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**INFORMATION EDUCATIONAL SYSTEMS FOR TESTING
AND MONITORING STUDENTS' KNOWLEDGE**

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Abstract

The experience of implementing information technologies in higher education system shows that the educational capabilities of this process can significantly improve the level and quality of training of future specialists. In the context of the implementation of modern information technologies in the educational process, the automated control of all aspects of the learning process is an important element. The purpose of the study is an analysis of the current state of the test control of students' knowledge, study of the existing computerized testing systems for monitoring knowledge and comparative analysis of some of them. The article describes the relevance of systems for testing and monitoring university students' knowledge. The analysis of the educational capabilities of computerized testing based on literary sources is performed. Based on the developed criteria, well-known testing software for monitoring knowledge and skills of students is analyzed and rated. The conditions for ensuring the objectivity of testing results are determined.

Keywords

University – Educational process – Testing – Computerized testing systems – Testing software

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Introduction

One of the most important elements of the modern educational process is the assessment of students' learning achievements. A significant increase in the volume and complexity of the information to be learned by students, with unchangeable learning periods and an increase in the self-learning activity, requires adequate changes in the system for the assessment of learning achievements S. G. Grigorev, V. V. Grinshkun¹.

The problem of quality control of knowledge and analysis of assessment results is quite relevant; therefore, recently automated systems for assessing knowledge have been intensively implemented into the education system, which allows obtaining a qualitative characteristic of learning, reduce and optimize the control process and organize adaptive learning management U. B. Umarova².

The focus of educational software on self-learning determines the need for such a component that allows a user to control the effectiveness of the learning activities and to compare the achieved training level with standards and requirements. Such a component is usually a built-in system of automated control of educational progress, which assesses the user's educational progress using testing.

Literature Review

Based on the analysis of pedagogical literature and teaching practice of recent years, special significance of the intentional development of the quality control of students' learning achievements using computerized testing has been clearly revealed. In their practice, teachers often use computer-based learning systems, which allows automating the routine work of monitoring students' knowledge. These include educational and testing programs, simulators, interactive environments, virtual laboratories, etc. Their importance in increasing students' motivation for learning and enhancing cognitive work has been proven by many researchers I. V. Robert, I. Kh. Galeev, V. G. Ivanov, D.L. Khramov, O. V. Kolosov, Thurlow M., Lazarus S. S., Albus D., Hodgson J³. Their assistance in unloading the teacher is obvious and clear. The economic reasonability of using computerized testing of students' knowledge is justified on the basis of the analysis of actual time spent by the teacher G.D. Bukharova, A.V. Kozlova⁴. The advantages of computerized adaptive testing in the educational process are described in works by foreign authors Čisar S.M., Radosav D., Markoski B., Pinter R., Čisar P⁵, Okocha F., Toluwani T. E., Owolabi S.⁶, Jimoh R. G., Yussuff M. A, Akanmu M. A, Enikuomelin A. O., Salami I. R.⁷.

¹ S. G. Grigorev and V. V. Grinshkun, *Informatizatsiya obrazovaniya. Fundamentalnye osnovy: uchebnik* (Tomsk: TML-Press, 2008), 286.

² U. B. Umarova, "Ispolzovanie kompyuternogo testirovaniya v podgotovke kadrov", *Young scientist* num 8 (2014): 887-889.

³ I. V. Robert, *Teoriya i metodika informatizatsii obrazovaniya: Monografiya*. (Moscow: IIO RAO, 2007); I. Kh. Galeev; V. G. Ivanov; D. L. Khramov and O. V. Kolosov, *Kompyuternyi kontrol znaniy (lokalno i distantsionno)* (Kazan: KGTU, 2005) y M. Thurlow; S. S. Lazarus; D. Albus and J. Hodgson, *Computer-based testing: Practices and considerations*. (Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes, 2010).

⁴ G. D. Bukharova and A. V. Kozlova, "Model metodiki vnedreniya web 2.0-tehnologii v organizatsiyu samostoyatelnoi raboty studentov", *Education and science* num 5 (2012): 96–107.

