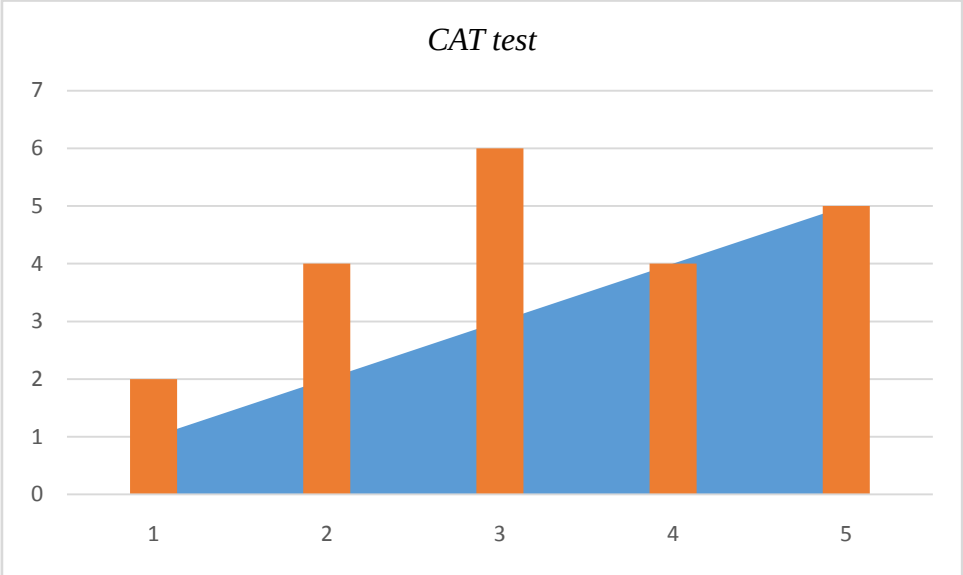

Chart 11 : Distribution of scores after **CAT-TLS** testing

Class	Subject	Number of students	**Classical testing**	**CAT testing**
			Average grade	Average grade
2nd grade	Programming	**146**	**2.43**	**3.03**

Table 12: Results of the conducted research, **phase I of the experiment:**

Chart 12 shows a comparative view of the results of **the classical** and **CAT-TLS** testing of the first phase of the experiment, and it can be concluded that CAT-TLS testing was successful and achieved better results.

