

# The Usage of Modern Information Technologies for Conducting Effective Monitoring of Quality in Higher Education

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## Summary

Information technologies in higher education are the basis for solving the tasks set by monitoring the quality of higher education. The directions of applying information technologies which are used the most nowadays have been listed.

The issues that should be addressed by monitoring the quality of higher education with the use of information technology have been listed. The functional basis for building a monitoring system is the cyclical stages: Observation; Orientation; Decision; Action.

The monitoring system's considered cyclicity ensures that the concept of independent functioning of the monitoring system's subsystems is implemented. It also ensures real-time task execution and information availability for all levels of the system's hierarchy of vertical and horizontal links, with the ability to restrict access.

The educational branch uses information and computer technologies to monitor research results, which are realized in: scientific, reference, and educational output; electronic resources; state standards of education; analytical materials; materials for state reports; expert inferences on current issues of education and science; normative legal documents; state and sectoral programs; conference recommendations; informational, bibliographic, abstract, review publications; digests.

The quality of Ukrainian scientists' scientific work is measured using a variety of bibliographic markers. The most common is the citation index.

In order to carry out high-quality systematization of information and computer monitoring technologies, the classification has been carried out on the basis of certain features: (processual support for implementation by publishing, distributing and using the results of research work).

The advantages and disadvantages of using web-based resources

and services as information technology tools have been discussed.

A set of indicators disclosed in the article evaluates the effectiveness of any means or method of observation and control over the object of monitoring.

The use of information technology for monitoring and evaluating higher education is feasible and widespread in Ukrainian education, and it encourages the adoption of e-learning.

The functional elements that stand out in the information-analytical monitoring system have been disclosed.

## Key words:

*modern information technologies, information and computer technologies, web-oriented resources and services, conducting effective monitoring, quality of higher education, systematization, classificatio.*

## 1. Introduction

To be able to obtain objective information on educational issues of interest to public authorities and consumers of educational services, the quality of higher education is monitored. It keeps track of the quality of education, its status, the state of the educational process, higher education institutions' scientific and pedagogical activities, students' contingent and academic successes, and the development of young professionals' professional abilities.

Modernity emphasizes one of the primary conditions for high-level monitoring of higher education quality - the use of information technology. This is the most important aspect in influencing the competitiveness of higher

education institutions as a whole. Information technology is considered as a process that can use the means, methods of collecting, processing, transmitting data to obtain new quality information about the state of the object, process or phenomenon [14].

## 2. Analysis of recent research and publications

Theoretical and practical aspects of monitoring education, monitoring as a technique of increasing the quality of the educational information management system, monitoring as a tool for evaluating educational quality, monitoring as an information basis in the quality system of education, teacher, student are studied by such scientists: A. Bosak (2011) Prerequisites for the formation of a systematic approach to management [2]; I. Gyrylovskaya (2020) Theory and practice of assessing the quality of future skilled worker training [6]; G. Dmitrenko (1999) Strategic management in the education system [5]; I. Tavlui (2011) Features of using a systematic management approach in the development and implementation of a higher education quality management system [18].

Y. Bobalo, Y. Danyk, L. Komarova and others in the monograph «Monitoring of objects in the presence of a priori uncertainty about information sources» developed a monitoring system with spatio-temporal instability of its parameters based on Cloud technologies, able to function effectively in conditions of a priori uncertainty about the quantitative composition and type, motion parameters, spatial distribution, informativeness and availability of data sources on the external environment. A set of intelligent measuring devices for monitoring and data collection has been developed [13].

The article «Problems of Distance Learning in Specialists Training in Modern Terms of The Informative Society During COVID-19» considers the training of specialists in education in the conditions of distance learning. It lights up the advantages of distance learning and determined the characteristic features of distance learning of students training in the implementation of these technologies in the educational process [9].