⁵ S. M. Čisar; D. Radosav; B. Markoski; R. Pinter and P. Čisar, "Computerized adaptive testing of Student Knowledge", *Acta Polytechnica Hungarica* Vol: 7 num 4 (2010): 139-152

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Despite many years of experience in Russian and world education in implementing automated control based on computerized testing, this effective method is not fully applied. Despite the relevance of this problem, at present, unified requirements and norms for software of this class have not been formulated and their classification is carried out in accordance with the implementation of knowledge control process, namely M. L. Gruzdeva, L. N. Bakhtiyarova⁸:

- systems focused on passing tests with further monitoring by the teacher;
- computerized testing systems with the results known in advance.

The systems of the first type have existed for a long time and have a number of disadvantages: the inability to automatically process test results, low speed of processing the results and lack of objectivity in testing assessment. All this leads to the fact that systems of the first type are used less often. As for systems of the other type, their main advantages include automated processing of the results, ensuring the objectivity of knowledge testing by avoiding the influence of the human factor, increased efficiency of testing, as well as the possibility of a centralized analysis of the quality of students' training, reducing the cost of the organization and conduction of testing Bodmann S. M., Robinson D. H.⁹

Another aspect of knowledge testing systems is the use of the Internet information network, which allows finding almost any information without leaving home or university building. Considering this, the creation of a testing system based on Internet infrastructure is a promising and urgent task. In addition, the territorial distance of universities, international integration of the educational process and rapid development of the Internet lead to the fact that any local models of testing systems are ineffective and unvital D. A. Ivanchenko¹⁰.

In the software market, there are a lot of systems of distance knowledge testing Karadeniz S.¹¹, Chua Y. P.¹². Each of them has its advantages and disadvantages. Therefore, it is necessary to analyze the relevant applications and identify the possibility to use them for testing students' knowledge.

⁶ F. Okocha; T. E. Toluani and S. Owolabi, "Student Perception and Acceptance of Computer Based Testing: A Case Study of Landmark University Students", *Journal of Digital Innovations & Contemporary Research in Science, Engineering & Technology* Vol: 5 num 1 2017:25-32.

⁷ R. G. Jimoh; M. A. Yussuff; M. A. Akanmu; A. O. Enikuomihin and I. R. Salami, "Acceptability of Computer Based testing Mode for Undergraduate Students Courses in Computer Science", *Journal of Science Technology. Mathematics and Education* Vol: 9 num 2 (2013): 12-20.

⁸ M. L. Gruzdeva and L. N. Bakhtiyarova, "Pedagogicheskie priemy i metody raboty prepodavatelei vuza v usloviyakh informatsionnoi obrazovatelnoi sredy", *Theory and practice of social development* num 1 (2014): 166-169.

⁹ S. M. Bodmann and D. H. Robinson, "Speed and performance differences among computer-based and paper pencil tests", *Journal of Educational Computing Research* Vol: 31 num 1 (2004): 51–60.

¹⁰ D. A. Ivanchenko, "Rol Internet-prostranstva v formirovanii obrazovatelnoi informatsionnoi sredy", *Distance and virtual learning* num 2 (2011): 19-30.

¹¹ S. Karadeniz, "The impacts of paper, web and mobile based assessment on students' achievement and perceptions", *Scientific Research and Essay* num 4 Vol: 10 (2009): 984–991.

¹² Y. P. Chua, "Effects of computer-based testing on test performance and testing motivation", *Computers in Human Behavior* num 28 (2012): 1580–1586.

Research hypothesis

The use of computerized testing is an effective and relevant method of testing knowledge, which saves the teacher's time, arouses the interest of students, encourages them to study the material well and allows receiving an objective assessment and self-assessment of student's knowledge. However, every testing system has its advantages and disadvantages.

Proposed Methodology

General description

The following research methods were used in the research:

- theoretical: analysis and generalization of theoretical, research and methodological sources on the studied problem;
- empirical: 1. comparison and classification of the analyzed software testing systems; 2. expert survey aimed to identify conditions for ensuring the objectivity of testing results.

The comparison and classification of the analyzed computerized testing systems were carried out according to the formed criteria: determination of the level of the user's training; effective system to replenish the knowledge base; independence from the user's location; continuation of testing after disconnection from the webserver; output and comparison of testing results; possibility of use in the educational process; use of built-in interactive tools; commercial use.

