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Algorithmic Aspects Of The Variability Of The Content Of Education In Higher Education

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Abstract:
In general, the credit technology of education has considered as a mechanism built on variability of educational programs, which are implementing universal traditions of the world concerning to education that meets international general educational standards. This article draws attention to the fact that the effectiveness of the credit-module system is directly related to the variability of the content of training, and analyzes the research aimed at introducing a variable approach to the curriculum and curricula of universities. In our opinion, the variation of the content of curriculum and syllabi in higher educational system is a complex, holistic procedural system, focused on the effectiveness of the results, associated with integrating some components, which have their specific typological classifications into the education system. In this research more than 48 university professors-teachers and about 800 students educational institutions have participated in this process. Due to the aim and objectives of the study, the methods and techniques like pedagogical observation, conducting electronic questionnaires, conceptual modeling, comparison and analysis have used. The main stage of the study preparation was carried out from 2018 (April) to 2019 (June) and the existing problems, functional tasks for the study were identified and methodological approaches were clarified. At the next stage (July 2019 – October 2021), the factors influencing the improvement of the curriculum and curricula at universities were considered. In the course of the study, the mechanism of formation of the variable structure of learning is revealed, using a conceptual model of variability is proposed, which is associated with the complexity and distribution of the training content in the form of optimal variants of training modules. The technology of determining the effectiveness of this model, the reliability of optimal options and the level of satisfaction of the needs and requirements of the subjects is proposed. At the end of the study, we came to the conclusion that the variability of the learning content in the credit-modular system is an adaptation of the general content of the curriculum, taking into account the needs of consumers and customers, as well as educational needs.

Keywords: content of learning, variation; optimal version(variant), target version (variant), needs of education, customer.

1. INTRODUCTION

Strengthening the educational-methodological base and material-technical infrastructure of leading higher educational institutions in the world, increasing the development of information technologies, the establishment of scientific-technological parks, establishing active cooperation with manufacturing companies, the enlargement of the organization and delivering educational

process on the base of credit-module system has been driving a special attention.

The credit-module system of education can be considered as a model, that

implements the basic function of the educational process, including the creative effort to increase knowledge through individual and independent learning, the choice of the educational strategies in the learning process, and the optimal determiner of the entire knowledge.

To achieve a single European Higher Education Area by 2010, the Commission's proposal for a European Qualifications Framework (EQF) offers the possibility of increasing mobility within the higher education sector, particularly at European level, and of increasing mobility or permeability between training sectors (Qarshiboev, 2020). From this point of view, we see that there is a large scale of research on the development of the higher education system. Including, parameters used in assessing the quality of higher education (Goutam, 2016), learning process management scales (David, 2016), the features and capabilities of Web 2.0 to improve learning behavior (Widyasari, 2019), tasks of creating educational programs in the credit-modular system and implementing the credit-modular system (Boytemirova, 2020), higher education governance reform (Bengoetxea, 2012), problems of quality management of education in higher education institutions (Tadeusz, 2020), the use of blended learning as a supplement in higher education institutions (Galvis, 2018).

Currently, there is a development of procedures and regulations for the introduction of the credit-module system focused on organization of educational process, which provides the integration of local and foreign experience into the content of unique educational environment and the comprehensive study of the prior factors in the activities of the universities (UP-5847. dated October 8, 2019. "On approval of the concept of development of the Higher Education system of the Republic of Uzbekistan until 2030").

The educational credit system based on the principles of student-centered learning, clarity of teaching and evaluation, which includes the collection and transfer and generate of the dynamic test units. The main functions of the cred it module system are recognized as follows (Boytemirova, 2020):

-Organization of the educational process based on modules;

-Unified scientific, course (credit) assessment;

-Assessment of students' knowledge based on the rating score;

-Create an opportunity for students to create their own curriculum on an individual basis;

-Increasing the share of independent learning in the educational process;

-Convenience of educational programs.

In general, the credit technology of education has considered as a mechanism built on variability of educational programs, which are implementing universal traditions of the world concerning to education that meets international general educational standards. In turn, the problems associated with the impact of the curricula of the higher education system on educational processes, the sequence of assimilation of knowledge and skills, control testing procedures are among the issues that are relevant in each period (Meena, 2020), (Dina, 2020), (Paul, 1992).

