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Summary. Article reconstructed genesis of ideas about education in the philosophical systems thinkers of classical Greece in the framework of the chronological end of VI - IV century. BC. e., when there are original ideas on education, the authors are famous thinkers, philosophers, scientists, Pythagoras, Heraclitus, Democritus, Isocrates, Socrates, Plato, Aristotle and others. In moral and ethical teachings of wise men find the idea of combining training and education, the formation of such important features as charity, patriotism, honesty, love of truth and more.

Keywords: education in the age of classical Greece and Hellenism, charity, mayyevtyky method, self

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THE METHODS OF CONSTRUCTING EXPERT SYSTEMS

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Summary. Discloses a technology development of an expert system, which includes five phases: identification, conceptualization, formalization, implementation, testing and trial operation. Each stage has its own components. Thus, the step of identifying connected with the comprehension of the challenges that lie ahead for future ES, and the formation of the requirements for it. At the stage of conceptualization conducted content analysis of problem areas identified used concepts and their relationships are defined methods for solving problems. This step completes the creation of a domain model. At the stage of formalizing the structure of assets and determined ways to present declarative and procedural knowledge. At run time, there is a creation of one or more prototypes of ES, which decides the required tasks. During testing, evaluates the selected method of knowledge representation in the ES as a whole. At this stage of trial operation check the suitability of ICS for the end user.

Key words: expert system, identification, conceptualization, formalization, implementation, testing, trial operation

Focus of problem. At the present stage of development of the Ukrainian state, the update of all spheres of social life in new ways to solve social, economic and political problems. Becoming independence accompanied by significant changes in the field of public relations, which provide a new type of relationship between education and society in general.

Researches and publications' analysis. In the last decade revived research in the field of artificial intelligence as one of the factors in the development of expert systems (V.Bespalko, V.Bykov, M.Bongard, I.Vasilevsky, M.Gavrilov, B.Gershunsky, V.Gladun, E.Mashbits, L.Mikulich, Newell, D.Pospelov, Yu.Ramsky,

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A.Stogny, O.Tihomirov, M.Tsetlin et al.). So, learning expert systems can be an important prerequisite for successful mastering of educational material, and thus a means of personal development.

The purpose and objectives of the article – reveal the design technology of expert systems.

The main material description. Currently, there is a certain technology development ES, which includes the following six steps: identification, conceptualization, formalization, implementation, testing and trial operation.