The main criterion for choosing these programs was their accessibility for teachers who do not have programming skills.

Thirty-eight university teachers took part in the discussion, comparison and rating of software testing systems, as well as in the expert online survey.

Algorithm

At the first step of the study, the analysis of scientific literature (Fig. 1) was conducted on the problem of using information systems for testing and monitoring students' knowledge.

At the second step of the study, the software testing systems were compared and rated. The expert survey was conducted on the conditions for ensuring the objectivity of testing results.

Flow chart

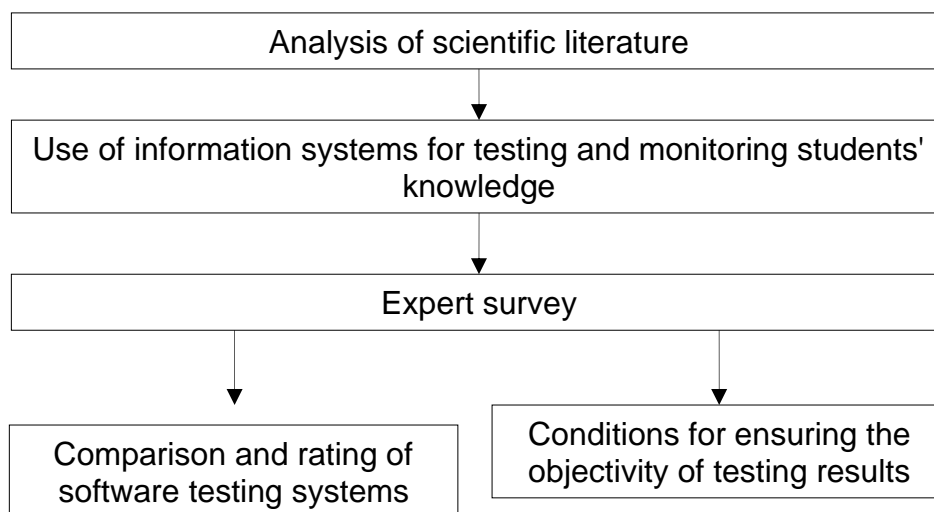


Figure 1
Analysis of scientific literature

Result Analysis

Results

Based on the above criteria, the experts analyzed and rated well-known testing software for monitoring students' knowledge and skills.

The results of the comparison of the analyzed software are shown in (Table 1.)

	MOODLE	Neyron	SinteZ	OpenTEST	USATIK	Argus-M	WEB-Thesaurus
Determinatin of the level of user's training	+	+	+	-	+	+	-
Effective knowledge base replenishment system	+	-	+	+	+	+	+
Independence of territorial location	+	+	+	-	+	+	+
Continuation of testing after disconnection from the webserver	+	-	-	+	-	-	-
Output and comparison of testing results	+	+	+	-	+	+	+
Possibility to use in the educational process	+	-	+	-	-	-	-
Use of built-in dialogue tools	-	-	+	+	+	-	-
Commercial use	-	-	+	+	-	+	-
Overall rating (according to the experts)	1	4-6	2-3	7	2-3	4-6	4-6

Table 1
Comparison of students' knowledge testing systems

MOODLE has a “Tests” module. Tests can be created in the system itself or imported from a special structured text file.

The “Tests” module provides the teacher with the opportunity to develop tests with questions of various types. The teacher can allow several testing attempts; questions can be mixed up or randomly selected from the question bank. A time limit may also be set. Each attempt is assessed automatically, except for such tasks as essays, with a record in the rating journal. The teacher can choose to provide students with tips or show feedback and the right answers to questions.

The MOODLE distance learning system allows creating the following types of tests: with the choice of one correct answer; with the possibility of multiple choice; determining compliance; giving the correct sequence; open type (short answer, essay); right/wrong type; getting a numerical answer.

Open tests are checked by the teacher; tests of other types are assessed automatically.

SinteZ is an interactive knowledge testing system consisting of three role modules. The “Director of Studies” module carries out preparatory administrative work, “Teacher” manages tests and edits the questions, “Student” starts the testing process. The system features include the ability to sort tests according to topics, use animated effects for questions and testing scripts, as well as create reports on testing results.