Variation-based of Curriculum and syllabi is a key factor that has a positive impact on the effectiveness of the implementation of credit-module system, which considered an advanced approach to the organization and planning of the educational process.

The purpose of our research is focused on this problem and the definition of effective technologies for the variability of the content of education, which are considered an important factor in improving the quality of education in higher education institutions.

2. LITERATURE REVIEW

The issues of implementing a variation approach into curricula and syllabi,

paradigmatic changes in higher education, forecasting the effectiveness of educational processes are a frequently discussed topic in the field of education (Prasolova, 2001), (Bakli, 2002), (Konovalchuk, 2005), (Kochergina, 2005), (Orekhova, 2001), (Bachina, 2002), (Tefera, 2020), (Askarov, 2019).

S. Berejnaya narrates the variation approach as following (Berejnaya, 2000): to the "upward" vertical vector as a qualitative change of the teachers in the field of motivation, function and activities, as a "forward" horizontal vector, the growth of professional experience on his or her specialty, as a "side" vector, the development of professional experience concerning to the basic knowledge on his/her professional field.

Malysheva research (Malysheva, 2007) emphasizes that variability is to get maximum satisfaction of different educational needs and professional interests of the individual and to provide potential opportunities of personal development for each student based on individual coordination.

R.Ahlidinov (Ahlidinov, 2006) states that curriculum and syllabi should be flexible in order to provide a variation and he has focused on completing basic components, combination of this components, catalogues in the spheres of subject or education, specific loadings (extending) of subjects and scopes (specialty) as well as the issues of general loading skills.

S. Bogdanova, in her researches (Bogdanova, 1997) presents the problems in the theory and practice of variation, the principles of forming variation and it is recommended to use specific effective forms and methods to enhance professional development focused on variational content.

According to the idea of Sh.Kurbonov and E.Seytkhalilov, variability is the quality of the education system, which characterizes the ability of the system to create and provide options for educational programs or specific services for students choosen according to their changing needs and opportunities to education (Qurbonov, 2006). In addition, the ergonomic aspects of training programs, interactions between curriculum design and use, the quality of education and its components were studied (Jeffrey, 2018), (Sabirova, 2019).

In our opinion, the variation of the content of curriculum and syllabi in higher educational system is a complex, holistic procedural system, focused on the effectiveness of the results, associated with integrating some components, which have their specific typological classifications into the education system.

In the higher education system, the curriculum and syllabi formulated basing on the suggestions about the learning content, they contain the concentrated educational needs and have common in nature, that is, each syllabus and curriculum are composed of sub-themes (curriculum-syllabi content) accordingly.

3. MATERIALS AND METHODOLOGY

The Termez State University and National University of Uzbekistan in the period of its career has made a great contribution to the development of education and science, as well as preparation of personnel for various sectors of the economy, social and spiritual spheres. In addition, the main directions of comprehensive development of the universities in 2019 - 2023, essential improvement of the system of preparing highly qualified specialists and increase of the scientific potential of the universities has identified. In the range of these directions there is existed the tasks taking into consideration the needs of development of the regions, economic sectors, science and the social sphere, planning, deepening and organization improving the quality of educational process according to the international practice.

In this regard, the world-recognized and advanced credit-module system, which is used on organizing and planning of the educational process have studied, and

elaborated curricula and syllabi of existed 23 bachelors direction in preparing students for pedagogical career. More than 48 university professors-teachers and about 800 students of educational institutions have participated in this process.

Due to the aim and objectives of the study, the methods and techniques like pedagogical observation, conducting electronic questionnaires, conceptual modeling, comparison and analysis have used. Furthermore, existing curricula and syllabi, normative-regulation documents have investigated.

The main stage of the study preparation was carried out from 2018 (April) to 2019 (June) and identified existing problems, functional tasks for fulfilling the research, and clarified the methodological framework.

At the next stage (July 2019 – October 2021), the factors influencing the improvement of the curriculum and syllabi of preparing students for pedagogical activities, the opportunities of algorithmic modeling of the teaching content based on the demands and needs of the customers have analyzed and delivered piloting.