O. Semenikhina, A. Yurchenko, A. Sbruieva and others (2020) in the article describes the results of quantitative analysis of open educational resources in the field of information technologies. The study is based on the analysis of the content of ten platforms which provide access to open resources. To achieve the goal, the following methods were used: theoretical (analysis and generalization of Internet sources to determine the popularity of educational platforms and resources on them); quantitative data analysis to determine the relative share of IT-courses on different parameters (the relative share of IT-courses in

general and on each platform, in particular, the language of teaching, quantitative content in the thematic areas) [16].

H. Plysenko the paper «Applying information technology in monitoring the quality of higher education under integrative system of competitive advantages application: theoretical and methodological aspects» suggests theoretical and methodological substantiation for providing monitoring of the quality of higher education through the use of information technology. The role of modern information technologies in higher education quality monitoring has been explored. An effect from monitoring the higher education quality on the integrative system of competitive advantages application is revealed and theoretically evaluated [14].

I. Vorotnykova reveals ways to use ICT to monitor and evaluate knowledge in e-learning. The article outlines the possibilities of using ICTs to monitor and evaluate knowledge in e-learning. The study of e-resources that can be utilized in e-learning for knowledge monitoring and evaluation, as well as the circumstances for their use in schools, is carried out. Programs and online tools for monitoring and evaluating students' knowledge were identified based on the results of the instructor survey. ICT provides the opportunity to monitor evaluation not only in computer classes, but also with the introduction of mobile phones, tablets that are connected to the Internet. The variety of free programs and services enables each teacher to choose the means for use at different stages of the classroom, with the ability to organize feedback on the students and monitor their knowledge [19].

O. Spirin in the article «Information and communication technologies for monitoring of scientific research results implementation» the issue of monitoring the implementation of scientific research findings is considered; it is presented the indicators of the monitoring for psychological and educational researches using web-based ICT tools. The fundamental ways of estimating the academics' writings impact, research groups and editions, including peculiarities of the use of scientometric indicators such as citation index and impact factor are analyzed. Based on the technologies and means of monitoring disclosure, dissemination, and use of published results, a classification of information and communication technologies for monitoring research results implementation was developed. The use of several web-based ICT tools for monitoring the application of psychological and educational research outcomes has been described. [17].

L. Komarova in the article «Organization of the complex monitoring situation informatively of communication cluster in a crisis situation». This paper examines current scientific challenges in developing methodological support for the organization of integrated monitoring, data

collection, and processing under a priori uncertainty of information sources' spatial location, temporal parameters of operation, structure, source information type, and accuracy. The reliability, efficiency and completeness of obtaining primary data, quantitative and existential consumers' distribution of monitoring results in conditions of information redundancy, significant dynamics of the situation, as well as the COP flow's density, have been considered [7].

V. Kotelianets. «Information Technology for Environmental Monitoring Based on Internet of Things Concept». Thesis is devoted to solving the urgent and important scientific and technical task of developing stochastic information technology for monitoring environmental parameters in the modern Internet of Things concept, taking into account the sources of information's a priori ambiguity and the possibility of impending crisis situations [8].

The purpose of this article is to discover how modern information technologies can be used to successfully assess the quality of higher education.

### 3. Research methods

To achieve this objective, the following research methods have been used: theoretical (analysis of philosophical, pedagogical, psychological literature), which allows to justify the starting points of the study; interpretive-analytical method, on the basis of which sources are studied with the use of synthesis, analysis, systematization and generalization.

### 4. Results

For efficient monitoring of higher education quality, educational system transformations based on the application of new information technologies are required.

Information technologies in higher education is considered to be the basis for solving the set tasks by monitoring the quality of higher education. Here are the areas of using information technology that are mostly applied nowadays: computer programs, training expert systems, training systems; systems based on multimedia technology, built using video equipment; information environments based on databases that allow direct and remote access to information resources; telecommunication systems that allow the use of e-mail, teleconferencing and accessing to global communications networks; electronic libraries that provide access to global information resources; geoinformation systems based on technologies for combining computer cartography and database management systems; information protection systems of different orientations, etc.

