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## **CASUAL-CLUSTER MODELING OF MASTERS' TRAINING**

The aim of the work is to build graphical causal models of the effectiveness of training masters at the university. In order to determine the reasons affecting the effectiveness of training masters, a causal diagram of Ishikawa was built, in which casual categories were identified that determine its effectiveness.

**Key words:** systems approach, cause-and-effect relationships, Ishikawa diagram, clusters, graph model.

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## **КАЗУАЛЬНО-КЛАСТЕРНЕ МОДЕЛЮВАННЯ ПІДГОТОВКИ МАГІСТРІВ**

Підготовка магістрів в Україні ускладнюється гострою нестачею сучасної науково-технічної літератури і іншими проблемами становлення магістерського навчання. Зрозуміло, використання інформаційних технологій та мережевих ресурсів пом'якшує ситуацію, однак не знімає актуальність вдосконалення підготовки з урахуванням сучасних результатів науки і техніки, розвитку методології і методик прикладних і фундаментальних наук на основі системного підходу. Практична необхідність використання системного підходу обумовлена потребою вирішення складних, міждисциплінарних завдань різної природи, в тому числі і у вищій освіті.

З його допомогою враховуються зв'язки між різними елементами систем і значимість цих зв'язків. Актуальність вирішення складних, міждисциплінарних завдань різної природи при модернізації вищої освіти з використанням системного підходу обумовлює практичну необхідність розвитку апарату системного аналізу і синтезу, починаючи з моделювання відповідних проблемних ситуацій.

В основі здатності бачити динаміку розвитку всіх елементів системи з урахуванням їх взаємодії знаходиться встановлення причинно-наслідкових зв'язків входів і виходів системи. Необхідно використовувати і розвивати казуальне моделювання процесів навчання у вищій школі.

Метою статті є побудова графічних причинно-наслідкових моделей ефективності підготовки магістрів в університеті. Для того, щоб визначити причини, що впливають на ефективність навчання майстрів, була побудована причинно-наслідкова діаграма Ісікави, в якій були визначені випадкові категорії, що визначають її ефективність.

В результаті побудови діаграми Ісікави встановлено, що найбільш важливими причинами, які впливають на рішення даної проблеми, є категорії «Магістрант», «Матеріально-технічне та навчально-методичне забезпечення навчального процесу», «Управління навчальним процесом», «Контроль навчального процесу».

**Ключові слова:** системний підхід, причинно-наслідкові зв'язки, діаграма Ісікави, кластери, модель графіків.

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Целью работы является построение графических причинно-следственных моделей эффективности подготовки магистров в университете. Для того чтобы определиться с причинами, влияющими на эффективность подготовки магистров, была построена причинно-следственная диаграмма Исикавы, в которой были выделены казуальные категории, обуславливающие ее эффективность.

**Ключевые слова:** системный подход, причинно-следственные связи, диаграмма Исикавы, кластеры, графовая модель.

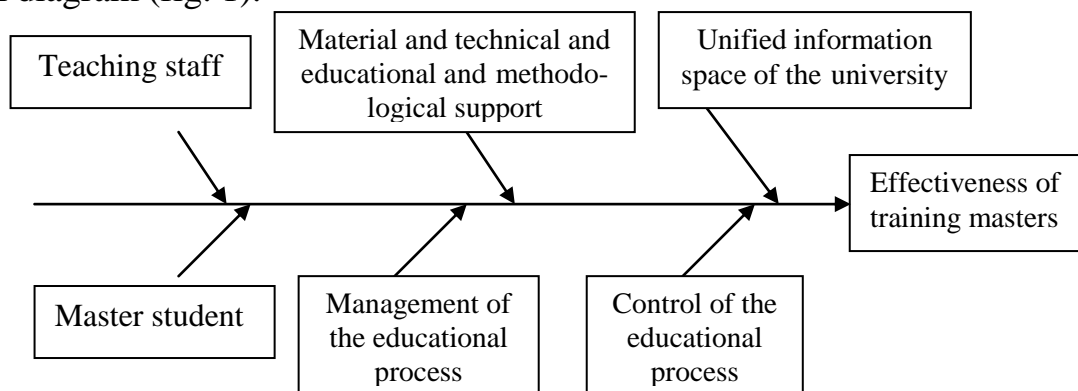
**Introduction.** Since the middle of the twentieth century, the ever-deeper specialization of the rapidly growing volume of knowledge threatened the emergence of a fragmented picture of the world among specialists limited by the current problems. As a result, there could be a loss of the pace of innovation processes and, as a consequence, a slowdown in the development of the economy. There was a need for intellectual tools that would improve the efficiency of managing complex technical, organizational, natural, social and other processes by attracting trained specialists.