Research analysis have shown that it is often necessary to separate the teaching part based on the hours allocated to the training modules. In the most cases there is observed generating of the curriculum content, namely from the updated content of this module collection (A) has selected the most relevant and topical (B) ones ($B \subset A$) and the courses will be organized basing on these selected modules (Askarov, 2017).

Having not included of some parts of the package A into the package B or because of including condensed parts by generating caused for dissatisfaction of the needs and observed as the following:

- students have already gained knowledge on the selected package (B);
- some included topics in this collection are not relevant to the student's future professional activity;
- topics that have not been included in the selected set or are condensed should be of interest to the participants of the course and considered necessary.

In such situation, the negative impact on the achievement of the educational aim and objectives is as follows:

- a decrease of the intrinsic motivation of the student associated with his activity and the content of learning;
- a destruction the logics of the learning process, that is ineffective effort, waste of time and money;
- impediment in the development of the higher educational institution.

Due to this, we can state that basing on such type of approach to the existing Curriculum of Higher is not conducive to achieving positive results, including qualitative changes.

Consequently, to draw attention to the variation of the content of the learning components offered to the student is very important to create a differentiated approach to the choice of educational programs.

The results of our research, published under the title “Motion of variativeness of curricula and syllabi for pedagogical personnel in the public education system” considered complex in terms of the implementation of curriculum variability. It is noted, that there have not developed effective technologies in the selection of appropriate variants based on specific parameters. There is given a mechanism on changing the topics referred to provision the needs of students and customers, and the result is “built on” their existing knowledge, skills and interests, namely a form of the best option of the content of learning modules have recommended (Askarov, 2016).

4. RESULT AND DISCUSSION

This article is the continuation of our previous studies for the higher education system. Our previous studies have improved and the theory and practice of forming a content-based curriculum has implemented, so that in this article, we will mention some of the models presented our previous article.

A set of rules consisted of a two-stepped algorithmic procedures have developed by determining the number of topics (*m*), which are selected for each option and targeted to solve the problem. The steps are the following:

Step 1 – defining the basic options that are equal to the number of topics covered by the needs and demands;

Step 2 - create optimal options by reducing and generating the number of base options as much as possible.

This mechanism involves studying the attitudes and needs of the main customers, recommendations of other organizations and the public community concerned to the content of the learning topics and implementing a number of algorithmic approaches that depended on the results. The individual attitudes towards the content of the learning topics are determined in the form of a questionnaire. Each participant in the questionnaire expresses his or her own attitude to the topic by identifying one of the elements: *Ne* - "necessary", *Pn* - "partially necessary", and *Un* - "unimportant" and these elements called attitude elements.

First step. The most optimal variants straightly depend on the participants' *Ne*- "necessary" elements of attitude that is the "eagers" of participants considered their needs and served as the basis of indicating the optimal variants. That is why, among the whole attitude of the participants ($\{a_{ji}\}$, $i = \overline{1,u}$, $j = \overline{1,n}$) to the theme – *j*, should choose ticked *Ne* elements of attitude ($a_{ji} = Ne$) and then defined the amount of attitudes which are appropriate to this elements from the other themes. For this including the ration $l_i^k(Ne)$ appropriateness to the theme

$$l_i^k(Ne) = \begin{cases} 1, a_{ji} = a_{ki} = Ne \\ 0, \text{otherwise} \end{cases}, k = \overline{1,n} \quad (1)$$

and calculate the number of implemented elements basing on all elements as following:

$$S_j^k(Ne) = \sum_{i=1}^{u} l_i^k\,(Ne) \quad (2)$$

By comparing calculated total amount results to each other, choose first "*m*" amount placing them in decreasing order and then fixed their index number (number of the theme). This set of fixed themes "*j*" called theme targeted Variant (V_j).