Monitoring the quality of higher education with the use of information technology should address the following challenges as part of an integrative system for achieving competitive advantages: compliance to higher education standards; to pass according to the current normative-legal documents and provisions; to assist in the development of a model for evaluating higher education quality utilizing modern information technologies; to promote the increase of specializations in specialties that would best meet the modern labor market and the needs of employers; to encourage the growth of scientific and pedagogical staff, as well as the material and technical support of higher education institutions, in order to provide high-quality educational services; establishment of a competitiveness system for higher education institutions in order to attract the maximum number of students [14].

Methodological techniques and methods of processing questionnaires and databases have been created for the analysis of information received within the scope of monitoring higher education quality; Initial analytical table models, schemes, graphics, and practical procedures for calculating each analytical table indication have been established. The main directions of higher education quality's analysis have been defined based on the acquired indicators. The main condition is that the entire monitoring system should be aimed at solving specific management tasks (Purskyi, 2013).

Information technologies are widely used in various sectors of life of individuals, society, state, and education, and they contribute to the country's technological, economic, social, and cultural levels [3].

It has to be remembered that the effectiveness of the automated monitoring structure depends not only on the implemented system, but also on the basic network environment (the productivity of the used server, the type of network operating system, computer network architecture).

One of the most important needs in the study of any system is to consider the features of system integrity, i.e., it is necessary to account for the peculiarities of its individual pieces, their relationships, and interdependence, as well as to analyze the system as a whole.

The main goal of information system modernization is to produce the necessary data to monitor higher education, which is required for effective resource management, the creation of an information and technical environment for higher education institution management, and the formation of a better system for monitoring the educational sector's development in modern economic conditions [1].

Electronic resources are increasingly exploited in obtaining the results of scientific research, scientific and

technical products. There is a clarification, as well as an expansion of the types and content of information tools for monitoring, implementing outcomes, and developing scientifically sound procedures, methodologies, and techniques of application. There is a need to use the latest monitoring technologies in the field of pedagogical sciences to solve theoretical and methodological problems of using information technology in education, and also justification for the development among these technologies for the proper functioning and development of educational systems. As a result of this work, electronic educational resources have been created. They are divided into: electronic resources for educational purposes, electronic resources to support research, electronic resources for management purposes. Based on this, the issues of selecting information technologies for monitoring the implementation of psychological and pedagogical research findings, but also identifying acceptable online tools for such monitoring, clarifying their main characteristics and methods of use, become relevant in education. The National Academy of Pedagogical Sciences of Ukraine uses information and computer technology to monitor research achievements in: scientific products (conference proceedings, monographs, collections of scientific papers, etc.); educational products (textbooks, curriculum, manuals, courses, texts, lecture precises, guidelines, textbooks, workshops; video and audiovisual teaching aids, electronic teaching aids); referential products (encyclopedias, dictionaries, directories, catalogs); electronic resources (resources, including websites, web portals); state standards of education; analytical materials; materials to state reports; expert opinions on current issues of education and science, normative-legal documents, government and industry programmes; conference recommendations; informational, bibliographic, abstract, review publications, digests.

The National Academy of Pedagogical Sciences of Ukraine establishes the criteria (prevalence of product information on the Internet; application of products in practice by users) and specifies the characteristics of indicators for tracking the implementation of research findings.

The quality of Ukrainian scientists' scientific work is evaluated using a variety of bibliographic markers. The most common is the citation index.

In recent years, the Hirsch index or h-index is the most popular among citation indices (h-index is the largest value of  $h$  at which  $h$  publications have at least  $h$  bibliographic references).

The impact factor is a metric that measures how important scientific journals are. Its worth is determined by the number of journals in the scientometric database whose publications are counted.

The traditional impact factor (coefficient of influence) is determined over three years as the average ratio of journal article citations obtained in the current year to the total number of articles published in this journal in the previous two years.

Universal impact factor, SJR (SCImago Journal Rank), developed for the Scopus database based on the Google PageRank algorithm to reckon on the importance of links to a particular journal publication.

