Analysis Of Results Of Experimental Control Of Information Communication Competency Development Diagnostic Program For To-Be IT-Professionals Via Federal University Information Educational Environment Means

Eremina I.I. [1], Sibaeva G.R. [2], Ishmuradova I.I. [3]

[1] Naberezhnye Chelny Institute (Branch) of the Federal State Autonomous Educational Institution of Higher Vocational Education "Kazan (Volga Region) Federal University" 423812, Russia, Republic of Tatarstan, Naberezhnye Chelny, Mira ave, bldg. 68/19, 423606, Russia, Republic of Tatarstan, Yelabuga, Mira ave, bldg.50, ap.136, ereminaii@yandex.ru

[2] Naberezhnye Chelny Institute (Branch) of the Federal State Autonomous Educational Institution of Higher Vocational Education "Kazan (Volga Region) Federal University" 423812, Russia, Republic of Tatarstan, Naberezhnye Chelny, Mira ave, bldg. 68/19, 423823, Russia, Republic of Tatarstan, Naberezhnye Chelny, H.Tyfana, bldg.18/51, ap.25,sigura2@mail.ru

[3] Naberezhnye Chelny Institute (Branch) of the Federal State Autonomous Educational Institution of Higher Vocational Education "Kazan (Volga Region) Federal University" 423812, Russia, Republic of Tatarstan, Naberezhnye Chelny, Mira ave, bldg. 68/19, 423803, Russia, Republic of Tatarstan, Naberezhnye Chelny, M.Chykova, bldg.30, ap.67,IIIshmuradova@kpfu.ru

Abstract: The article deals with mathematical model of information communication competency development diagnostic program experimental data: module of statistical processing of key components in information educational environment, principles and criteria of estimation of information communication competency elements by means of a professional chart.

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1. Introduction.

One of priority guidelines in the process of modern society modernization is to-be IT-professionals' information communication competency. Nowadays vocationally-orientated education in IT-sphere requires a new approach, therefore in the process of obtaining higher engineering education of any IT-direction a future specialist should get special knowledge and master the information technology successfully.

It is well-known that modern students get through tasks of reproductive character more easily, but they show low level of orientation towards complicated situations and using correct managemental decisions in IT-sphere. This in its turn requires formation of a certain level of students' information communication competency (ICC), allowing them to use ICT to the utmost in conditions of humanity's global computerization[4]. The effectiveness of usage of information technology is evident only when a to-be specialist is motivated for using it, has broad-based knowledge, able to use software tools (of both common and professional purpose), to estimate the role and place of information technology in his/her profession.

2. Methods.

Traditional form of education does not provide sufficient training of a highly qualified specialist who would be able to work in conditions of field's computerization with equipment and technology that change fast. The reason for this is unpreparedness of a modern specialist. That is why it becomes vital to find methods, forms and means of to-be IT-specialists training, which will meet modern requirements[1].

Information educational environment (IEE) is an effective mean for solving such types of problems. One of ways to use IEE is it's being a tool to promote information communication competency development, which allows to draw students' attention to peculiarities of the content they study with the help of concrete examples and processes they are connected with[1].

One of the most famous and widespread systems of e-learning management, which can develop ICC with correct academic supporting, is LMS Moodle (module object-oriented dynamic

learning environment). Moodle is a project which is constantly developing with success. Nowadays on the basis of Moodle system distance and e-learning have been organized in the biggest universities of the world, in 193 countries. Work with IEE on the LMC Moodle platform gives a student an opportunity to get a substantial face-to-face support in his/her learning; a possibility for educational environment to register and assess results of student's individual performance; it has a great impact on student's appraisal of his/her capabilities of advancing in the material under study; provides feedback via hyperlinks which is very much helpful for each student individually; presence of multimedia and interactive technologies in the IEE fundamental considerably increases level of perception of suggested information.

3. Main part.

In Kazan Federal University the IEE on the LMS Moodle basis has been already functioning for several years, so some experience of working with it has been gained, along with observations and conclusions on the IEE's impact on educational process and its active participants – students and teachers. The main method of information communication competency development level check is a summary test of each suggested section and solving of cases.

It should be noted that one of important advantages of the test technology is an opportunity to get objective characteristics allowing to assess quality of tests and their components – test tasks (questions).