In the process of choosing "*m*" from the themes placed in decreasing order $S_j^k(Ne)$, if the total amount of elements are equal they will be chosen basing on the $S_j^k(Un)$ smallest quantum:

$$S_j^k(Un) = \sum_{i=1}^{u} l_i^k\,(Un) \quad (3)$$

here

$$l_i^k(Un) = \begin{cases} 1, a_{ji} = Ne \ \ and \ a_{ki} = Un \\ 0, \text{otherwise} \end{cases}, k = \overline{1,n} \quad (4)$$

If the smallest quantum of the $S_j^k(Un)$ are equal, they will choose according to $S_j^k(Un)$ the largest quantum:

$$S_j^k(Pn) = \sum_{i=1}^{u} l_i^k\,(Pn) \quad (5)$$

here

$$l_i^k(Pn) = \begin{cases} 1, a_{ji} = Ne \quad and \ a_{ki} = Pn \\ 0, \text{otherwise} \end{cases}, \ k = \overline{1,n} \quad (6)$$

Besides, if there is existed any theme accepted "zero" $S_j^k(Ne)$ quantum and their distinction amount of the module on any of the theme is minor from "*m*", considered there isn't any theme targeted on this variant.

It is clear, that the number of chosen variants are not more *n*, that is it can be equal to the number of themes.

Step two. In this step, the process of integrity basing on the theme will formulate. That is the number of theme-targeted variants will reduce.

Comparing "*j*"-theme-targeted V_j variant's elements with other targeted variant elements separated completely repeated elements in V_j (that is $Vt \cap Vj$) or amount of variants at least *4/5* parts have repeated from the total amount the elements of variants ($\frac{S\{V_t \cap V_j\}}{m} \geq 4/5$). In the process

of integration besides above-mentioned requirements, the situation related with the learners' *Un*-"unimportant" attitude should also take into consideration. For this, at first the "*x*" elements of V_j, which is not existed among V_t variant (themes) separated on $S_t^x(e_1)$ and $S_t^x(e_3)$.

If for all the "*x*" elements the quantum of the $S_t^x(e_3)$ and $S_t^x(e_1)$ will be smaller than 1/3,

$$\frac{S_t^x(e_3)}{S_t^x(e_1)} \leq \frac{1}{3} \quad (7)$$

there is not rejected element of V_j in V_t. It is accepted in this way (in the entire situation) and these variants rounding into V_j. Otherwise V_t variant will find unbounding into V_j.

Above given tasks will look check for other variants basing on V_j variant and separated a set of variants appropriate to V_j variant. V_j variant considered – optimal variant for such kind of variants.

$$O = V_j \quad (8)$$

If the above-mentioned $\frac{S\{V_t \cap V_j\}}{m}$ assignment are met, it is also necessary to look through the ratio of duplication of the V_t variants in other basic variants. Because in some variant V_k it can also be as a $\frac{S\{V_t \cap V_k\}}{m} \geq \frac{S\{V_t \cap V_j\}}{m} \geq 4/5$ variant. This shows the feasibility of generating V_t into the base variant V_k.

The activities specified for the 2nd step will do onto all other variants, except V_j and other integrated variants into it and continued identification of optimal variants. In the situation of the absence of similar options to satisfy the above comparison criteria for any base option, this considered as the next optimal option.

So, *Or* optimal variants to be defined and the task minimizing the number of conceptual modeling variants to be done. Here, *r* - is the number of optimal variants (*r=[I..R]*, *R*-is an amount of optimal variants).

During the research period, a method and strategy on identifying the effectiveness of the proposed algorithmic model for variation of learning topics, the reliability of the optimal variants and the degree of satisfaction of the needs of participants have developed.

At first, in the piloting on this direction, the optimum options have selected according to the relevance of the needs for the participant who expressed his/her attitude to the learning topics in feasible extent. For this purpose, the elements of the optimal variant (b_{kO_r}) have compared with the participants' attitude and formed a set of collections $\{C_i^{O_r}(Ne)\}$, $\{C_i^{O_r}(Pn)\}$, $\{C_i^{O_r}(Un)\}$ relevant to each elements of optimal variant consisted of e_1, e_2, e_3. Here the number of the optimal variant $i = \overline{1,u}$, $O_r - r$ is the optimal amount numbers of *(r=[1..R]*, R- is an amount of optimal variant(options).

