Software System for Formation the Composition of Academic Groups (Subgroups) Based on the Diffusion-Like Model

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Abstract: **In this paper, the method of forming a composition of academic groups (subgroups) in an educational institution was developed. The method based on a diffusion-like model of the dissemination of knowledge potential. The application of this method ensures the formation of academic groups (subgroups) in such a way as to maximize the coefficient of distribution of knowledge potential within each of the formed groups (subgroups). Software system, which implements the specified method, is also considered.**

Keywords: **diffusion-like model, knowledge potential, academic group.**

I. Actuality of the Problem

Student academic group is a kind of small group, with its stages of transformation into a collective, with parameters of development and criteria of formation. Constant studying of the level of development and knowledge of each student and the team of the academic group enables to effectively develop the educational process in a higher educational institution, taking into account the changes that the student's team undergoes in general and each member in particular, to correct the content and methodology of this process [1-5].

The initial formation of academic groups is based on the level of knowledge of each entrant, which usually reflects as the average rating point for the implementation of certification works on selected external subjects of external independent testing (EIT).

External independent testing (EIT, formerly also External testing, ET) - entrance exams for higher education in Ukraine. The complex of organizational procedures (first of all - testing) aimed at determining the level of educational achievements of graduates from secondary schools when they enter higher education institutions [6]. At the same time, the division of students into groups (subgroups) in educational institutions, usually carried out on the basis of the average rating point without taking into account its detail that is, the compliance of competing subjects of EIT chosen specialty. An applicant may receive a high score from the "Ukrainian language and literature" and at the same time and a low from the "Mathematics" at the entrance to the technical specialty, where his level of knowledge plays an important role in the field of mathematics. In addition, in other cases, the formation of academic groups from the list enrolled to study entrants can be carried out in alphabetical order, without considering at the same time the level of knowledge of applicants, which does not provide in the future the maximum effectiveness of the educational process. Further, during the studing process, formed training groups for laboratory (practical) classes on individual disciplines can be divided into subgroups. In this case, such a division is usually carried out in alphabetical order. Such an approach is completely unreasonable, since it does not take into account the assessments received by students for related disciplines in accordance with the structural-logical scheme specialty.

Therefore, it is important to develop a method for forming a composition of academic groups (subgroups) in an educational institution, in such a way as to ensure the maximum effectiveness of the educational process. To construct this method expedient to use a diffusion-like model of the propagation of the knowledge potential, which simulates the transfer of knowledge between students by analogy with the crystallization process of the solid body from the melt at the outlet from the heat [7, 8]. In addition, it's need to develop the software module for the implementation of this method.

II. Modeling of the Composition of Academic Groups and Subgroups by Application of the Knowledge Potential Distribution Coefficient

During the formation of the composition of academic groups, we will take into account the calculated coefficient of distribution of the knowledge potential calculated for them [8], that is, the higher this value is the better. It is important to note that the possible maximum value of this coefficient is unknown in advance. In addition, the distribution of compositions to academic groups or subgroups is carried out in such a way as to ensure the highest and virtually equivalent values of these coefficients for all formed academic units. Then the task of finding such a distribution of student compositions can be equationted in the form of a multivariate discrete optimization problem.

At the same time, we will examine all possible variants of the composition of the academic groups, which in turn shows that this task is extremely complex and belongs to the NP-complex class. For each combination, the value of the coefficient of distribution of the knowledge potential of the group will be compared, which will be based on the level of knowledge of each student, taking into account the individual characteristics of each discipline and specialty.

So, determination of the coefficient of distribution of the known potential will be calculated C_n^k times, where C_n^k - number of combinations from n to k; k – number of students in the academic group (subgroup); n – total number of

students; m – required number of groups (subgroups). It will be received C_n^k sets of coefficients of distribution knowledgeable potential $\overrightarrow{b_i} = b_1 \dots b_m \ , i = 1 \dots k$ which we will store, for further determination of the "best" according to the following criteria:

$$\begin{cases} b_1 \to max, \ \ b_1 \in \overrightarrow{b_i}; \\ \dots \\ b_m \to max, \ \ b_m \in \overrightarrow{b_i}; \\ |b_1 - b_2| \to 0, \ \ b_1, b_2 \in \overrightarrow{b_i}; \\ \dots \\ |b_1 - b_2| \to 0, \ \ b_{m-1}, b_m \in \overrightarrow{b_i}; \end{cases} \quad (1)$$

For example, when dividing students into two subgroups will be implemented $C_n^k/2$ comparisons of the distribution coefficients of the knowledge potential of the formed subgroups As can be seen from expression (1), as a result of the test, an option is chosen for which the difference in the knowledge potential among the groups formed will be the smallest, and the value of the knowledge potential will be greatest. One of the options for introducing generalized potential K $_j$-group $\varphi_{j,m}$. There is a representation of it in the form of some function from $\varphi_{j,k,m}$, in particular, in the form of a generalized arithmetic mean:

$$\varphi_{j,m} = \frac{1}{k_j} \sum_{k=1}^{k_j} a_{j,k} \varphi_{j,k,m} \quad (2)$$

where $\alpha_{j,k}$ – some weight factor.