Indicators determined by the search and scientometric system Google Scholar (Google Academy), are those that form the ranking of the best publications with publications.

The traditional impact factor (coefficient of influence) is determined over three years as the average ratio of journal article citations obtained in the current year to the total number of articles published in this journal in the previous two years (ingathering, processing, safekeeping, promulgation, applying, distribution).

In order to conduct a qualitative systematization of information and computer monitoring technologies it is necessary to carry out classification on the basis of certain indications (processual support for implementation through publication, dissemination and use of research results). Thus, according to the procedural components of their implementation, they are divided into ICT for monitoring the publication, ICT for monitoring the spread and ICT for monitoring the use of research results. The ICT monitoring methods of research results implementation as a way of monitoring the publishing must be regarded in this classification [10].

It is vital to identify the characteristics of the use of web-oriented resources and services as information technology tools that encourage the spread of product information and provide downloads of electronic versions, allow users to browse websites and automate the process of gathering, analyzing, and rendering qualitative and quantitative data.

It is vital to consider web-oriented Internet resources and services, which automate the process of gathering data from users on the facts of research results use. Herewith various web-based services can be used.

The easiest and most accessible is the Google Docs service, which, with the help of the Google Form tool, allows you to create and use electronic forms. This allows: to create questionnaires to assess educational quality; to send invitations to engage in education quality monitoring to respondents' e-mail addresses; to save data from completed questionnaires in the form of spreadsheets in order to measure educational quality; to submit educational quality monitoring data in the form of charts, using Google

or other tools, such as MS Office, having previously performed data import.

Various web-based feedback support services that allow you to publish the results of monitoring the quality of education, as well as comments on such products, can be a data source for monitoring the quantitative and qualitative aspects of product use based on the results of research etc. (in electronic scientific publications developed on the OJS platform, it is possible to use the commenting service of each individual article with comments in the annotation to the article) [17].

With the emergence of wireless sensor networks in the world, such as WSN, this branch of science has gained development and practical applications in almost all areas of human activity. WSN brings new quality in modern systems of receiving, accumulating, processing and transmitting information, monitoring educational activities. Their implementation creates new issues in the field of radio communication and telecommunications process management, which can be addressed through more extensive information technology development. The concept of a *sink network*, which may be WSN, is that information sources that are distributed in space, both fixed and mobile, which can be much a lot, transmit information directly to the base station (data collection center). These are *single-hop networks*. If the network is organized in such a way that it is able to transmit information through other nodes, to some extent indirectly, then it is a multi-hop network[8].

In connection with the development of technology around the world, Ukraine has a task to provide users with a sufficient range of modern scientific information services, which is based on information and communication networks. In order to facilitate the implementation of the market's requirements for information services, there is a need for network architecture, that would compromise the optimization of existing equipment with new technologies. With the help of these requirements, a global information infrastructure has been created, which is based on the concept of networks of the future (FutureNetwork). There have been developed methods of structural-parametric synthesis of complex distributed ergatic information systems for monitoring and accumulation of target information.

The monitoring system includes: sensors; center for accumulation and processing of information with a set of automated workstations; specialized software and mathematical software; telecommunication means.

Management of modern information and communication networks based on next generation network principles is a vital step in organizing educational quality

monitoring and developing an automated management system based on a defined level of functional reliability.

Management systems are aimed at the formation, modification and self-development of a single information space where monitoring processes take place.

The functional basis for building a monitoring system is the cyclical stages: Observation (information gathering from internal and external sources); Orientation (formation of many possible development options, evaluation by a set of criteria); Decision (choosing the best action plan); Action (monitoring and information processing, which are used to put the chosen action plan into practice.).

Several methods of obtaining information are used to monitor certain educational quality objects.

Methods of obtaining primary information implement direct observation at appropriate stations, posts, etc. Remote modes of observation are also used to collect data on the subjects of education quality monitoring.