Each element of the set $\{C_i^{O_r}(Ne)\}$ calculates as following:

$$C_i^{O_r}(Ne) = \sum_{j=1}^{n} l_i(Ne) \quad (9)$$

here $l_i(Ne) = \begin{cases} 1, a_{b_{kO_r}i} = Ne \\ 0, or\ else \end{cases}$ $k = \overline{1,m}$ (10)

Each element of the set $\{C_i^{O_r}(Pn)\}$ calculates as following:

$$C_i^{O_r}(Pn) = \sum_{j=1}^{n} l_i(Pn) \quad (11)$$

here $l_i(Pn) = \begin{cases} 1, a_{b_{kO_r}i} = Pn \\ 0, or\ else \end{cases}$ $k = \overline{1,m}$ (12)

Each element of the set $\{C_i^{O_r}(Un)\}$ calculates as following:

$$C_i^{O_r}(Un) = \sum_{j=1}^{n} l_i(Un) \quad (13)$$

here $l_i(Un) = \begin{cases} 1, a_{b_{kO_r}i} = Un \\ 0, or\ else \end{cases}$ $k = \overline{1,m}$ (14)

b_{kO_r} – *k*- is an element of O_r optimal variant.

For the largest element "*p*" ($c_{pi}(Ne)$=SUP$\{C_i^{O_r}(Ne)\}$, *p=[1..R]*) by

$\{C_i^{O_r}(Ne)\}$ the following conditions are checked:

The first condition.

$$\frac{c_{pi}(Ne)}{m} \geq \frac{1}{3} \quad (15)$$

The second condition.

$$c_{pi}(Ne) \geq c_{pi}(Un) \quad (16)$$

here $c_{pi}(Un)$ – $C_i^{O_r}(Un)$ is the element of "p".

In the occasion of the implementation of both tasks optimal option O_p considered relevant variant, that is appropriate the needs of the participant "i". A satisfaction degree of the optimal option (O_p) for the participant consists of

$$\frac{c_{pi}(Ne)}{m} \cdot 100, \quad \frac{c_{pi}(Pn)}{m} \cdot 100, \quad \frac{c_{pi}(Un)}{m} \cdot 100 \quad (17)$$

That is, it is assumed that 3 values are measured simultaneously.

If the amount of the largest elements are more than one in both implemented terms (for example, $c_{pi}(Ne) = c_{fi}(Ne)$, $f=[1..R]$), then there is identified relevant optimal option for participant "i" to these elements $c_{pi}(Pn)$ and relatively to the largest of $c_{fi}(Pn)$. If there is defined the equity of these elements, then identified the optimal option for the participant "i" according to the smallest amount of $c_{pi}(Un)$ and $c_{fi}(Un)$.

At the same time, the set of $\{C_i^{O_r}(Ne)\}$ can be fulfilled for the other elements of the set in descending order relative to the largest item (p), which means that the optimal option for this participant is more than one.

Moreover, the following two cases lead to incompletion of these terms: 1) in case the participant's questionnaire was filled out incorrectly by the them, that is, the attitude was not implemented consciously; 2) in case the topics included in the questionnaire did not really apt to the participant's satisfaction (in most cases, the participant has chosen *Un* (or *Pn*).

In this case, it is recommended to study the participant's attitude individually, and, in essential conditions, the components of the optimal options should be revised based on these participants' needs.

Thus, the process of functioning of the presented algorithmic model, that is, the allocation of variable trainable topics, is carried out in stages in Figure 1.