In the initial iteration of the use of the method that is, the formation of a composition of academic groups of students of the first year will determine the knowledge potential of each student based on the results of the EIT. In this case, each item will be given a coefficient of importance that corresponds to the chosen specialty. Thus, the knowledge potential of a particular student will look like:

$$\varphi_{j,k,m} = \sum_{i=1}^{t} z_i p_i \quad (3)$$

where z_i - coefficient of importance of an object, p_i - subject score, a t – number of subjects. The sum of the coefficients of importance $\sum_{i=1}^{t} z_i = 1$.

To form a composition of subgroups for the subject, you should introduce the notion of the source of knowledge, which will be the lecturer who will conduct practical classes. Depending on the qualification, each lecturer will be assigned the appropriate efficiency factor, which will characterize him as a source of knowledge. Table one shows the adequacy of the efficiency coefficients for the qualifications obtained.

TABLE 1. CONFORMITY OF THE POINTS FOR THE CALCULATION OF THE QUALIFICATIONS

Obtained qualification	Level of qualification	Efficiency coefficient
Lecturer trainee	1	60
Lecturer	2	65
Lecturer, Ph.D.	3	80
Senior Lecturer, Ph.D.	4	90
Docent, Ph.D.	5	100

The formation of subgroups of students from groups in the first semester of the first year will also be based on the results of the EIT. Thus, the equation for determining the coefficient of distribution of the knowledge potential of the formed subgroup $A_{j,g,m+1}$ will look like:

$$A_{j,g,m+1} = \sum_{j=0}^{j} \varphi_{j,k,m+1} - \varphi_{j,k,m} \ \text{ where}$$
$$\varphi_{j,k,m+1} - \varphi_{j,k,m} = f_{j,k,m} + \\ + D_{j,k,m} \sum_{1 \le \underline{k} < k < \bar{k} \le k_j} \sigma_{k,\underline{k},\bar{k}} (\varphi_{j,\bar{k},m} - 2\varphi_{j,k,m} + \varphi_{j,\underline{k},m}), \quad (4)$$

$f_{j,k,m}$ - source of knowledge, $D_{j,k,m}$ - coefficient which characterizing the ability k-agent j-group redistribute information (knowledge) at the time m (analog of diffusion coefficient)[7].

It should be noted that for the use of equation (4), the student's marks with the EIT, which are calculated in the 200-point system, should be converted into 100-point system. It is known that the minimum passing point of the EIT is 100 points, while the minimum score required for passing the discipline at the university is 60 points. We will make the appropriate proportion for transfer of points from the 200-point system to 100 points, which is represented by the equation:

$$x = \frac{60 * c}{100}, \quad (5)$$

where c – EIT score for a subject.

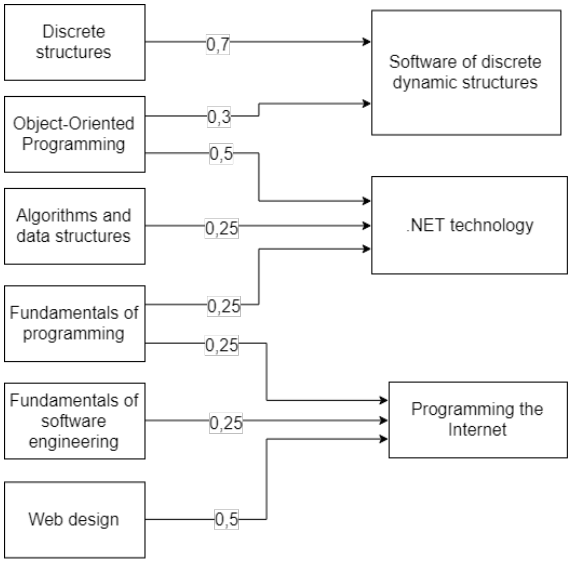

Fig. 1. A fragment of the structural-logical scheme of the related disciplines of the specialty "Software Engineering"

After forming a set of all possible combinations of the formed groups (subgroups), we calculate the value for them $A_{j,g,m+1}$ (on initial iterations φj,m and then determine the best combination by the equation (1). The time spent on forming all possible combinations of the subgroup depends on the number of groups (subgroups) and the number of students in these groups (subgroups). Reduction the timing of these operations may be the subject of a study in the future.

