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About the analysis of process of the solution of educational tasks

In article the analysis of process of the solution of educational tasks is given. In article it is shown that this process consists of several stages: understanding of the text, formation of representations or mental model, formation of physical model and decision. On each of these stages the being trained carries out a complex of cognitive operations. Formation of mental representation in working memory of the being trained results from creation of propositional structure of the text. The physical model is created on the basis of cognitive structures on the basis of private signs of a solved task. Operating by physical models assumes existence at the student of spatial imagination.

Key words: educational task, mental model, physical model, mathematical model, cognitive structure.

Important element of training is educational tasks. It is connected with two reasons. First, tasks form ideas of physical laws, borders of their application, of physical quantities and communications between them, about the physical principles of functioning of electro technical and electronic devices, semiconductor devices, etc. Secondly, tasks are a development tool of the person.

To teach to solve problems — the main pedagogical problem. In the course of the decision it is possible to allocate some stages. The student has to understand the text and statements of the problem. Then representation, or situational mental model, i.e. interpretation of statements of the problem is formed. Further the physical model of object or the phenomenon is formed. The mathematical model and the analytical solution of a task is in summary developed.

On each of the listed stages the student has to carry out the whole complex of informative operations. Therefore training in the solution of tasks has to make the main maintenance of practical studies.

Educational tasks are a universal object of training as the student masters and processes large volume of information. Thus division of tasks on «difficult» and «difficult» is today conditional. Uniform approach and uniform technique of determination of complexity of tasks in scientific literature isn't present [1, 2]. In [2] it is offered to estimate complexity of tasks of three factors: number of data in a task; number of the elementary operations which is carried out between a question of a task and the answer to it; and decision structure. However at all the subjective factor here isn't considered. The perception the student of a task as difficult or difficult is defined by process of judgment of its condition. Simplicity or complexity of the solution of a task depends on how the student analyzes her condition, establishes internal connection of data. By various estimates [2, 3] to 60 % of impact for efficiency of the solution of tasks has inability of pupils to transfer verbal information to images.

The problem of understanding of the text of a statement of the problem also is difficult and has interdisciplinary character. It is a consequence of psychological features of process of training. It should be noted that unambiguous interpretation of the term «understanding» in literature still is absent [4, 5]. In each subject domain of training process of understanding has the peculiar features caused by concrete features of a subject matter. By the text mean active process of the address of experience of the person on the text for the purpose of development of the contents of the text and the reality described in it.

How there is a process of understanding of the text containing the description, for example, of a physical task? When preprocessing text the student on the basis of visual and verbal data forms in memory mental representation of this phenomenon (either problems, or situations) — an intellectual image. If the student isn't able to imagine a situation in which objects possess properties and the relations specified in the text, he won't be able to understand the text.

The model of a task is formed as a result of gradual opening of communication this and required in the task, designated in [6] as «the main relation of a task».

Thus, at the solution of a physical task most important preprocessing of the text and formation of mental model are.

Text processing and its understanding begin with touch perception. Thus the person is capable to perceive the text only small parts from one — two words. As information processing speed less than a speed of its receipt, and memory size of the person I am limited, it is necessary to level input and information processing speeds. One of ways of decrease in speed of input of information is repetition, at which the pupil (mentally or aloud) pronounces read, translates touch perception of fragments of the text from a visual form in audile and motor. «Loop» on which information which hasn't got to short-term memory [7] circulates is thus formed.

Further transition from touch representation of the text to semantic in which the text is submitted in the form of system of values and meanings follows. At first there is an allocation from the text of familiar terms and concepts which are used further as main for formation of the general sense of a task and a conclusion [8].

At this stage value of control of integrity of the text, internal consistency of sense of a task and its compliance to a source text especially increases.

Then the stage of division of the text on separate elementary semantic units (pro-positions), i.e. portions of information which can be presented by a simple sentence follows. The offer can be estimated as true or false.