These characteristics are considered and justified in the pedagogical measurements theory. The fact that tests and their components are multiply used for large test groups allows to use statistical methods during processing of their results for calculation of a number of characteristics. These values with the help of pedagogical measurements theory can be interpreted for assessing tests quality. The statistics gathering system is based on Rasch metric system, which allows to reason upon pedagogical measurements quality.

However, the problem is that statistical processing of results of tests, calculations and subsequent interpretation of necessary characteristics is quite complicated. This is a serious obstacle for using these characteristics by a wide range of teachers who use tasks in the form of tests in their work, but who are for the most part not specialists in the sphere of mathematical statistics[5].

In this regard one of Moodle learning management system's advantages is that it has native tools for such processing and calculation of different characteristics of tests. Nevertheless, unfortunately, we must state that nowadays very few of teachers know, let alone use these possibilities in practice for assessing quality of their test materials[6].

Let's review the most important (to our mind) characteristics of estimating ICC which are automatically generated by the system Moodle 2.1 after considering the testees' results.

All characteristics are divided into two groups: the first group covers the whole test, the second one relates to each question or questions category contained in a test.

The following values are characteristics allowing to assess the whole test quality.

− *The average score of testees* — the arithmetical average of scores of all students carrying out a test.

$$T = \frac{1}{S}\sum_{s \in S} T_s$$

where *S* is a set of students who carried out a test, *Ts* is a score of an *s*-student's test.

− *Median* is a median value of scores of testees *Ts*. This is the method which served as a basis for creating a summary table of user's test data.

− *Standard error of test estimation* is a generraly accepted degree of variations of gained scores for a concrete test group. It describes a test's discriminating fineness, that is its efficiency in dividing testees in a group according to their attainment level. This characteristic is determined from the formula

$$SD = \sqrt{V(t)} = \sqrt{\frac{1}{S-1}\sum_{s \in S}(T_s - T)^2}$$

− *Coefficients of skewness* and *excess* are measures describing dissimilarity of the structure of distribution of scores gained by testees from normal distribution.

− *Test reliability coefficient* which is also called Cronbach's alpha

$$CIC = 100\frac{p}{p-1}\left(1-(s-1)\frac{\sum_{p \in P}(x_p(s)-\bar{x}_p)}{\sum_{s \in S}(T_s-\bar{T})^2}\right)$$

where *p* is a number of a test task in a set of tasks in a test P.

This is an average scatter of results of each student in the course of answering all questions of a test.

The less scatter of results of each student in the course of answering test questions is in relation to scatter of overall estimates of the whole test, the more concordant test questions are.

− *Standard error* describes the luck factor and shows inaccuracy limit for a student's score for a test:

$$SE = \frac{ER}{100}SD$$

If standard error is 10%, and a student gained 60% of a maximum score, then his/her true score is within the range 50% - 70%.

The pedagogical measurements theory states that in a better test testees' arithmetical average score equals to median value of scores in tasks which are used, coefficients of skewness and excess do not deviate from values of results normal distribution standard curve. It is also good when values of arithmetical average, mode and median coincide. This is a sign of the test's general difficulty level orientation towards testees' level of training. Also coincident average values of scale scores, coefficients of skewness and excess allow to compare results distribution in different tests correctly.

The second group of parameters allows to estimate quality of certain test tasks (questions), which constitute a test.

− *Easiness index* is a part of students (in percent) who answered a certain test question correctly. For a test task No. *i* it is determined from the formula $F_i = \overline{x}_i$, using 100-points rating scale, where averaging is performed for all testees who fulfilled this task.

− *Standard deviation* describes range of testees scores values when answering a certain test question.

− *Score for random guessing* is a score which could be gained by a student for random guessing of answers.

− *Assumed influence* is influence which was planned by a teacher for a test task during composition of a test scenario.

− *Effective influence* shows what influence on students' summary score for a test a certain question has.

The Moodle system tools performed statistical estimation of questions' quality[3].

There is such important statistical characteristic of test tasks' discriminating fineness, which can be estimated by the Moodle tools, as Coefficient of Differentiation (CD). It is recognized that a task has sufficient discriminating fineness if coefficient of differentiation is greater than or equal to 30%.