Note, during the program implementation of equation (1), it is advisable to select several "best" combinations of groups (subgroups) and give the user the opportunity to select the "optimal" combination. Formation of subgroups of students in all subsequent semesters will be carried out on the basis of the results of previously studied adjacent disciplines, asking them with the coefficients of importance, based on the structural-logical scheme of the specialty. For example, in Figure 1, a fragment of the structural-logical scheme of adjacent disciplines for the specialty "Software Engineering".

The equation for determining the knowledge potential of a subgroup based on the results of related disciplines corresponds to equation (4). The equation (3) will be used to determine the knowledge

For example, the formation of subgroups for the discipline ".NET Technology" will be based on the results of previous related disciplines, where, according to the equation (3) $z_1 = 0{,}5$ - the coefficient of the importance of discipline "Object-oriented programming", $z_2 = 0{,}25$ - "Algorithms and data structures", $z_3 = 0{,}25$ - "Fundamentals of programming". Student's points for the above-mentioned disciplines will be, for example, $p_1 = 75$, $p_2 = 77$, $p_3 = 86$ accordingly. Then, according to equation (3), his knowledge potential in relation to the discipline ".NET Technology" will equal:

$$\varphi_{j,k,0} = 0{,}5 * 75 + 0{,}25 * 77 + 0{,}25 * 86 = 78{,}5$$

Now we can equationte an algorithm for the implementation of the proposed method for forming the composition of academic groups (subgroups) with the use of a diffusion-like model, whose block diagram is shown in Figure 2.

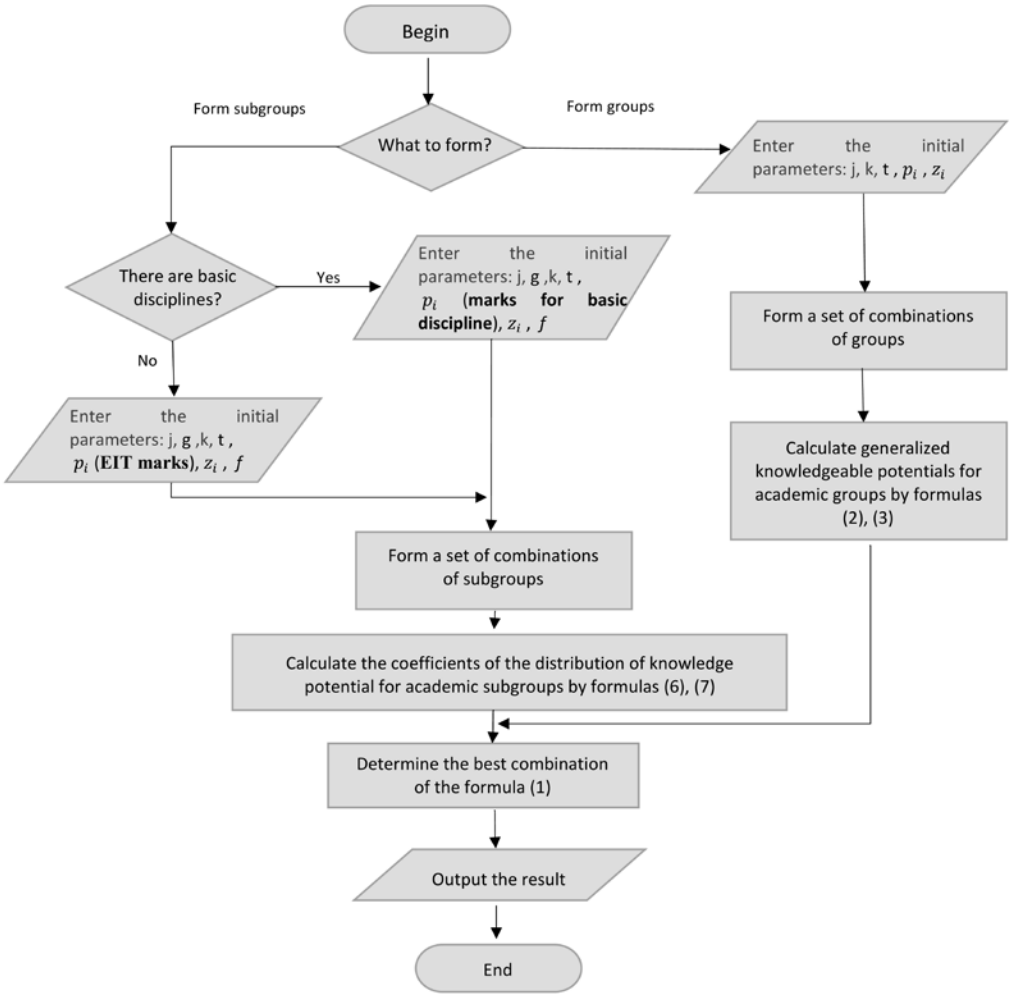

Fig.2. Algorithm for the implementation method for forming the composition of academic groups (subgroups) with the use of a diffusion-like model