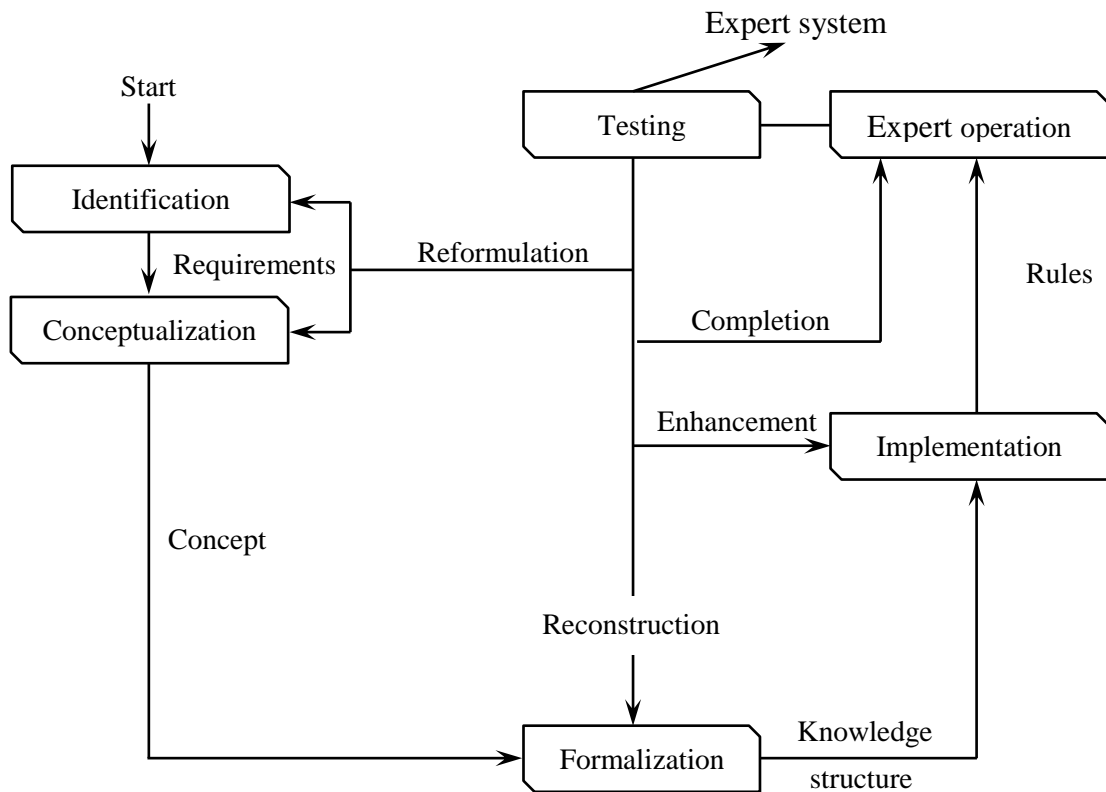


Figure 1. Technique (stages) of the development of ES

Tier identification. Phase identification is associated primarily with the comprehension of the challenges that lie ahead for future ES, and the formation of the requirements for it. The result of this phase is to answer the question, what should be done and what resources are necessary to enable.

Typically, the development of ES attended by at least three or four people - one expert, one or two knowledge engineer and a programmer involved for modification and harmonization tools. Also, the process of developing ES may be involved, as appropriate, and the other participants.

Identification of the problem lies in the preparation of non-verbal (verbal) description, which shall include: the general characteristics of the problem; subtasks are allocated within a given task; key concepts (objects) of the input (output) data; conjectural form of the solution, as well as knowledge related to the task at hand.

In the process of identifying the problem the knowledge engineer and expert work in close contact. Initial informal description of the problem using expert knowledge engineer to clarify the terms and buzzwords. Expert corrects the description of the problem, explains how to deal with it and what considerations form the basis of a decision. After a few cycles, clarifying the description of an expert

and the knowledge engineer prepared the final informal description of the problem.

In the design of ES resources are typical sources of knowledge, development time, computing resources and funding. For the expert knowledge sources serve his previous experience in solving the problem, the book known examples of problem solving, and for the knowledge engineer – experience in solving similar problems, methods of knowledge representation and manipulation, software tools.

At the *stage of conceptualization* conducted content analysis of problem areas identified used concepts and their relationships are defined methods for solving problems. This step completes the creation of a domain model (software), including basic concepts and relationships. At the stage of conceptualization identifies the following features of the problem: the types of data available; source and output data subtasks general problem; used the strategy and hypotheses; types of relationships between objects, the types of relations (hierarchy, cause – effect, part – whole, etc.); processes used in the decision; part of the knowledge used in solving the problem; types of constraints imposed on the processes used in the decision; composition of knowledge used to inform decisions.

There are two approaches to the process of constructing a model of the domain, which is the goal of the developers at the stage of conceptualization ES. Indicative of an attribute or an approach assumes that the information received from experts in the form of triples object – attribute – the attribute value, and the availability of training information. This approach is developed in the framework of the direction, known as the generation of knowledge, or «machine learning».

The second approach, called structured (or cognitive), carried out through the allocation of domain elements, their relationships and semantic relationships.

For attributive approach is characterized by the most complete information about the subject area: about objects, their attributes, attribute values. In addition, the essential point is the use of additional training information, which is given by grouping objects into classes on a particular substantive criterion. Three object – attribute – the attribute value can be obtained using the so-called method of reclassification, which is based on the assumption that the problem is an object-oriented objects and tasks are well known to the expert. The idea of the method is that the constructed rules (the combination of the attribute values), allowing to distinguish one object from another. The training information may be given on the basis of precedent right expert opinions, for example, by the method of extraction of knowledge, known as «thinking aloud protocol analysis».

If you have training information for the formation of a domain model in the conceptualization stage, you can use the whole arsenal of methods developed in the framework of pattern recognition tasks.

A structural approach to building the domain model involves the allocation of these cognitive components of knowledge: 1. Definitions. 2. Relationships. 3. Meta-concept. 4. Semantic relationship.

The allocated domain concepts should form a system, which is understood as a set of concepts, with the following properties: Unique (lack of redundancy); completeness (a complete description of the various processes, facts, phenomena, etc. subject area); reliability (validity – corresponding to the selected units of semantic information to their real name) and consistency (absence of homonyms).

When building a system of concepts using the «method of local representation» the expert asked to break the task into subtasks for the transfer of the target states and describe the general categories of targets. Next to each partition (local view) formulates expert information and facts gives them a clear name (title).

«The method of calculating the utilization rate» is based on the following hypothesis. Data Element (or the fact of the information) may be a concept, if:

1. It is used in a large number of subtasks.
2. It is used with a large number of other data elements.
3. Rarely used in conjunction with other elements of data compared with the total number of its use in all subtasks (this is the utilization factor).

The obtained values can serve as a criterion for classifying all data elements and thus for the system concepts.