The disadvantages of the system are the inability to export and import question files and edit tests in the program environment.

USATIK (Universal Automated Testing and Control System) is designed to create tests in real time with the support of the WYSIWYG mode (What you see is what you get). A feature of the system is the flexibility of testing modules with a developed user interface; they can work both in file-server and client-server modes with the possibility of detailed statistics.

The disadvantages of the system include its compatibility only with Windows systems, which significantly limits its use in educational institutions with UNIX-like platforms, and absence of any guarantees of proper operation due to free use.

Neyron is an open testing system used to check the knowledge of users in the context of the educational process. This system is a joint development of teachers and students of Moscow State University and is intended mainly for self-assessment of students.

The disadvantages of the system are its inability to be used in the educational process due to an ill-designed system for assessing knowledge and a betting pool for questions incompatible with the educational process, as well as the inefficient system of replenishing the knowledge base due to free access by any user.

Argus-M is a testing system implemented as a PHP module. The functionality of the system is determined by the ability of Apache server, which is used to store control and methodological materials and testing results. A feature of the Argus-M system is the

ability to generate a certification task based on a set of rules combined into Certification Scheme, which defines about 30 parameters: the description of the testing field, from which the task will be generated; the rules for choosing questions; the restrictions on the number of questions and possible answers; the rules for navigation and display of certification; the access restrictions, etc. This scheme allows creating various certification tasks, which are easy to reproduce in case of repeated certification.

The disadvantages of the system are the inability to create and edit personal certificates, lack of support for W3C WAI and commerce use.

WEB-Thesaurus is a client-server knowledge testing program, created based on WEB-technology with a developed user interface. A feature of the system is the ability to test the user's knowledge using Internet communication channels, which provides the ability to perform tasks regardless of the user's territorial location. WEB-Thesaurus is based on LAMP technology (Linux-Apache-MySQL-PHP). The role of the client part is performed by any Internet browser (WEB browser).

The disadvantages of the system are the mistakes in test tasks, the inefficiency of the system for counting scored points, as well as the low level of protection, which significantly worsens the level of users' testing.

OpenTEST is a computerized knowledge testing system designed for the final quality control of learning the theoretical material. The system is used for final testing and qualification tests. A feature of the software is a developed security system during testing: the protection against password guessing, the inability to work simultaneously with the same identifier and the use of a secure SSL data transfer protocol.

The disadvantages of the system are the underdeveloped system for assessing the complexity of questions and, as a result, inaccurate results, which can only be used for internal testing.

Discussion

According to the experts, the distance form of testing and monitoring students' knowledge requires systematic and regular study of the material and, for this reason, the study level of each content module should be checked. In this case, it becomes important to ensure the objectivity of both intermediate and final assessment.

On the one hand, the problem of objectivity is associated with the level of responsibility of the student, providing the opportunity to study by independently, and also, as the experts emphasize, with resolving the student's identification and implementation of the necessary control procedure.

Currently, methods used for identifying computer users are based on the use of passwords and (or) specialized devices (smart cards, electronic keys). The experts note that the use of such security systems has revealed their disadvantages. Often passwords are intercepted and specialized devices are stolen or faked. There are situations when one of the users deliberately passes the password to an unauthorized person. For example, in distance education during testing, students are ready to replace themselves with a person more familiar with the studied subject.

Therefore, as the interviewed experts note, the task is to create a flexible system of control over the intermediate testing procedure, which would stimulate a student to conduct honest and objective control of knowledge, as well as identify and take measures for irresponsible students.

According to the experts, all existing systems can be divided into intramural control systems (on-line or synchronous mode), when a student is monitored either in the classroom or in a distance mode, and extramural (off-line or asynchronous mode). If in the first case, all problems are solved by the teacher or observer, then in the second case, there are problems of identification of the person who is allowed to testing and the possibility of post factum control of the testing procedure itself.

According to the experts, leading foreign educational systems Coursera, EdX and others rest this responsibility on the test-taker, who is primarily interested in the knowledge quality. "Code of Honor" of Coursera prohibits copying answers, so discussions between students should not contain an exchange of answers, but only useful comments.

