Application of monitoring of the informational and educational environment in the engineering education system

Dmytro Babenko
first vice rector
Mykolaiv National Agrarian University
Mykolaiv, Ukraine
babenko@mnau.edu.ua

Olena Gorbenko
department of Agroengineering
Mykolaiv National Agrarian University
Mykolaiv, Ukraine
gorbenko_ea@mnau.edu.ua

Ilona Batsurovska
line 2: *dept. name of organization (of Affiliation)*
Mykolaiv National Agrarian University
Mykolaiv, Ukraine
bacurovska@outlook.com

Iana Andriushchenko
department of Production Management and Innovative Activity of Enterprises
Mykolaiv National Agrarian University
Mykolaiv, Ukraine
andriushchenko@outlook.com

Nataliia Dotsenko
department of General Technical Disciplines
Mykolaiv National Agrarian University
Mykolaiv, Ukraine
dotsenkona@outlook.com

Nataliia Kim
department of Agroengineering
Mykolaiv National Agrarian University
Mykolaiv, Ukraine
kim_ni@mnau.edu.ua

***Abstract* — The article considers the possibilities of educational monitoring of the results of training of higher education applicants in the engineering specialties in the terms of the informational and educational environment. The monitoring system of the informational and educational environment includes the monitoring of the work of higher education applicants and the monitoring of the work of professors. The management of the educational process in the informational and educational environment is carried out using statistical data, which are formed as a result of the passing of course and the use of interactive electronic educational tools by higher education applicants. The statistics take into account the attendance of higher education applicants, the review of educational content, the index of discrimination and the easiness factor. On the basis of the received data there is an opportunity to correct the educational content, forms and methods of its submission in the terms of the informational and educational environment. The means of monitoring the training of higher education applicants of engineering specialties in the terms of the informational and educational environment are also considered. These include methods of assessment, analysis of responses and statistics. These tools help applicants and professors to adjust further actions and create educational content.**

Keywords — monitoring, educational results, future specialists in agroengineering, informational and educational environment, engineering education

I. Introduction

Modernization of higher education institutions highlights informatization as one of its priorities, the main task of which is the creation of information and educational environment as a system for managing the process of future engineers' training. Modern electronic systems are expanding the capabilities of engineers' training. Supplementing the classroom work with the means of interactive computer training provides an opportunity to take into account the methods of visualization. Also, due to the use of informational and educational environments, it is possible to systematize and structure information, in particular for self-study. Information and educational environment is aimed at satisfying the needs of users in information services and resources of educational nature, as well as monitoring system quality of engineers' training. Modern monitoring systems of the information and education environment are able to collect and accumulate information on educational outcomes.

II. Problem Statement

A. Defining the problem

The training of future engineers requires a systematic analysis of the degree of knowledge acquisition at different stages of training, the acquisition of competencies in the specialty, encouraging yourself as a specialist for further self-improvement. The presentation of educational content should take into account the degree of complexity of tasks in the context of acquiring competencies and, if necessary, the use of interactive tools for the correction of knowledge of future engineers. Our research provides an opportunity to assert that in the training of engineers, electronic monitoring systems are not used in full, but only fragmentarily. There is a need to study the information and educational environment monitoring system that can be used to improve the quality of engineering education.

B. The purpose of the article

The purpose of the article is to study the possibilities of monitoring in the terms of the informational and educational environment in the system of engineering education.

III. Analysis of Recent Research and Publications.

According to studies of V. Yu. Bykov, I. Zakharova, I. Robert, S. Sysoeva and others. [1, 2], the necessary capacities include appropriate teaching methods in the conditions of the informational and educational environment, because they are capable of providing personalization of training, adaptation to their own abilities of higher education, development of their autonomy and creativity, access to new sources of educational information. In the scientific works of R. Gurevich, M. Kademii, S. Litvinova [3, 4, 5], the informational and educational environment is defined as an educational system that provides openness to learning, its adaptation to the skills of higher education applicants,