Analysis of CD value in the case under research showed that 14% of test tasks used in the experiment do not satisfy these requirements (CD < 30%), and what is more, one task has a coefficient value which is negative (-40.69%), and that speaks for evident flaws of the question. Statistical estimation of test questions base allows to improve the test.

The most important characteristic of a test is its reliability, which lies in reproducibility of test results and their accuracy. Reliability coefficient is a correlation coefficient showing coincidence rate of results of one and the same test performed in identical conditions. Test's reliability depends on a measurement error. When there is no error, reliability coefficient is equal to one. If a measured test score is completely based on a measurement error, test's reliability is equal to zero. According to statistical estimation of the test under analysis, error in this case amounted to 5.66%, and internal consistency index amounted to 95.90%.

In view of information about test tasks' quality, which was obtained earlier, test statistical estimation was performed without "unsatisfactory" questions on different parameters.

4. Conclusion.

After considering the analysis results, we can draw the following conclusions:

− in case of tests based on elementary ("easy") questions, known methods of improving reliability do not have expected effect;

− small quantity of tasks in base of questions and in test leads to unreliable estimation of the test's quality and creates conditions for impossibility of using methods of its improvement.

Thus, system of analysis of statistical results of tests in the study course, which is above mentioned and implemented in Moodle learning management network system, can be both effective instrument for educational institution administration to control quality of ICC development diagnostics test materials created by a teacher, and convenient tool for this teacher during refining test and test tasks for improving education quality and academic progress control.

Let's take a look at description and analysis of results of experimental check of using information educational environment of KFU on the LMS Moodle platform and methodology of student's information communication competency level estimation (also in case of a final year student), as exemplified by to-be IT-professionals, who are trained via new generation educational programmes of the federal state educational standard of higher vocational education.

For the purposes of the research pursuance 2 testees groups were organized – 255 students of 4 IT-directions, for diagnostics of ICC development in the course of to-be IT-professionals training according to their future job content.

As an initial assessment of completeness of theoretical knowledge and practical skills in the sphere of computer science and IT, results of USE of "Computer science and ICT" branch were taken. Using of Pearson criterion ($\chi 2$) in comparison of tests of control and experimental groups (table 1) led to the conclusion that groups are uniform. We should

note certain insignificant difference in completeness of students' knowledge and skills depending on time of entering a higher educational institution, which can be explained by demographic conditions and modern schools' orientation towards training of schoolers for USE.

For checking effectiveness of professional ICC development in IT-sphere, teaching materials and implementation of programmer engineer's professional ICC development pedagogical conditions, on the basis of Naberezhnye Chelny Institute of the Federal State Autonomous Educational Institution of Higher Vocational Education KFU we created a professional technological chart. It contains the list of competences which are necessary for an IT-professional and oriented towards ICC development. It points out, concretizes and classifies the most important forms of implementation of requirements for IT-professional's ICC development according to 9 closely related types of competences (in this list I-VI are taken from main educational programmes of higher vocational education in training directions 230700.62 Applied Information Science, 080500.62 Business Computer Science, 010400.62 Applied Mathematics and Computer Science).

For students, a professional technological chart is a preset base of activity oriented towards ICC development. It puts students up to forthcoming work aims, to implementation of which students proceed in proportion to professional advancing, concurrently chosing available methods of problem solving.

As final results (in fourth academic year) we took summary score of ICC development in a student's professional technological chart.

Diagrams 1 and 2 below show that the experimental group students' ICC development is higher than in the control group.

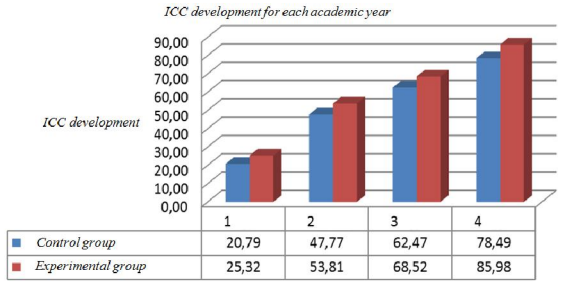

Diagram 1. Results of ICC development in control and experimental groups for each academic year