Unfortunately, according to one of the experts (Vladimir P.), the features of the educational process in Russia (and in other post-Soviet countries) do not allow using this method, which results in the problem of identifying the person tested by the system.

In addition, such control systems, according to the experts, should satisfy the following requirements:

- availability of the protocol of passing tests by the student, with saving all the answers for further analysis;
- availability of statistics for test tasks with saving all possible answers which were obtained as a result of testing;
- adaptive choice of the next question depending on the correctness of the student's previous answers;
- ability to create different tasks from one set of questions.

Using the system containing such components will make the learning process student-centred since when working with the system, the education process is transformed into self-education. A student will acquire knowledge individually, based on their capabilities and abilities depending on the level of already formed knowledge Adeyinka T., Bashorun T.¹³

As the experts note, the advantage of the synchronous mode is that the teacher or authorized observer personally identifies the student's identity and monitors the testing procedure. At the same time, this is also a disadvantage, because it makes all students get in touch with the teacher at a fixed time. The number of students who should be controlled is also a problem. As a rule, online video conference tools allow connecting with a limited number of participants. Server software (MS LYNC) requires the installation on users' computers or the presence of students in special communication centers.

¹³ T. Adeyinka and T. Bashorun, "Attitude of Undergraduate Students towards Computer Based Test International", Journal of Information and Communication Technology Education Vol: 8 num 2 (2012): 35-45.

To solve this problem, the experts propose a system of intermediate distance testing with photo and video recording of the process.

Taking into account that testing of different students can take place according to different schemes, the off-line control system proposed by the experts is combined with a criterion (indicator) assigned to each student, which is called a “confidence rating” (CR).

Depending on CR, a student can pass testing either by themselves in a self-testing mode at any place and any time, in accordance with the established requirements, or in the information and communication center (ICC) in the presence of an employee of this center or at the university.

CR can have the following values:

- CR=2 is the highest CR for a student who performs all steps of the educational process in accordance with the existing requirements and does not commit violations and abuses when passing current tests using photo and video recording mode, at least for the whole academic year. A student with CR=2 has the right to pass **intermediate and final** tests by themselves at the time determined by the schedule of the educational process using photo and video recording mode. CR=2 is assigned by a special commission based on the student's application and analysis of their learning activities (performance of tests, term papers, passing intermediate and final tests, etc.) for the previous academic year. The decision of the commission is announced on the website of the department.

- CR=1 is a high CR, assigned at the beginning of the education in the 1st year. A student with CR=1 has the right to pass **intermediate** tests by themselves with the mandatory use of video recording mode (self-testing mode);

- CR=0 is a reduced CR, which is assigned when identifying violations committed by the student when passing intermediate tests or when refusing to use photo and video recording mode for testing procedure. A student with CR=0 is required to pass intermediate tests only at the ICC in the presence of a responsible employee of the Center;

- CR=-1 is an unsatisfactory (negative) CR, which is assigned for a student who has systematically violated testing rules of both **intermediate and final** tests at the ICC. A student with CR=-1 is required to pass intermediate tests at the central (basic) university or at the ICC in the presence of a university teacher using video conference (as for the final control).

According to the experts, at the beginning of the educational process at the university, all students are assigned CR equal to one. In the future, based on the analysis of passing intermediate tests by the information system of distance learning, the employees of the corresponding dean's office and teachers, by decision of the dean of the department can change a student's rating downward with canceling grades that were received with violations, while informing the student about this.

Restoring the original CR or its increase are possible only in a new academic year on the student's personal application addressed to the dean of the department. As CR may vary during learning, the authorized persons should have constant information about the performance of testing. In this case, the check of the password, fingerprints, voice, etc. allows identifying only the beginning of control by the relevant person, but not its course.

The system proposed by the experts provides for constant control of a person and testing process using periodic photo and video recording (at a randomly selected time interval). The resulting photos are an integral part of the testing protocol. At the beginning of off-line testing (which is performed from a student's personal page in the university system), a student sets up a web camera so that the image matches as much as possible the photo in the database. Next, the window with the image of the web camera can be hidden, but the periodic recording of the image passes occurs by a student. If there is no camera installed on the computer, the system notifies the student of the impossibility of a self-testing with $CR=1$ and assigns $CR=0$ for the current session. In this case, it is mandatory to identify the password of the person (teacher, methodologist) who is responsible for the testing process of this student. A student with $CR=0$ is tested in the same way.