development of their autonomy and creativity, access to new sources of educational information, etc. The issue of monitoring the educational process is the subject of research by scientists. V. Bespalko, S. Shishov and V. Kallney are studying the problems of monitoring the quality of stereoschool education; A. Mayorov considers the monitoring in education as a scientific and practical phenomenon in his works. A. Dahin examines the monitoring of success and analyzes the effectiveness of educational work in the outlined context. G. Yelnikova [6] investigates the monitoring of the activities of participants in the educational process. O. Samoylenko investigated [7] monitoring problems within distance education. Kristin Stephens-Martinez, Marti A. Hearst and Armando Fox from University of California, Berkeley considered that quantitative data sources such as grades, although useful, are not sufficient; understanding the activity in discussion forums and student surveys was rated useful for all use cases by a large majority of respondents, chat logs were not seen as useful, for the most part, the same sources of information were seen as useful as found in surveys of smaller online courses, mockups of existing and novel visualization techniques were responded to positively for use both while the course is running and for planning a revision of the course [8]. Some massive open online courses providers, such as the University of British Columbia, pay a small cohort of academic assistants to monitor and contribute to the MOOC discussion forums [9]. But the issue of monitoring the information and education environment in the system of engineering education remains researched insufficiently.

IV. Presentation of the main research material

The purpose of monitoring is to create a basis for the synthesis and analysis of the received information about the state of the educational process and the main indicators of its functioning, for the evaluation and forecasting of development trends, the adoption of management decisions for the achievement of quality of education [10]. Under the term of "monitoring in the terms of the information and education environment" we will understand the collection, storage, processing and dissemination of information on the activities of higher education applicants in engineering specialties in the specified environment, which is built on the basis of the integration of information and computer technology. With the use of a monitoring system, it is possible to control, correctly select the tools, submit the training content, and the electronic learning information developed in this way provides high efficiency. The ability to monitor independently the results of learning activities can improve the quality of knowledge of future engineers. The use of such a system is an analysis of statistical information in the information and educational environment and it is able to provide correction for educational content on the basis of the received statistical information. The general scheme of the monitoring system of the informational and educational environment is divided into monitoring of the work of higher education applicants and professors.

A. The monitoring of the work of professors.

The monitoring of the work of professors consists of monitoring the presentation of the task, the statistics of educational content views, the time interval of the task fulfilment, visits to the information and education environment.

Monitoring of the quality of the presentation of the problem can reveal the current status of the quality of knowledge of higher education applicants of engineering specialties, positive aspects and disadvantages from the point of view of achieving educational goals, taking into account their further improvement. Such monitoring provides an opportunity to analyze the degree of mastering the material within the theme, module, course and respond to the low quality of knowledge acquisition by future engineers.

The quality of the presentation of tasks in the informational and educational environment for future engineers should take into account the index of ease, the index of discrimination, the rate of discrimination. The professor should avoid tasks the results of which can be received by guessing the correct answer, mechanical repetition, etc. [11].

Analysis of statistical data due to the index of easiness is a comparison of the simplicity of one or another task. Indicator of the *Index of Easiness* is the ratio of average values of points gained by the higher education applicants in engineering specialties to the maximum number of points for the assignment. This indicator is a measure of how this task is easy or difficult for higher education applicants.

The Index of Easiness is calculated by the formula:

$$IE_i = {}^{X_{aver.i}}/_{X_{max}} \qquad (1)$$

where ID $_i$ – the Index of Easiness of the task;

$X_{aver.i}$ – the average number of points that all the applicants of higher education can get for the task;

$X_{max\,i}$ – the maximum number of points that is possible to get for the completed task.

The Standard Deviation measures the difference between the points obtained by the applicants when answering a specific test question. For questions that are evaluated with 1 and 0, the maximum is 0.5, when half the higher education applicants respond correctly. If all applicants answer the questions the same way, then the distribution of responses, which is characterized by this parameter, will be zero. This indicates that this question is not a test and therefore should be deleted [11]. The Standard Deviation is calculated by the formula:

$$SD_i = {}^{Y_{k.i}}/_{X_{\max i}} \qquad (2)$$

where SD $_i$ – the Standard Deviation of the task;

$Y_{k.i}$ – the number of points that the applicant of higher education can get for some task;

$X_{max\,i}$ – the maximum number of points that is possible to get for the completed task.

General statistics on the analysis of test questions for higher education graduates in engineering specialties in the informational and educational environment, taking into account the easiness index and the coefficient of discrimination, are presented in Fig. 1.

The Index of Discrimination is a rough indicator of the ability of a specific task to distinguish more successful higher education applicants. By the general result, higher education applicants in engineering specialties are divided into three groups: well-trained, medium-trained and poorly-trained. Each group includes one third of the total number of applicants. This parameter can vary between +1 (all

applicants from the well-trained group responded correctly, and the poorly-trained ones were incorrect) and -1 (applicants from the well-trained group answered incorrectly, and the poorly-trained ones, on the contrary, correctly). The negative value of the index indicates that the higher education applicants from the third group respond to this question better than the applicants from the first group. Such tasks are discarded, as they reduce the accuracy of the entire evaluation procedure.