Necessary condition of understanding of a task is the understanding stage. Process of identification of relationships of cause and effect is closely connected with this stage between separate pro-positions. These communications are indistinctly expressed in the text, but can come to light in conclusions.

Thus, the first action at the solution of a task including physical is a propositional analysis of the text. But if the student has a small lexicon and there is no experience with texts, the analysis becomes impossible. Therefore by drawing up and writing of collections of tasks it is necessary to consider that students on level of knowledge of language represent non-uniform group. The language form of information transfer in educational texts has to be simple and effective. Such option is characteristic for the most popular Russian collections of tasks of physics, electrical equipment, electronics and other technical science [9–11]. Such feature of texts of tasks is caused by need of minimization of time which spends for judgment of reading separate offers.

Time necessary for formation of mental model, has to exceed time of preprocessing of the text.

Process of formation of situational model also includes some stages. At first data which treat active elements in the text are processed and remembered. Then these to data are attributed concrete values. Further there is a judgment of the hidden communications and properties of the considered objects which haven't been described in the text. Thus last experience which contains ideas of objects, the facts and communications between them in a verbal and figurative form becomes more active.

Processing of arriving information and its understanding happen in parallel. The image of a situation which collects all information for understanding of the text is as a result formed. Formation of mental model of a situation happens in the course of judgment of the text and stops after the structure of model becomes consistent and adequate to the text.

Quality of mental model depends on existence at the student in memory of a necessary set of basic images. The listed factors make essence of intelligence [8].

Mental images of objects share on two types: reproductive (visual) and images of imagination [7]. Both visual images, and images of imagination on complexity of a form and structure are equivalent to real (perceptual) images. Reproductive images are connected with memory. Images of imagination are created on the basis of the text description, schemes, formulas, the image, etc. Formation of images of imagination in the course of judgment proceeds under the influence of a task context, i.e. those communications and conditions which obviously in the text aren't described, but implicitly are present. The understanding of the text and context of a task has the same value, as well as creation of figurative representations of physical processes considered in it. If it isn't present, the course and sequence of the decision are formed in the conditions of uncertainty or lack of basic data. Formation of a paradoxical situation is as a result possible: the student solves a problem correctly, but not that which was offered him, and that which it created itself when reading the text of an initial task. As a rule, surface semantic treatment of a condition is the reason of such substitution. The model thus is under construction on the basis of templates and the stamps which are forming during training, at excessive hobby of so-called standard tasks.

Thus, a basis for the solution of a task is the mental model which is created by the student on the basis of the task text. Thus the student has to possess defined by perceptual experience and nonverbal knowledge of objects which are considered in a task. The image of a situation which results from interpretation is a basis for the following operations of thinking according to the solution of a task. In the solution of a task the most important is process of creation of this image. Therefore the best pupils use the main part of time for judg-

ment of statements of the problem, formation of idea of a situation and decision planning, and small part of time use for procedure of the solution of a task [7].

Processing of the text and creation of mental model of a task are connected with each other. Thus the second is a consequence of the first. The main operation in processing of the text of an educational task is the analysis. When forming mental model of a situation which is considered in a task, on the first place there is a concept and synthesis procedure. As a result of association of mental representations the image of an educational task as complete phenomenon is created. As a rule, information in the text of a task is insufficient to apprehend a situation. This information needs to be added with the details entered by pupils on the basis of perceptual experience and knowledge. Thus the initial uncertainty of information necessary for a choice of a way of the solution of a task is eliminated.

For all physical (and not only) educational tasks one general feature is characteristic: their objects are structured and possess system signs. The student at a stage of creation of an image of object of a task makes reflexive [12] transition to its description as systems. It is thus important to differentiate levels of a structure of object, their structure, the relation. The image of the physical phenomenon not always is visual, but idea of it as about set arises on the basis of cognitive structure.