One of these tools has become a systems approach as a method for studying complex and developing objects. It takes into account the connections between various elements of systems and the significance of these connections. The relevance of solving complex, interdisciplinary problems of various natures during the modernization of higher education using a systems approach determines the practical need for the development of the apparatus of systems analysis and synthesis, starting with modeling the corresponding problem situations.

The training of masters in Ukraine, which provides a complete higher education for students, is complicated by an acute shortage of modern scientific and technical literature [1] and other problems of the development of the second level of education in universities. Of course, the use of information technologies and network resources softens the situation, but does not remove the urgency of improving training, taking into account modern results of science and technology, the development of methodology and tools of applied and fundamental sciences.

**Problem's Formulation.** The ability to see the dynamics of the development the all elements of the system, taking into account their interaction, is based on the establishment of cause-and-effect relationships between the inputs and outputs of the system. It is necessary to use and develop casual modeling of learning processes in higher education. The aim of the work is to build graphical causal models of the effectiveness of training masters at the university with the transition to the results of such training.

**Presenting of main material.** In order to determine the reasons affecting the effectiveness of the training of masters, let us consider the corresponding Ishikawa causal diagram (fig. 1).



**Fig. 1. Ishikawa diagram of determining the effectiveness of training masters**

In accordance with the “six M” rule [2] (to avoid excessive cumbersome of the model, no more than six main possible reasons-categories), casual categories are identified that determine the effectiveness of training masters, namely:

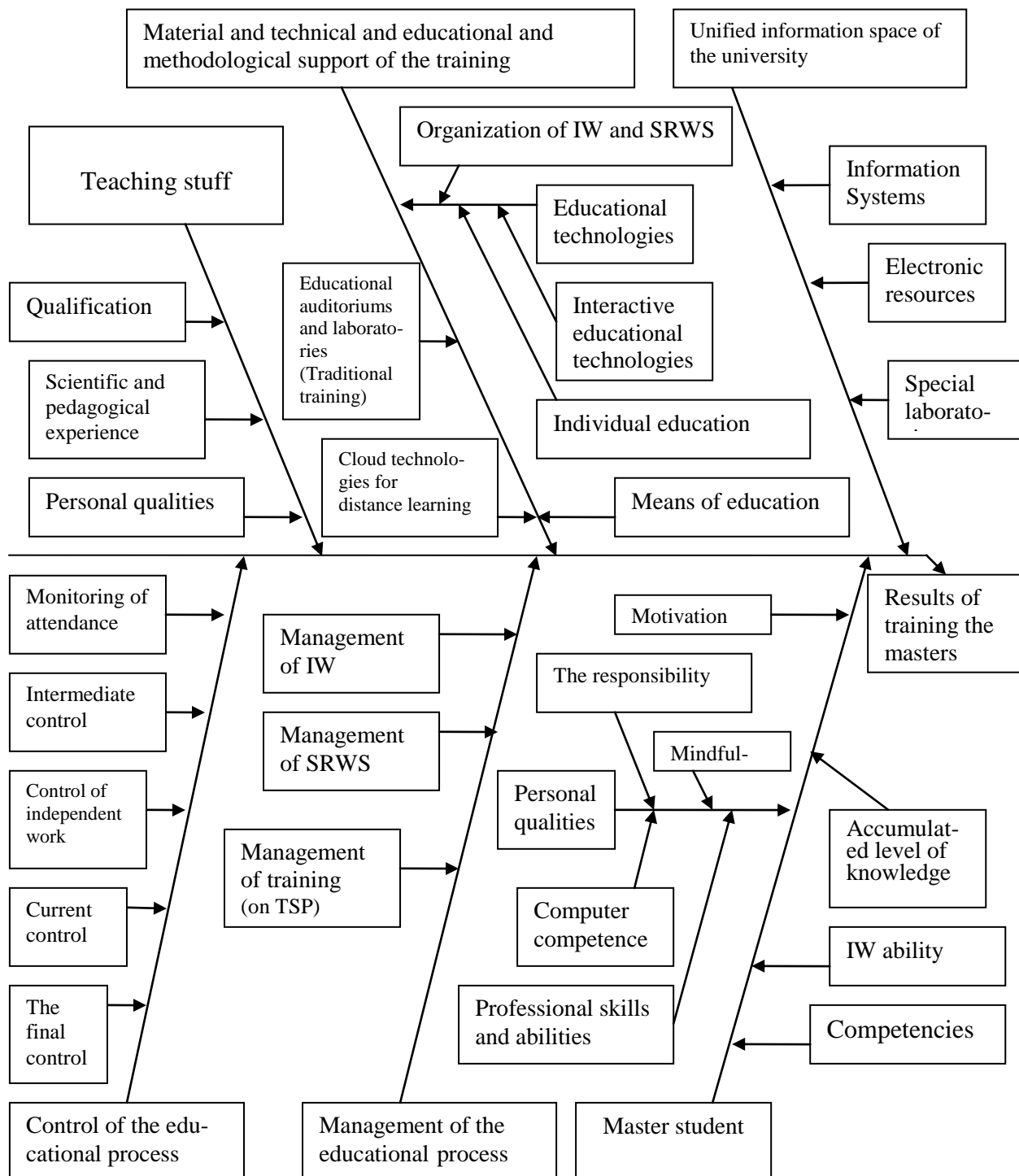
- "Teaching staff",
- "Material and technical and educational and methodological support of the educational process",
- "Unified information space of the university as an external environment of the educational process",
- "Master student",
- "Management of the educational process",
- "Control of the educational process".