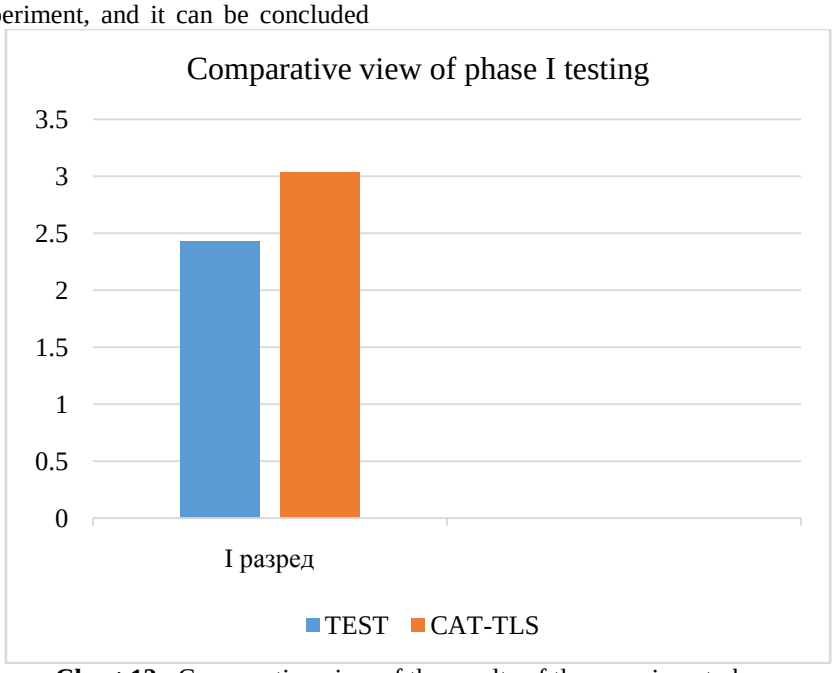

Chart 12 : Comparative view of the results of the experiment phase

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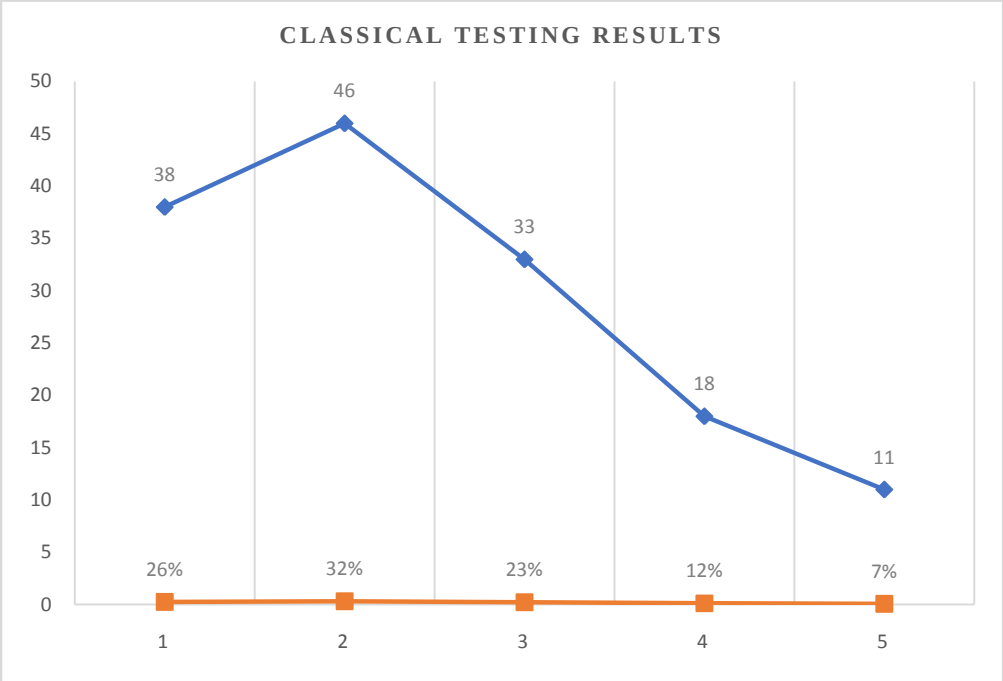

Chart 12.1 : Comparative view of the results of the experimental phase

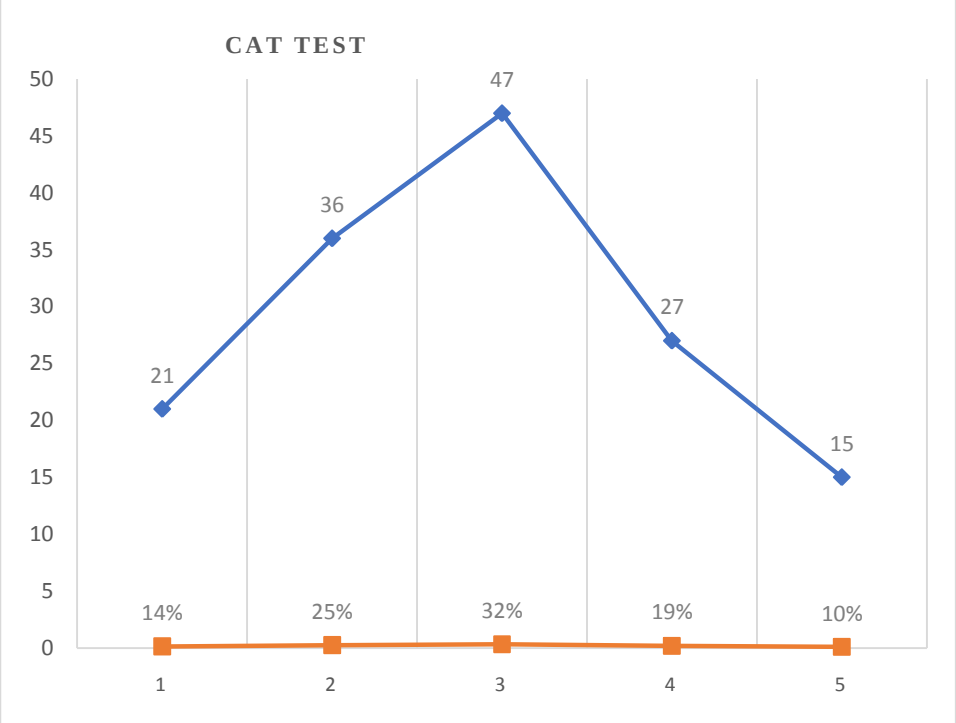

Chart 12.2 : Comparative view of the results of the experimental phase

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Class	Subject	Number of students	**Classical testing**	**CAT testing**
			Average grade	Average grade
First grade	Mathematics	24	**2.50**	**2.79**
2nd grade	Electronics	22	**2.09**	**2.69**
Grade III	Web programming	24	**2.83**	**3.41**
Grade 4	Databases	21	**2.51**	**3.28**

Table 13: Results of the conducted research, phase II of the experiment

Chart 12 shows a comparative view of the results of **the classical** and **CAT-TLS testing of the II phase of the experiment, and it can be concluded that CAT-TLS testing** was successful and achieved better results .