Internal stable psychological systems of representation of knowledge which are at the same time systems of the analysis of information treat cognitive structures. Cognitive structures include base of empirical knowledge of the surrounding subject world. Concrete knowledge of the facts, laws, the phenomena has to develop on the basis of these structures. They form a stable basis of dynamic processes of the analysis, synthesis, abstraction and generalization [8].

Schemes of knowledge as elements of cognitive structures define a way of interaction studying with environment (Piaget). Development of the student is a consequence of congenital aspiration to make use of the experience for achievement of the maximum adaptation to environment. It is promoted by two main processes: assimilation and accommodation. Assimilation allows reacting to environment on the basis of experience and existing cognitive schemes. Accommodation or change of mental structures happens at emergence of a cognitive imbalance when existing knowledge doesn't allow reacting to external incentive adequately.

The active role in interaction with environment belongs to the subject of knowledge (to the student, the pupil). In this case forecasting or planning of reaction of environment and its analysis is possible. Thus, a driving force of cognitive development is the aspiration of the pupil to dynamically equilibrium state in the course of vigorous activity. And formation and development of cognitive structures possibly in the conditions of a cognitive imbalance, in the presence of certain contradictions between influences of environment and cognitive structures. Such situations arise both in practical activities of the pupil, and in the course of training.

Representation of physical knowledge is carried out by difficult cognitive structures. These structures represent physical models and describe real material objects and their interactions among themselves and environment [3]. Formation of physical models happens in the course of practical activities and as a result of the academic training. In the first case their value is limited to private practical tasks. The models resulting scientific researches, are elements of public knowledge.

The physical model of object differs from its mental image the following signs:

- metric properties;
- determinism of changes and dynamic characteristics;
- spatial characteristics;
- differential and integrated properties.

As metric properties of model understand physical quantities which describe properties of model. The determinism of changes and dynamic characteristics of model are caused by changes of physical quantities as a result of interaction of components with each other and with environment. Spatial characteristics of model fix its own spatial properties and the relations with other objects.

Use of physical models assumes high level of spatial thinking. In the course of the solution of a physical task difficult physical models are formed of the mental image created on the basis of a statement of the problem, or of simple physical models during their transformations. Thus training is always directed from objects less differentiated to objects more differentiated that corresponds to the principle of system differentiation [8, 11].

The essence of mathematical model is made by mathematical communication between physical quantities and their changes. In the course of the solution of a physical task this stage is possible after formation of mental situational model, it's possible transformation and creation of physical model.

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Есепті шешу үдерісін талдау

Мақалада есепті шешу үдерісі талданған. Оны шартты түрде бірнеше сатыға бөлуге болады: есептің мазмұнын, шартының ерекшеліктерін мұқият талдап түсіну; есептің шартындағы физикалық құбылыстарды және олардың жүру ерекшеліктеріне аса көңіл аудару; есепті шешу барысын елестету; есепті шешу; есепті шешу барысында алынған деректерді талдау. Келтірілген әрбір саты барысында студенттердің танымдық мүмкіндіктері қалыптасады. Есептің мазмұнының, шартының ерекшеліктерін талдау барысында студенттердің танымдық мүмкіндіктері артып, логикалық ойлау қабілеттері жетілдірілді.

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К анализу процесса решения учебных задач

Проанализирован процесс решения учебных задач. Показано, что он состоит из нескольких стадий: понимания текста, формирования образного представления или ментальной модели, формирования физической модели и последующего решения, на каждом из которых учащийся осуществляет комплекс когнитивных операций. Отмечено, что формирование ментального образа в рабочей памяти происходит в результате построения пропозиционной структуры текста на основе имеющихся в памяти базовых структур, путем их трансформации или объединения. Авторами определено, что физическая модель создается на основе когнитивных структур при наделянии их частными признаками решаемой задачи. Доказано, что оперирование физическими моделями и отношениями между ними предполагает наличие у студента развитого пространственного воображения.

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