The Index of Discrimination is calculated by the formula:

$$ID_i = {[X_{strong.i} - X_{weak.i}]}/{N} \qquad (3)$$

where ID $_i$ – the Index of Discrimination;

$X_{strong.i}$ – the sum of fractions of points (scored to the maximum) that received high points;

$X_{weak.i}$ – the sum of fractions of points (scored to the maximum) that received lowpoints;

N – the total number of applicants of higher education.

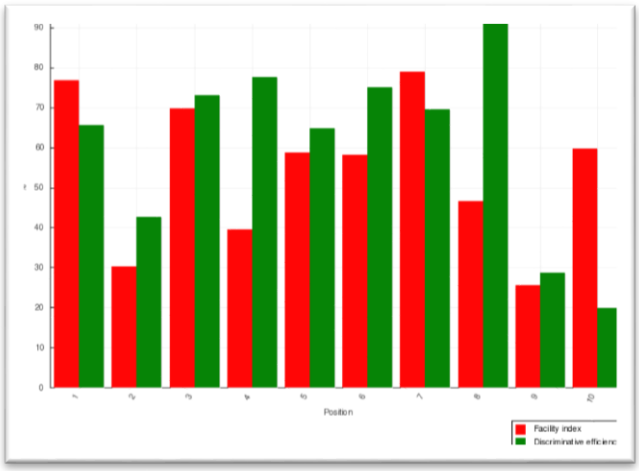

Fig.1 General statistical data on the analysis of test questions for the higher education applicants in engineering specialties in the terms of the informational and educational environment, taking into account the index of easiness and effectiveness of discrimination.

The Coefficient of Discrimination is the correlation coefficient between the set of values of answers received by future engineers in answering a specific question, with the results of their task as a whole. This parameter can also vary between 1 and -1. Positive values are consistent with the issues that really distinguish well and poorly-trained higher education applicants in engineering specialties, while the negative value of the coefficient indicates that poorly-trained higher education applicants are, on average, better respond to this question than those well-prepared. Such tasks should be avoided. The Coefficient of Discrimination is calculated by the formula:

$$CD_i = Sum\,(X \cdot Y) \,/\, N \cdot S_x \cdot S_y \qquad (4)$$

where CD $_i$ – the Coefficient of Discrimination;

Sum (X·Y) – the sum of the multiplication X to Y;

S_x – the standard deviation from the scores obtained in response to the question;

S_y – the standard deviation from the scores obtained in response to the task;

N – the total number of responses to the task.

The advantage of the ratio of discrimination compared with the index of discrimination lies in the fact that the first uses information from the whole amount of higher education applicants, but not only the critical upper and lower thirds of this population.

Monitoring of statistics of educational content views allows to analyze the types of its presentation and provides an opportunity to improve the educational content by regulating the presentation of textual, audio and visual information. Monitoring of the visits to the information and education environment is implemented due to the using of statistical indicators, which include: frequency of viewing educational content, frequency of attendance, index of easiness and effectiveness of discrimination. Monitoring the attendance of information and education environment by higher education applicants in engineering specialties is carried out by monitoring the results of work with interactive electronic educational tools, such as: lectures with audiovisual support, multimedia presentations to practical works, interactive laboratory work, interactive computer training simulators, etc.

The monitoring of the time interval of tasks fulfillment allows to conclude which materials need additional time for refinement, which tasks were performed with the help of additional materials. The optimal structure of educational content, adherence to general guidelines for the design of educational content pages, and recommendations for providing information on the pages of the information and education environment, the design of engineering models, and graphic material of the pages affect the statistics of views [5].

The following indicators are used to monitor the educational process carried out by means of the e-learning system: the activity of higher education applicants in the electronic course, the statistics of the passing of the training programs, the rates of completion of the courses, the evaluation of the results of training.