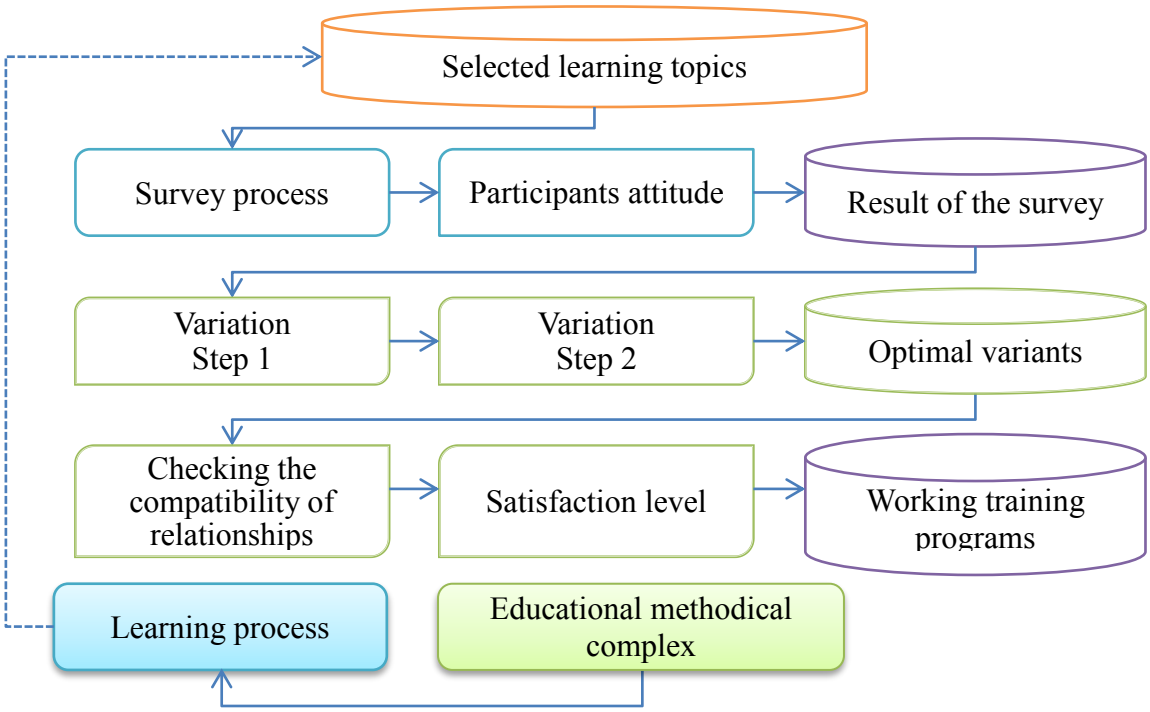


Figure 1. Implementation stage of variation

5. SUMMARY

The calculation of the maximum degree of relevance of the optimal options to the participants attitude has done as following:

$$\frac{c_{pi}(e_1)}{m} \cdot 100 + \frac{c_{pi}(e_2)}{m} \cdot 100 - \frac{c_{pi}(e_3)}{m} \cdot 100 \quad (18)$$

Aligning on these analysis, the following criteria have set for the level of optimal option:

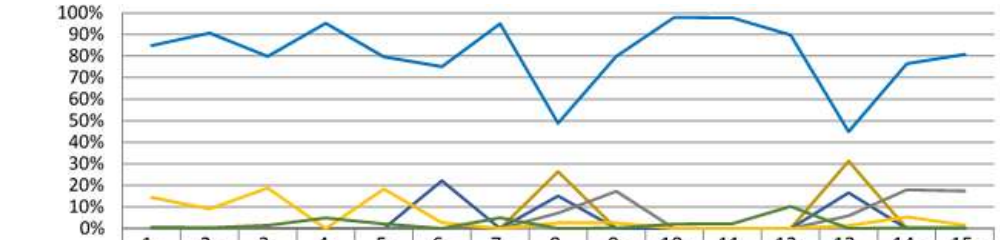
- Level 1: 100 % relevance of the option to the needs(attitudes);
- Level 2: 86-99 % relevance of the option to the needs(attitudes);
- Level 3: 71-85 % relevance of the option to the needs(attitudes);
- Level 4: 56-70 % relevance of the option to the needs(attitudes);
- Level 5: 0-55 % relevance of the option to the needs(attitudes).

If the value of the above-given expression is less than "0", it can be concluded that none of the selected options have satisfy the participant's needs, in this case the participant has not responded positively to most of the topics given in the questionnaire.

For selecting optimal options with the help of needs analysis 769 respondents have been involved. The participation of 769 respondents in the piloting process conducted 15 times was vary. They have been presented with subsets of modules (15) containing learning topics (*n*) and number of topics (*m*) to be selected from these topics and then the results have compared (Table I, Figure 2).