During the decomposition, the factors that determine the influences of the above reasons are noted (fig. 2).

As a result of constructing the Ishikawa diagram, it was found that the most important reasons that affect the solution of the problem - the effectiveness of the training of masters, are the categories "Master student", "Material and technical and educational and methodological support of the educational process", "Management of the educational process", "Control of the educational process". Having considered the category "Material and technical and educational and methodological support of the educational process", we can conclude that, in turn, the most important link is "Educational technologies", which include such important components as the organization of independent work and research work of future masters, interactive educational technologies and individualization of education. In modern conditions, the implementation of educational technologies is directly related to the functioning of information systems. The "Information Systems" factor determines the nature of the activity of the entire university, since information technologies ensure the movement of educational digital resources from university to undergraduate, create a unified information space of the educational institution, which

makes the work of the university easier, more convenient, reduces the load factor on its various departments and often excludes errors due to human factors.

At the present stage, the joint activity of the student and the professor on the development of a plan for additional training becomes relevant.

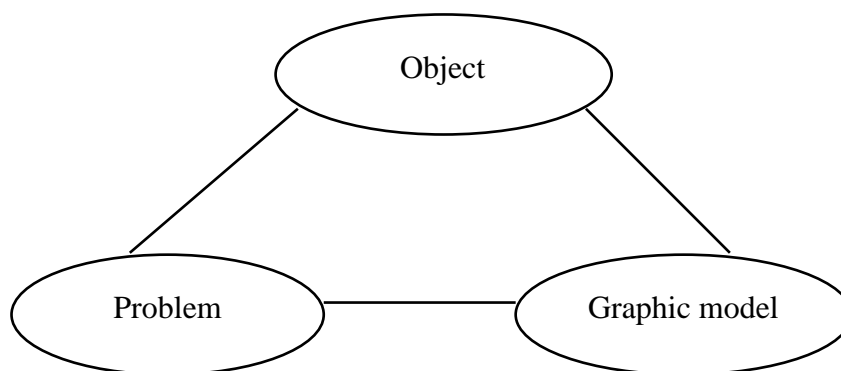


**Fig. 2. Ishikawa diagram of determining the results of the preparation of masters**

By defining the teaching plan, in fact, a strategy for improving the level of training is being developed. The study of topics cannot be chaotic. First, the order of study should be established for selected new topics; and secondly, all these topics

must be evenly distributed over the entire academic year so that they are consistent with the material considered in educational and professional programs [3]. For the scientific and methodological substantiation the design of training, you can use the graphical modeling of the cluster (fig. 3).

The structural representation of a set of topics (problem) with their interrelationships leads to the construction of a graph, i.e. to building a cluster [4]. At this point, the cluster is perceived as a set of new concepts and new methods, and we can say that it belongs to a conceptual type.