Methods of obtaining secondary information consist in organizing and processing primary information. The results are fixed in the form of maps, tables, graphs. To summarize information geographic information systems have been used, including special application packages, database management systems. The type of monitoring object determines the mix of technical monitoring measures and can be carried out using technical information and measuring means (systems, complexes).

The following collection of indicators are used to evaluate the efficacy of any means or method of observation and control over the monitored object: selectivity and precision in determining; reproducibility of the produced outcomes determination sensitivity; dynamism (time for measurement, processing and analyzing of results).

Modern systems for monitoring the quality of higher education use an integrated list of primary sources. In order to organize the functioning of the higher education quality monitoring system, the remote monitoring or telemetry approach is preferred, in which the sensory elements receiving primary information are located directly at the controlled objects, and the control center of the education quality monitoring system is far away. This demands the establishment of communication channels, which are divided into: radio systems, which are used to monitor primarily facilities that do not have cable infrastructure; leading line monitoring systems that use the city telephone network as a communication channel; monitoring systems based on channels of mobile communication networks (GSM, CDMA); local area network (Ethernet) monitoring systems; multi-channel quality monitoring systems for higher education.

As a result, methodological support for the organization of comprehensive monitoring of higher education quality, data collection and processing with a priori uncertainty of information sources due to their spatial location, temporal parameters, composition, type of source information, accuracy, reliability, efficiency, and completeness of primary data have been developed. Significant dynamics of changes in monitoring results objectively leads to the need for global-local, spatially-disparate monitoring of facilities within a single system through the solution of partial problems: establishment of theoretical foundations for situational synthesis of higher education quality monitoring system; development of the theory on nonlinear information processing in the system of monitoring higher education quality; enhancing decision-making approach in the system of assessing higher education quality; refining the decision-making technique in the higher education quality monitoring system; establishment of service-oriented systems for assessing higher education quality on the basis of required theoretical foundations (Komarova, 2015).

In Ukraine, using information technology to monitor and evaluate higher education is viable and prevalent, and it encourages the use of e-learning. The phenomenon of e-learning is related to distance learning technologies and mobile learning, cloud calculations. These new technologies enable the flexible use of a large number of given resources and ways [11].

Methods for analyzing and monitoring the quality of higher education are the focus of researchers.

The development of the information society, in which almost every student and teacher has modern gadgets and access to the Internet, helps to increase interest in the use of information technology for monitoring and evaluation of knowledge in education. The most commonly used service is Mytest, which has been updated to MyTestX and consists of a system of programs (respondent testing program, test editor and results log) and can be conducted in a computer class, even without an access to the Internet. The service allows you to create and conduct computer testing, collection and analysis of results according to various criteria. MyTestX works with ten types of tasks: single, multiple selection, matching, true or false statements, manual entry numbers, manual text input, choosing a place in the image, rearranging letters, filling in the blanks. Tests can be created considering the proportionality of the number of questions on different topics according to their complexity. The disadvantage of the program is that newer versions are not free.

There is also Google forms service (requires Internet access) as part of Google Drive office tools. The service is convenient and accessible for conducting a survey or test, it is constantly updated and allows not only to choose the

correct answer, but also to send it by attaching a file. The test can be sent to respondents by e-mail, it can also have embedded spreadsheets. If all respondents are included in the Google class, the teacher can collect data on all assessments and monitor academic achievement over a long period of time using an electronic journal in which students see only their own grades. Herewith, it is mandatory to register respondents on the Testorium and Master-test services. Online systems allow creating your own test libraries and using the other teachers' resources. The service can be used for students' self-assessment. It makes the teacher's job easier and allows pupils to test their knowledge on the internet. The Master-test platform is an educational service for interactive student's knowledge testing. Computers, phones and tablets can be used to quickly get feedback from respondents.

Online service for quick tests - Go Pollock does not require registration of respondents. They can be carried out during the lesson, while doing homework. Integration with Khan Academy allows you to use quality questions in English. In Go Pollock there is an opportunity to organize the cooperation of students with the use of the storytelling method (animated story is proposed, it depends on the responses of the entire group of respondents for its development: the more correct answers - the further the story progresses).