III. Software Realization

The software system of forming the composition in academic groups based on a diffusion model is developed using an object-oriented approach and .NET technology, programming language C#. Student data, lists of formed groups, as well as other data necessary for the functioning of the system are stored in RDBMS MySql.

Consider functional details of system. After launching the program, the user will be given full access to the entire functional system. The "Form groups" function gives the user the ability to form groups of first-year students based on the

results of external testing. In this case, each item will be given a coefficient of importance that corresponds to the chosen specialty.

The logical and conceptual description of the functionality system for the function "Form groups" is reflected in the sketch of the form, which is presented in Figure 2.

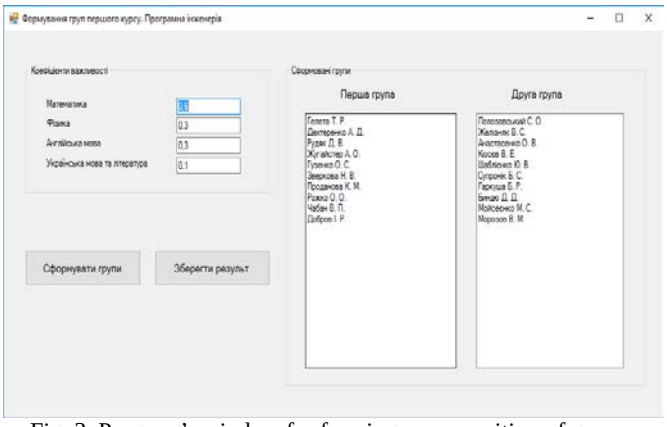

Fig. 3. Program's window for forming a composition of groups

The function "Form subgroups" is similar to the "Form groups" function, but in this case, possible combinations will be formed as a result of division of the group into subgroups. The division into subgroups will be carried out for a specific discipline, taking into account the results of previously passed disciplines, which are the basis for this discipline in accordance with the structural-logical scheme of the specialty.

In general, to split a group into a subgroup, you must first select from the list the course, then the group that is on this course. Then choose the discipline for which the subgroup will be subdivided. After selecting the discipline there will be a list of disciplines that are the basis or adjacent to the discipline for which division is carried out.

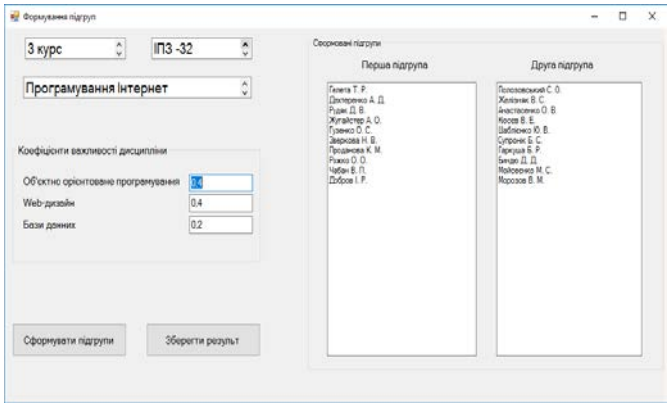

Fig. 4. Program's window for forming a composition of subgroups

The lecturer of discipline serves as a source of knowledge for the formed subgroup and affects its know-how. Therefore, for him, the coefficients of efficiency will be given, which will reflect his level of knowledge, which we will determine based on the acquired qualification level (table 1).

The logical and conceptual description of the functionality of the system for the function "Form subgroups", is reflected in the sketch of the form, which is presented in Figure 3.

Once the groups and sub groups have been formed, the user will be able to save them or form them again, having previously changed the parameters.

IV. Conclusion

The paper analyzes the existing methods of forming the composition of academic groups (subgroups) and shows that they are not effective, because they do not take into account the influence of the interaction of students between groups and the lecturer on the effectiveness of the educational process. It is shown that for constructing the method of forming the composition of academic groups it is expedient to use the diffusion model of the process of dissemination of knowledge potential.

A new method is proposed for the formation of composition of academic groups based on a diffusion-like model using the coefficient of distribution of the knowledge potential of the group as the main comparison parameter.

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