«The method of formation of the list of concepts» is what the experts (it is desirable that there were more than two) is given the task to make a list of concepts related to the study subject area. Concepts, isolated all the experts are included in the system of concepts, the rest to be discussed.

«Role-based method» is that given the task to train the expert knowledge engineer solving some problems of the subject area. Thus, the expert plays the role of the teacher and the knowledge engineer – the role of student. The learning process is recorded on tape. Then, a third party listens to audiotape and writes on paper all the concepts, the use of a teacher or student.

When using the method of «drawing up a list of elementary actions», the expert is given the task to make such a list for solving the problem in an arbitrary order.

In the method of «drawing up a table of contents of the textbook» the expert is invited to imagine a situation in which he was asked to write a textbook. It is necessary to create on paper a list of expected titles, chapters, sections, paragraphs and subparagraphs of the book.

«Textual method is» the formation of concepts is that the experts given the task to write down of guidelines (books, specialty) some elements, is a unit of semantic information.

Group methods of establishing the relationship involves the establishment of semantic proximity between the individual concepts. At the heart of the establishment of the relationship is the psychological effect of «free association», as well as a fundamental category of the proximity of objects or concepts.

The effect of free association is as follows. The subjects were asked to respond to a given word first came to the mind of the word. Generally, the reaction of most of the subjects (if the words were not too unusual) are the same. The number of transitions in the chain can be a measure of «semantic distance» between the two concepts. Numerous experiments confirm the hypothesis that for any two words (concepts) there is an associative chain, consisting of no more than seven words.

«The method of free association», is based on a psychological effect.

In the method of «sorting cards» starting materials are drawn on card concept. Apply two variants of the method. In the first expert to set some global criteria for the subject area in which it should be guided when folding cards into groups. In the second case, when it is impossible to formulate criteria for the global expert is given the task to spread the cards into groups according to the intuitive understanding of the concepts of semantic proximity requirements.

«The method of detecting regularities» based on the hypothesis that the elements of the chain concepts that a person remembers with certain regularity, have a close relationship associative. For the experiment, 20 randomly selected concepts. The expert presented one of the selected numbers. The procedure is repeated up to 20 times, and each time the initial concepts have to be different. Then

the knowledge engineer analyzes the chain in order to find the recurring concepts (regular). Inside the allocated so that groups are set associative relationship.

In addition to the above-mentioned informal methods to establish relationships between different concepts also apply formal methods. These primarily include the method of semantic differential and repertory grids.

Dedicated domain concepts and the relationships established between them serve as the basis for the further construction of the system metaconcept – meaningful in the context of the study of the subject area groups of concepts. To determine these groups use both informal and formal methods.

Interpretation is usually easier to give expert groups if obtained by informal methods. In this case separate classrooms more apparent to the expert. And in some subject areas it is not necessary to establish the relationship between the concepts, metaconcept, figuratively speaking, «lie on the surface».

The final step in constructing a domain model with the conceptual analysis is to establish semantic relationships between the selected concepts and metaconcept. Set semantic relationships – this means to determine the specifics of the relationship resulting from the use of various methods. To do this, you must understand the relationship of each lock and take it to one or another type of relationship.

«Direct method» of establishing semantic relations based on direct understanding of each relationship.

For the «indirect method» does not necessarily have a relationship, but rather the existence of a system of concepts. Formulate some criteria for which the system selects a certain set of concepts. This collection is presented expert to give a verbal description to formulate criteria. Concepts are presented to the expert all at once (preferably on the cards). In case of difficulties experts resorted to a partition selected concepts into groups using smaller criteria. The initial number of concepts can be arbitrary, but after the split into groups in each of these groups should be no more than ten concepts. Once compiled descriptions for all groups, experts are invited to combine these in a single description.

The next step in the indirect method of establishing semantic relationships – an analysis of the text drawn up by an expert. Concepts replaced by figures (this may be the original numbering), and ligament left. Thus, we construct a graph whose vertices are concepts and arcs – binder (for example, «view», «results», «put on one side», «determining,» «combining,» «determine») This method allows you to set not only the basic relations, but also relations that are specific to a particular domain.

The above methods of forming a system of concepts and meta concepts, networking and semantic relations in various combinations are used on the conceptualization stage in building the domain model.

At the *stage of formalizing* the structure of assets and determined ways to present declarative and procedural knowledge, carried out this representation and eventually formed the description of the solution of the problem on the proposed ES (knowledge engineer) a formal language.

The output stage of formalization is a description of how the problem can be represented in the selected or developed formalism. This includes the designation method of knowledge representation and identify ways to manipulate this knowledge and interpretation of knowledge.

The purpose of the runtime – the creation of one or more prototypes ES solving the tasks required. Then, at this stage, based on the results of testing and pilot operation creates the final product suitable for industrial use. Development of a pro-

prototype consists in programming components or selecting them from known filling tools and knowledge base.