After finishing testing, the test protocol is sent to the teacher-tutor page for approval or cancellation. It contains all information about the student, their photo, phone and email, as well as information about the subject (developer). The protocol also contains general testing results, assessment and its time. Then, there are photos of the whole testing procedure and analysis of the answers to each test task. Any image can be enlarged for a more detailed analysis. According to the experts, such a protocol provides the teacher-tutor with the information answering the following questions:

1. whether the control event was passed by the person who was supposed to take it;
2. whether the testing process took place independently;
3. what test tasks caused the greatest difficulties;
4. whether there were any mistakes in test tasks;
5. how quickly the student answered this test;
6. if testing was carried out at the Center, the teacher can compare the testing time with the work schedule of the Center and the responsible employee.

If the teacher-tutor doesn't doubt the protocol, they approve it. Otherwise, a detailed review of the committed violations is sent to the student and the testing results are canceled. Such cases are recorded by the system and sent for consideration to the department management serving as the reason to change a student's CR to a lower one.

Also, according to the experts, it is possible to expand the system in the direction of automatic analysis of answers to each type of question, questions on each topic, as well as form testing strategy depending on the answers that the student gave to previous questions. All this, as well as the possibility of recording the procedure in a video mode with sound, will make testing a perfect and objective tool for monitoring the level of students' knowledge Abylkasymova A. E., Popei-ool S. K., Shishov S. E.¹⁴, Abylkasymova A. E., Ryzhakov M.V., Shishov S. E.¹⁵, Ryzhakov M.V., Abylkasymova A. E., Shishov S. E.¹⁶.

¹⁴ A. E. Abylkasymova; S. K. Popei-ool and S. E. Shishov, "On The Theory Of Personal Identification In The System Of Continuous Pedagogical Education (Analysis Of Foreign Experience)", Bulletin of the National Academy of Sciences of the Republic of Kazakhstan num 3 (2019): 186-198.

¹⁵ A. E. Abylkasymova; M. V. Ryzhakov and S. E. Shishov, "A Retrospective Analysis Of The Reforms Of The Content Of General Secondary Education: How They Contribute To The

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Conclusion

The results of the study confirmed the hypothesis that the use of computerized testing is an effective and relevant method of monitoring knowledge, which saves the teacher's time, arouses students' interest, encourages them to study the material well and allows an objective assessment and self-assessment of student's knowledge. However, each of the testing systems has its advantages and disadvantages.

The analysis of software for testing knowledge shows that not all of it is fully suitable for solving scientific and practical task of testing users' knowledge according to the formed criteria. Its commercial use makes the task of designing a new system relevant.

The proposed off-line control system with periodic photo and video recording of the testing procedure allows solving the problem of student's identification and provides information to the teacher-tutor about the content of test tasks, their validity and the level of learning theoretical material achieved by each student. However, it contains incentives that increase students' interest in fulfilling all requirements for objective self-control of the knowledge level and allows taking measures in relation to students who violate this procedure. Thus, the proposed system is able to turn self-control into an objective transparent procedure, the assessment for which can surely be included in the final cumulative assessment on the subject R.M. Abdulaeva, V.P. Bikbulatova, R.S. Rabadanova, G.N. Yulina, M.Sh. Gereeva¹⁷, I.V. Nekrasova, R.S. Rabadanova¹⁸.

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¹⁶ M. V. Ryzhakov; A. E. Abylkasymova and S. E. Shishov, “About The Lessons On The Development Of State Educational Standards In The Russian Federation And The Republic Of Kazakhstan”, Modern Journal of Language Teaching Methods Vol: 9 num 1 (2019): 625-636.

¹⁷ R. M. Abdulaeva; V. P. Bikbulatova; R. S. Rabadanova; G. N. Yulina and M. Sh. Gereeva, “Psikhologo-pedagogicheskie tekhnologii v realizatsii prakticheskoi napravlenosti obrazovatelnoi sredy vuza”, Espacios Vol: 38 num 40 (2017).

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