TABLE I. The results of piloting on defining conceptual model of optimal learning options

Piloting №	Total participant (u)	Number of topics (n)	Number of choice (m)	Number of optimal option
Pilot 1	767	6	3	4
Pilot 2	769	7	3	5
Pilot 3	769	8	4	6
Pilot 4	769	4	2	3
Pilot 5	767	7	4	5
Pilot 6	765	19	7	17
Pilot 7	769	4	2	3
Pilot 8	391	23	15	22
Pilot 9	393	12	6	11
Pilot 10	393	5	2	4
Pilot 11	393	4	3	3
Pilot 12	391	3	2	2
Pilot 13	374	27	15	26
Pilot 14	374	13	6	10
Pilot 15	374	10	5	8



	1-exp.	2-exp.	3-exp.	4-exp.	5-exp.	6-exp.	7-exp.	8-exp.	9-exp.	10-exp.	11-exp.	12-exp.	13-exp.	14-exp.	15-exp.
level 1	85%	91%	80%	95%	80%	75%	95%	49%	80%	98%	98%	90%	45%	76%	81%
level 2	0%	0%	0%	0%	0%	0%	0%	26%	0%	0%	0%	0%	31%	0%	0%
level 3	0%	0%	0%	0%	0%	22%	0%	15%	0%	0%	0%	0%	17%	0%	0%
level 4	0%	0%	0%	0%	0%	0%	0%	7%	17%	0%	0%	0%	6%	18%	17%
level 5	14%	9%	19%	0%	18%	3%	0%	3%	3%	0%	0%	0%	1%	5%	2%
neglib.	1%	0%	1%	5%	2%	0%	5%	0%	0%	2%	2%	10%	0%	0%	0%

Figure 2. The Satisfaction Dynamics of optimal options with respondents needs

In general, the efficiency of the optimum variants is 89 %, using the above-mentioned method of meeting the needs and requirements of the survey participants. This proved that the algorithmic model of optimal variants has formed correctly (Figure 3).

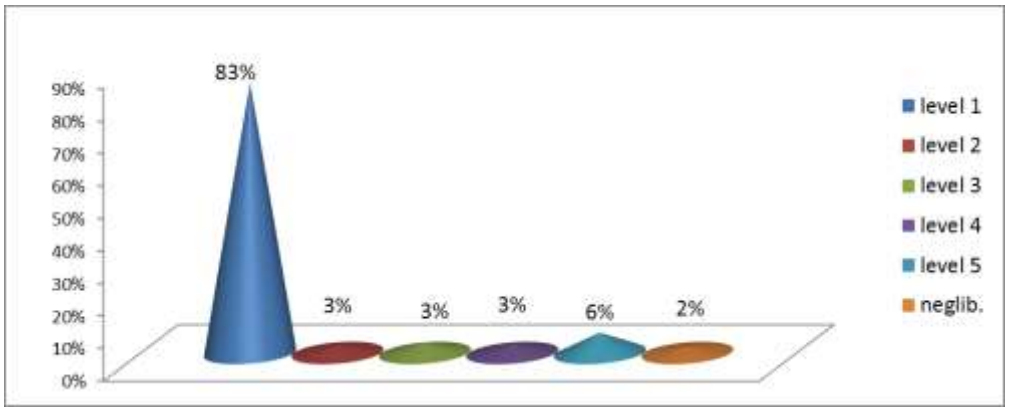


Figure 3. General indicator of respondents' satisfaction with optimum options

6. CONCLUSION

In order to increase the efficiency of the data analysis process, the electronic software product "Selection of optimal variants for working programs" was developed, which automatically determines the optimal options for the working curricula of universities, based on the appropriate parameters and sorting of the attitudes of each participant, as well as the selection of optimal options.

The effectiveness of the presented conceptual model for determining the optimal options depends on the correct implementation of the following organizational issues, which will lead to the close interrelation of learners needs:

- reliability of the topic substance;
- correct determination of content load of themes and number of options (variants);
- conducting survey accurately and fairly;
- analysis and discussion of identified optimal options (variants) and their application;
- there is a high potential for the introduction of differentiated learning topics in the Credit-Module system, so that students can provide a diverse set of learning topics based on their needs (and attitude).

This is:

- to improve the efficacy and opportunities of the student on choosing learning modules;
- to ensure the integration of updated and enhanced professional knowledge with the practical application of acquired comprehension and skills;
- to rank the cohort of students;
- timely updating and improvement of curricula on the basis of competitive indicators;
- the possibility of developing an electronic software product to sort out the attitudes of each participant to the topics content and automatically determine the optimal options based on the relevant parameters.

Thus, we can conclude that the variability of the learning content in the credit-module system is an adaptation of the overall content of the curriculum based on the needs of the customers and as well as the educational needs.

Conflict of Interest

The author declare no conflict of interest.

7. ACKNOWLEDGMENT

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