Important in creating a prototype is provided to the prototype test the adequacy of the ideas, methods and techniques of knowledge representation tasks. Create the first prototype should confirm that the selected methods of making and methods of presentation suitable for the successful solution of at least a number of tasks from the current domain, and demonstrate a tendency to obtain high-quality and efficient solutions for all the problems of the subject area as the increase of knowledge.

During the testing phase evaluates the chosen method of knowledge representation in the ES as a whole. To do this, the knowledge engineer selects examples to scan all possible to develop ES.

There are the following sources of failure in the system: test cases, input-output, output rules, control strategy.

Demonstration test cases are the most obvious reason for the unsuccessful operation of ES. In the worst case, test cases can be generally outside the domain to which the ES is calculated, but often a lot of test cases is too uniform and does not cover the whole subject area. Therefore, the preparation of test cases should be classified according to their subproblems domain, highlighting the cases of the standard, defining the boundaries of difficult situations, etc.

Input-output characterized by the data acquired during the dialogue with the expert and the conclusions brought by ES during the explanation. Methods of data acquisition may not produce the desired results, as, for example, asked the wrong questions, or are not collected all the necessary information. In addition, the system issues can be difficult to understand, meaningful and relevant knowledge user. Entry errors can also arise due to inconvenient for the user input language. In some applications the user input is not only useful in the printing, but also in graphical or audible form.

Often errors in the ES led applied control strategy. Changes in strategy is necessary, for example, if the ES analyzes the nature of the procedure other than the «natural» for the expert.

Criteria for evaluation of ES depend on the point of view.

At the stage of *trial operation* check the suitability of ES to the end user. Suitability ES user is determined primarily by ease of handling it and its usefulness. Under the ES understood the usefulness of its ability during the dialogue to define user requirements, identify and eliminate the causes of failures in the work and meet the specified needs of the user (solve the problem). In turn, the usability of the ES implies the naturalness of interaction with it (communication in a familiar, does not tire the user form), flexible ES (system's ability to adjust to different users and take account of changes in the qualification of the same user) and the stability of the system to errors (the ability to not fail when the erroneous actions of inexperienced users).

During the development of ES is almost always carried out its modification. There are the following types of system modifications: the reformulation of concepts and requirements, reverse engineering knowledge representation system and the improvement of the prototype.

Conclusions. Thus, the development of expert system technology includes five phases: identification, conceptualization, formalization, implementation, testing, trial operation.

МЕТОДИКА ПОБУДОВИ ЕКСПЕРТНИХ СИСТЕМ

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***Анотація.** Розкрито технологію розробки експертної системи, яка включає п'ять етапів: ідентифікація, концептуалізація, формалізація, виконання, тестування, дослідна експлуатація. Кожному етапу притаманні свої складові. Так, етап ідентифікації пов'язаний з осмисленням тих завдань, які належить вирішити майбутньої ЕС, і формуванням вимог до неї. На етапі концептуалізації проводиться змістовний аналіз проблемної галузі, виявляються поняття і їх взаємозв'язки, які використовуються, визначаються методи розв'язання задач. Цей етап завершується створенням моделі предметної галузі. На етапі формалізації визначаються склад засобів і способи подання декларативних і процедурних знань. На етапі виконання відбувається створення одного або декількох прототипів ЕС, яка вирішує необхідні завдання. У ході тестування проводиться оцінка обраного способу представлення знань в ЕС в цілому.*

***Ключові слова:** експертна система, ідентифікація, концептуалізація, формалізація, виконання, тестування, дослідна експлуатація*

МЕТОДИКА ПОСТРОЕНИЯ ЭКСПЕРТНЫХ СИСТЕМ

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***Аннотация.** Раскрыта технология разработки экспертной системы, которая включает шесть этапов: идентификация, концептуализация, формализация, выполнение, тестирование и опытная эксплуатация. Каждому этапу присущи свои составляющие. Так, этап идентификации связан с осмыслением тех задач, которые предстоит решить будущей ЭС, и формированием требований к ней. На этапе концептуализации проводится содержательный анализ проблемной области, выявляются используемые понятия и их взаимосвязи, определяются методы решения задач. Этот этап завершается созданием модели предметной области. На этапе формализации определяются состав средств и способы представления декларативных и процедурных знаний. На этапе выполнения происходит создание одного или нескольких прототипов ЭС, которая решает требуемые задачи. В ходе тестирования производится оценка выбранного способа представления знаний в ЭС в целом.*

***Ключевые слова:** экспертная система, идентификация, концептуализация, формализация, выполнение, тестирование, опытная эксплуатация*