**Fig. 3. Section of the cluster**

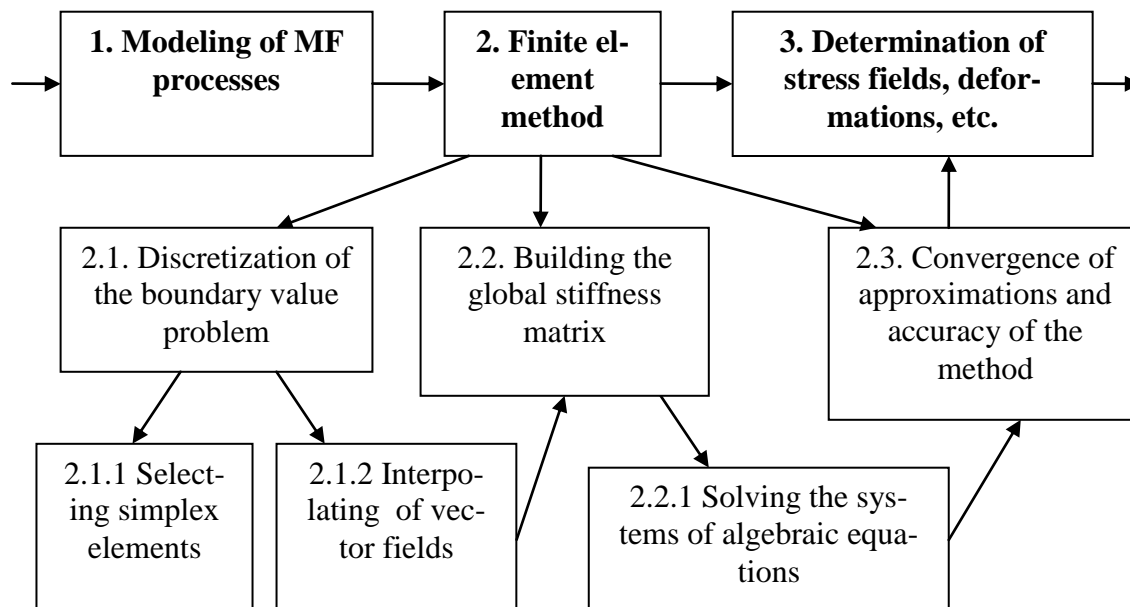
Further concretization of the content of each topic shows that it, as a system, again contains some elements. Each theme becomes a micro-cluster, the elements of which can be depicted on this cluster.

In order to the clarification of the content depicting the relationships between the topics, linking the cluster to time periods, marking the places of study in which one can receive education or advice on this topic it can using the design of the cluster, that turns into the development of tactics for improving teaching in accordance with the selected level. At need moment, the cluster can be rebuilt, and since the student perceives it as some kind of guidance (algorithm) for the upcoming activity, it will be of the algorithmic type.

In addition to the topics from program, the study of which should last from 2 to 4 hours, it is necessary to highlight a section with the conventional name - "program mixture". This is a set of tasks (problems) that are formally within the framework of the program material, but are characterized by the unusual wording of the questions. Standard methods must were master in the cluster, which are the basis for starting the development of non-standard topics.

It is obvious that the cluster as a structural and logical scheme has a number of advantages over the textual presentation of the material. When the material is perceived in the form of text, it can be quite difficult to determine the structure of the studied phenomenon, as well as to establish significant connections between the components of the system, which complicates the understanding and comprehension of the studied object (material). However, these difficulties in most cases are removed with a cluster feed of material, where the relationships are depicted and viewed more clearly.

For example, one of the main sections of the discipline "Methods of Analysis, Modeling and Optimization of Metal Forming Processes", which is part of the mathematical training of university undergraduates, is the finite element method. We consider the section as a sub-cluster in the design of methodological support, planning and conducting classroom studies and independent work (fig. 4).



**Fig. 4. Graph model of teaching the section "Finite element method"**

The constructed graph model for studying the "Finite Element Method" section develops students' understanding of the sequence of presentation the educational material on this topic, and also provides the student with an understandable algorithm for solving problems related to dividing the area under study into finite elements, finding solutions to algebraic systems, convergence of the obtained approximations, etc.