Plickers service (plickers.com) allows you to conduct mobile voting and face-to-face polls during a training session on the studied or current material in test form.

Working with the mobile app takes no more than a few minutes. Instant poll results are displayed on a computer screen (TV, projector) that has Internet access. Respondents do not need smartphones or computers: only a teacher's smartphone (tablet) with Internet access, on which the free Plickers application is installed. With the help of this application you can read QR-codes from paper cards of respondents prepared in advance.

Kahoot service is free and intended for use in the classroom - the teacher shows the questions on the screen, and students answer the questions using computers or smartphones (Android, iOS, Windows Phone). It is possible to group students. To enter the virtual classroom, as in Go Pollock, students need to enter a special code provided by the teacher. The service allows you to build progress diagrams and save the results of each student.

Quizzy allows you to create tests quickly so that can be used with mobile devices or desktop computers, but requires additional payment for use.

QuizOperator is free and allows respondents to easily create and work with tests using QR codes.

Teachers create tests in Excel and PowerPoint, Test-W, Mentimeter.

It's worth noting that only around a third of instructors systematically use information technology in their work to evaluate educational quality and assess knowledge, and introduces in the work e-learning.

You can choose from a wide range of programs and services to assess higher education quality.

The following are the requirements for using information technology to monitor and evaluate knowledge in e-learning: participants' digital competency in the educational process; teachers' readiness to use information technology to monitor and evaluate students, platforms' accessibility, online systems for monitoring and evaluating the quality of education, Internet access [19; 4].

Nowadays, technologies of personal, local, global telecommunication networks are used, which makes it possible to provide a monitoring system for the required area. Object parameter sensors are connected to the data transmission node using personal networks, the data transmission node itself is connected to the server for selection and primary processing of information using local networks (it is possible use of both wired and wireless technologies). Network settings should provide the required level of efficiency, and therefore meet the delay of data transmission. Using worldwide telecommunication network technologies, servers for information selection and primary processing are linked to servers for monitoring data analysis. Together, the sampling and primary processing servers and the monitoring data analysis servers form a two-tier global distributed dynamic monitoring data processing center. The system of monitoring data analysis servers should be fully reserved, reckoning on data copying, as it plays a key role in making management decisions and correcting the behavior of the monitored object.

In the information-analytical monitoring system there are such functional elements that are present in various applied information-analytical systems and differ in subject orientation and focus on different data structures. Such elements are: primary observation input and editing; solving information retrieval and computational-analytical tasks; report production and printing; working with electronic documents; working with spatially bound data; solving poorly structured tasks based on knowledge and multi-criteria assessments. Thus, the technological basis of such systems are the means of formation, data should be tracked in a consistent manner; analysis, aggregation and display of information coming from different sources; transformation, statistical and analytical data processing; evaluation and selection of optimal management solution options based on the decision support system; Using specialized techniques of creating unregulated reports in the

environment, automated formation on regulated reporting and data access; providing regulated access to information to external users of the system. As a result, decision-making information and analytical support systems in the field of global monitoring are a difficult functional complex, in which the main components are: database organization and management tools, geographic information systems, multifunctional analytical processing, analysis and modeling, etc. [13].

## 5. Conclusions

The system of monitoring higher education quality supplies society with trustworthy data on the current state of the education system, allowing it to be improved and function more effectively. The application of new information technology enables for more effective monitoring of higher education quality.

The teacher can automate the assessment of works by monitoring and assessing responders' understanding using information technology, planing educational work, identifying areas where students' knowledge, skills, and abilities need to be improved.

With the emergence of mobile phones and tablets that are connected to the Internet, information technologies enable options to monitor the assessment of higher education quality in computer classrooms.

The development and use of a model for assessing the quality of education in higher education institutions using information technology provides opportunities for further scientific investigation.

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