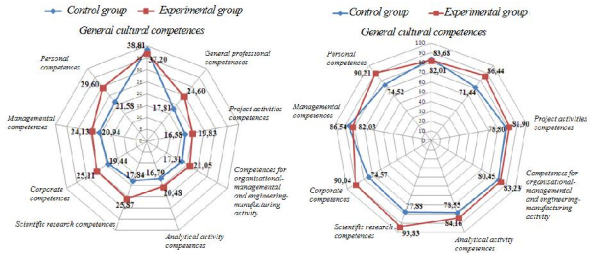

Diagram 2. Results of processing of information communication competency development professional technological chart of control and experimental groups of the 1st and the 4th academic year

The diagnostic program is based on a complex expert appraisal of projects, portfolios, informational-technological activity in situations of uncertainty[5]. Results of diagnostic program's analysis of students' ICC development are shown in the table 1.

Table 1. Value of χ^2 – Pearson criterion for comparison of training results

	Start		End	
	Control gr.	***Exper. gr.***	***Control gr.***	***Exper. gr.***
«3»	73%	80%	32%	16%
«4»	24%	17%	67%	70%
«5»	3%	3%	1%	14%
χ^2	1.33		12.93	

Excess of experimental value χ2 – Pearson criterion over critical value (χ2cr=5.99146) at the end of experimental pilot work allows to consider it to be credibly proven that using the suggested method of ICC development increases the level of completeness of theoretical knowledge and practical skills in the sphere of computer science and information technology, and that speaks for to-be IT-professionals having a cultured ICC cognitive pragmatist component.

For estimating the level of completeness of to-be IT-professionals ICC personal component we used the following empirical methods of research: observation, conversation, questionnaire, analysis of students' work practice report documentation and others.

For performing scoring of ICC completeness we used qualimetric analysis allowing to find integrated coefficient (K) of the level of completeness of to-be IT-professionals competency under research.

With the help of the expert evaluation method we found weight coefficients of each ICC component: a=0.2 (ICC listed in the federal state

educational standard); b=0.3 (ICC pointed out by employers); c=0.25 (axiological motivational component); d=0.25 (reflexive projecting component), and a+b+c+d=1. Expert evaluation was performed by 15 teachers of computer science and subject disciplines; chiefs of IT-departments of firms where students had their practice.

This research gives the formula for finding the integrated coefficient of ICC completeness level:

$$K=(aK_1+bK_2+cK_3+dK_4)*100\%,$$

where K_1,K_2,K_3K_4 are coefficients describing completeness of components marked by us.

The coefficient which describes completeness of one of components is calculated by the relation:

$$K_1=n_1/n,$$

where n_1 is a number of components mastered by a student; n is the total number of components which have been pointed out.

With the help of the expert evaluation method such levels of to-be IT-professionals' ICC development have been distinguished:

$K < 70\%$ – *user level*,

K within 70% - 90% – *technological level*,

K over 90% – *professional level*.

It should be noted that the user level is characterized by students having information communication competences specified by the federal state educational standard of the higher vocational education. Technological and professional levels of ICC development, apart from the specified components, presuppose employers' competences which in their turn consist of axiological-motivational and reflexive-projecting units.

5. Resume.

In the course of experimental pilot work diagnostic tables were given to experts and students. Results of completed tables were generalized, and conclusions on ICC development levels were drawn.

Table 2. Results of students distribution (%) according to ICC development levels

Levels of information communication competency development	Academic years			
	1 year	2 year	3 year	4 year
User level	100%	95%	60%	12%
Technological level	0%	5%	40%	57%
Professional level	0%	0%	0%	31%

The table analysis allows to draw a conclusion that most of students are at the technological level of information communication competency, i.e. to-be IT-professionals can use information and network technologies in professional activity, including situation of uncertainty in the IT-sphere.

Thus, represented experimental data allow to deduce that using of the suggested complex of ICC development under the conditions of IEE in federal university provides ICC development up to the highest professional level of to-be IT-professionals. Using of the above given method allows to obtain objective information on quality of training of higher educational institution students (graduates) based on measurement of level of their competences' completeness and to estimate this level's conformance to requirements of the new generation federal state educational standard. High reliability of findings is provided not only by the fact that for estimation of competency components completeness level we use diagnostic tools, quality of which satisfies scientifically grounded criteria, but also by the foreseen possibility to control this quality in the course of estimation performing.

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