The method of working with mathematical clusters of specialized disciplines in practical classes with students, for example, according to the textbook [5], can be organized using case technology, the stages of which are:

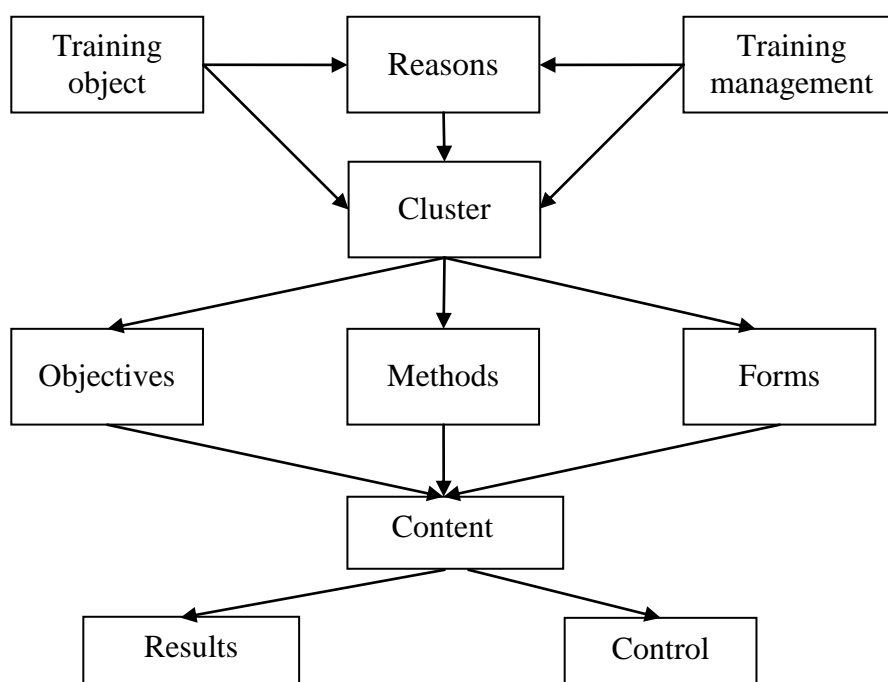
- analysis of a specific situation on the topic in order to form the need for the presentation of text information for the cluster;
- demonstration of the advantages of cluster presentation of information and the formation of methods for mastering this result by students;
- actualization of a certain set of knowledge and skills, which the student must own;
- division of the study group into subgroups, which are given tasks for the development of clusters;
- analysis of activities in terms of subject matter and in terms of self-study after the preparation of clusters.

The use of case technology increases students' interest in active teaching methods, develops communication skills, forms the ability to listen, competently express their thoughts and substantiate their conclusions.

When developing clusters in mathematics, situational tasks (cases) can be created in various directions, in accordance with the accepted classification of clusters:

- conceptual clusters for the systematization of knowledge in the presence of a large number of the simplest concepts;
- conceptual clusters for structuring knowledge to highlight links between the simplest concepts;
- conceptual clusters for the formation of correct speech and understanding the meaning of the entering symbols in a complex concept (for example, an integrand function, upper and lower limits of integration, differential of a variable, variable of integration in a complex concept of a definite integral);
- operational clusters;
- algorithmic clusters,
- story clusters;
- reminder clusters.

The cluster as a teaching tool and as a teaching and development method influences many components of the teaching methodological system (fig. 5).



**Fig. 5. Components of a methodological training system**

Planning, organizing and conducting classes of various forms with using casual-cluster modeling provides one of the most effective implementations of a systems approach in the training of undergraduates.

**Concluding discussion.** In modern conditions, the training of masters requires the introduction of modern forms and methods of teaching, a radical restructuring of the process of activities of the tutors and master students, and improvement of methodological support. The use of a systematic approach in the form of casual graphic modeling in the analysis and synthesis of solutions to emerging problems contributes to the improvement of master's training.

When building any cluster, the image of elements in the form of a graph or other graphic model reflects a specific arrangement of elements. Visualization of textual, formulaic and calculated information plays an important role in understanding the material under study, further operating with the constituent elements, but a particular cluster may reflect some particular case or some type of general concept. Consequently, guidelines for using a cluster should help to move from a general concept encoded in textual information to an image of a cluster, that is, illustrations in some special cases, and then to a return to obtain appropriate conclusions in the language of a general case.

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*Received 29.06. 2021.*