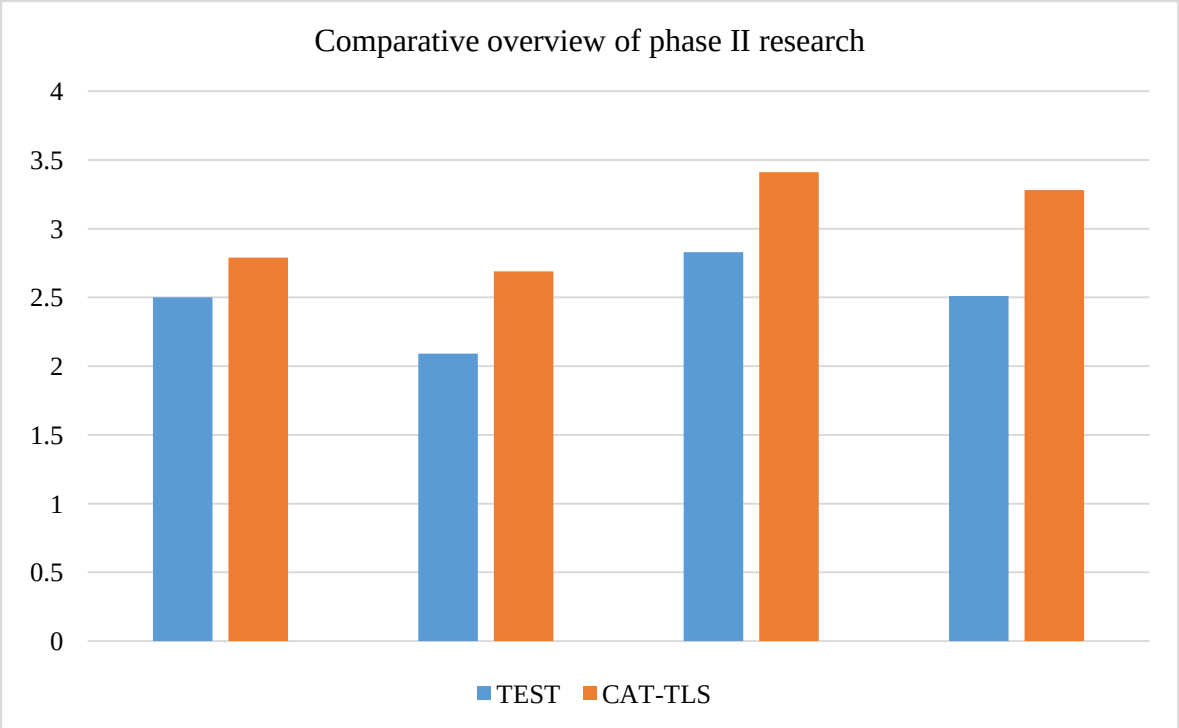

Chart 12 : Comparative results of **the classical** and **CAT-TLS Phase II experiments**

II. CONCLUSION

Results implemented research clearly indicate on advantages applications computer-based adaptive testing (CAT-TLS) in relation on classic way checks knowledge students . In all subjects and classes in which is carried out experiment , established is growth average grades after application of the CAT model , as well as reduction number insufficient rating . Especially is significantly what adaptive approach enables adjustment levels weight questions individual abilities student , which everything achieves bigger objectivity and motivation student during testing.CAT-TLS model is showed potential yes transforms process evaluations knowledge , improving myself quality teaching process . Students which are were engaged in research showed are better results , with reduced anxiety on the occasion testing , which confirms importance

adjustments exam environments needs contemporary student .

On basis these results , recommends everything further development , upgrading and application of CAT testing in a wider context educational context , as well as training teacher for creation content and application adaptive tests in the classroom practice . Improvement system evaluations directly affects on quality education and better preparedness student for contemporary company knowledge .

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