B. Monitoring of the work of higher education applicants in engineering specialties in the system of informational and educational environment

Monitoring of the work of higher education applicants in engineering specialties in the system of informational and educational environment consists of monitoring the assessments of the tasks performed in the informational and educational environment, the answers of higher education applicants, work with thematic modules, work with theoretical content, practical tasks and training simulators. Monitoring of the work of higher education applicants is characterized by the *Degree of Passing* the course. This degree is calculated for each position such as completed tasks, answers of higher education applicants, the work of higher education applicants with theoretical content, thematic modules, practical tasks, training simulators etc. The Degree of Passing the course is calculated by the formula:

$$S = R \cdot k \qquad (5)$$

where S –the Degree of Passing the course;

k – the coefficient that depends on the quantity of the modules in the course.

$$R = R_1 + R_2 + \ldots + R_n \qquad (6)$$

$R_{1,\ldots,n}$ – the result of performance of tasks by the module.

$$R_1 = \frac{N_{1+}\, N_{2+}\, \ldots . + N_{m.}}{r} \qquad (7)$$

r– the quantity of the tasks in the module;

N_1 – the result of passing the task of the 1st module (in %);

1, 2, …., m – the number of the task.

The result of a task is high if its result is the maximum number of points or the maximum is the acquisition of competencies (from 90 to 100%). The result of the task is

average if the task is performed on the average score or the acquired competence is from 40 to 90%. The result of the task is low if the task is not performed or executed on the minimum score, and the percentage of acquisition of competences is less than 40%.

The result of the task is determined by formula.

$$R = \frac{\sum_{i=1}^{n} Ni_1 + \sum_{i}^{n} Ni_2 + \sum_{i}^{n} Ni_3 + \sum_{i}^{n} Ni_m}{r} \quad (8)$$

Consequently, the degree of distance learning in the informational and educational environment can be determined by the formula:

$$S = k \cdot \frac{\sum_{i=1}^{n} Ni_1 + \sum_{i}^{n} Ni_2 + \sum_{i}^{n} Ni_3 + \sum_{i}^{n} Ni_m)\cdot}{r} \quad (9)$$

The degree of passing the course is given in percentage terms. High Degree of Completion of the course S≥90%; the middle S≤89%; the low S≤39%.

Monitoring of assessment of completed tasks in conditions of informational and educational environment. For each higher education applicant, you can see the quality of the task's fulfilment - done, partially completed, not fulfilled. Such monitoring of process dynamics is presented in a way that allows you to process the test results, analyze and evaluate the quality of each test task or question from the point of view of its complexity, as well as, if necessary, adjust the educational outcomes.

Monitoring of the answers of higher education applicants in engineering specialties in the terms of informational and educational environment. The environment allows you to analyze and process text responses of higher education applicants. Higher education applicants in engineering specialties can review comments on these answers for each task. Higher education applicants in engineering specialties can review comments on these answers for each task

Monitoring of the work of higher education applicants with theoretical content. Based on observations on the frequency of review of theoretical material, one can conclude that the most appropriate forms of theoretical content are multimedia presentations, lectures with audiovisual support, video tutorials, etc.

Monitoring of the work of higher education applicants in engineering specialties with thematic modules. Such monitoring allows to find and individual approach to each higher education applicant in engineering specialties, correct the system of accumulated knowledge. Monitoring the study of the thematic module allows us to analyze the degree of learning content studying by future engineers by studying the results of all the tasks proposed in this module. From the standpoint of independent work, the higher education applicant has the opportunity to assess comprehensively the knowledge obtained for the performed tasks in the module. It is also possible to analyze those aspects that require further study.

Monitoring of the work of higher education applicants with practical tasks allows us to identify the difficulty in performing tasks and, based on these data, pay attention on the problematic points. Also, on the basis of the data on the time of the task, the teacher can choose the most satisfactory results of the higher education applicants and navigate the time of presentation of studying content in the information and education environment.

Monitoring of the work with training simulators. The effective use of tasks for training simulators is facilitated by the monitoring of the use of training simulators by higher education applicants in the terms of the informational and educational environment, where each type of question has its own statistical indicators that allow to determine the frequency of random guessing, the number of attempts, the time of execution, etc.

V. Conclusions and Prospects for Further Research

In the terms of the informational and educational environment it is expedient to monitor the assessment of the performed tasks, the analysis of responses and the work of future engineers with the training modules, theoretical content, practical tasks, training simulators, etc. Indicators of such monitoring are the index of easiness, the index of discrimination and the coefficient of discrimination. Such means of monitoring the information and education environment help to correct further actions and develop educational content that provides the quality of engineering education. The monitoring system of the informational and educational environment includes monitoring of the work of professors and the higher education applicants. On the basis of this information, one can adjust the processes in the information and education environment.

Prospects for further research are the determination of a plan of action for the correction of means and tools and the provision of educational content to the informational and educational environment on the basis of information obtained during the monitoring of the training of future engineers.

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