Effective system of learning for engineers

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Abstract. The article analyzes the problem of the formation of a system of intensive computerized learning (SICL), based on the consistent use of didactic foundations for creating effective learning systems. The paper generalizes experience of using SICL to create training courses for students of technical areas and specialties. The paper uses the author’s experience of implementing an additional professional educational program for advanced training and professional retraining of higher education teachers “Development of the content of professional education, improving its quality in inextricable connection with science”. The creation of SICL for academic discipline begins with the statement of the didactic task and continues with the formation of the didactic system (a system of methods, means and forms of training). The didactic system (DS) takes into account the conditions of the didactic task and the laws of learning. The theory and methodology of SICL are described for three groups of stages of learning: lecture (presentation), work (bringing to the required level of mastery of educational issues) and final (bringing to the required level of mastering of the content of topics, sections and parts of the academic discipline). The stated positions can be used to create a computerized textbook that forms the basis of SICL.

1. Introduction

In recent decades, a large-scale modernization of education has been taking place in the Russian Federation. It aims to create new principles for the formation of a competent and highly qualified human potential, as an important factor in innovative economic development and the country's geopolitical competition. Activities carried out by the state in this direction are reflected in the National Education Project (2019-2024). The project is subordinate to the development of the educational space in our country. It is aimed at ensuring the global competitiveness of Russian education and becoming one of the 10 leading countries in the world in the quality of general education. [5,7]
The implementation of the National Project involves the implementation of several main areas of development of the education system, including: updating its content, creating the necessary modern infrastructure.

Achieving high learning outcomes has always been the main requirement for our universities. And the results are formed, first of all, by the competence and motivation of teachers, their knowledge of the methods of effective training systems and ensuring the availability of these systems for students.

2. **Formation of the competencies of an engineer in the field of construction, road, lifting and communal machines**

In our opinion, the list of the main competencies of a modern teacher should include a set of professional and pedagogical knowledge, skills and possessions, which allows him to be in demand and participate in practical research in the field of construction, road, lifting and communal machines, as well as in the development of intensive systems of training, and in the implementation of such systems in the educational process for students of construction specialties and areas. [3]

3. **Creation of a system of intensive computerized learning (SICL)**

The problem of creating effective learning systems has interested the pedagogical community all the times. This issue is considered as one of the most significant for modern education in Russia. The creation of effective learning systems is also of interest to higher school teachers. There are many studies on this subject. [2]

The most progressive solution in creating effective learning systems is contained in the work of the research team under the guidance of A.A. Zolotarev. The authors developed a concept that highlights the theory and methodology of systems of intensive computerized learning (SICL). The purpose of the concept is to offer the developers of the educational process, and, first of all, teachers and practitioners, a theoretical basis applicable in any subject area, which combines the best of the well-known author's pedagogical schools and their own experience into an effective holistic system that allows students to form competencies. [6]

The creation of a system of intensive computerized learning (SICL) for each academic discipline is formed by certain sequential actions:

1. First, the didactic task is carefully developed and set.
2. After that, the didactic system is formed.
   - The teacher (as a researcher and as a developer) should be able to set a didactic task:
     - set learning goals,
     - form a structured content of the discipline,
     - determine the degree of readiness of students to study the discipline,
     - take into account the risks of organizational and material-technical groups,
   - Then the teacher designs, develops and implements the didactic system:
     - a system of methods,
     - system of tools,
     - a system of forms of learning,
     - adequate to the laws of teaching and the conditions for the implementation of the pedagogical process.
   - This basic idea can be represented in the form of a written summary (Figure 1).
Figure 1. The main idea of intensive information learning.

The symbol "hift" means the student’s chair, in which the teacher should be mentally, designing the training system (technology) in accordance with the laws (stages shown in steps) of learning. Each of the nine stages has its own didactic system (Table 1.).

Table 1. The relationship between the stages of learning (teaching) and the elements of the didactic system.

| Elements of the didactic system | Lecture stages | Work stages | Final stages |
|-------------------------------|----------------|-------------|--------------|
|                               | Initial        | Key         | With full support | With reduced support | Without external support, slow | Without support, free | Final generalization | Control | Corrections and adjustments |
| Methods of learning | The system of teaching methods for lecture stages     | The system of teaching methods for work stages        | The system of teaching methods for final stages      |
| Tools of learning     | A set of training tools for lecture stages             | A set of training tools for work stages                | A set of training tools for final stages             |
| Forms of learning     | System of forms of teaching at lecture stages          | System of forms of teaching at work stages             | System of forms of teaching at final stages          |

The group of lecture stages (presentation) includes the first (initial) and second (key) stages. At these stages, the student studies the content in the volume of the educational topic, including several educational questions. The level of assimilation of the content at these stages demonstrates only the ability of the student to begin reproduction of information based on all the necessary teaching tools.

The group of work stages (internalization) includes stages from the third to the sixth inclusive. Here, on the background of the learned topic, each individual educational question is studied. The level of mastering the question increases with the transition from stage to stage and at the last stage - the sixth - reaches the ability to perform an action in the mental form at the skill level, i.e. automated, without supports.

The group of final stages includes stages from the seventh to the ninth. The seventh stage is devoted to the final generalization. It is similar to the work stages, but it does not apply to individual issues of
the topic, but to the topic as a whole. This stage may contain several sub-steps necessary to ensure mastery of the learner to the level of ability to perform a complex action at the level of proficiency. [4]

In the SICL concept, emphasis is placed on the phased assimilation of the learning content as the main pattern of learning.

The completion of the formation of SICL provides the passage of two steps in the formation of the didactic system, which corresponds to the condition of the stated didactic task and the laws of learning. At the first step, an a priori didactic system (DSa) is developed, and at the next, a real (DSr) system is developed.

In the process of formation, the a priori didactic system (DSa) does not take into account the restrictions imposed by the condition of the didactic task on the material base and the organization of training. Learning tools are only named at this stage.

The real didactic system (DSr) provides the limitations of the material base and the organization of training. This section is especially relevant for the training of engineering personnel in the field of construction, road, lifting and communal machines. Learning tools are defined here. It can be landfills, laboratories, stands, which will allow in practice to master competencies. Such objects can either belong to an educational organization or be used on a contractual basis. [1]

When designing a DSa, the learning tool are just named; when developing DSr, they are formed. With such a step-by-step procedure for the formation of the didactic system, it is possible to fix the difference between the “ideal” structure, which corresponds to modern knowledge about the pedagogical system, and the actual one, which is possible under the specific restrictions of pedagogical practice. This allows us to outline a plan for moving from a real system to a priori.

4. Structure of a system of intensive computerized learning (SICL)
This concept is included in the SICL as the first section. The second section of the SICL defines the content of the regulations for the process of setting the didactic task. Here, on the example of a certain topic, the sequence of steps of the SICL developer is presented, which includes: the formulation of the learning objectives; collection, selection and structuring of the content of the educational material; setting the levels of assimilation of educational material and requirements for the initial level of competence of students; the procedure for accounting for the inclusion of restrictions that are imposed on the input design data of the didactic system. [1]

The third and fourth sections demonstrate the theory of designing didactic systems, both at the lecture (presentation) and at the work stages of training, in addition, they prescribe the methodology for their development and use in the educational process. The third and fourth sections begin by examining the features of the formulation of didactic tasks.

The paragraphs of the sections that relate to the design of DSa should be completed with tables reflecting the relationship of the stages of training and elements of these systems.

The points of development of the DSr contain information on the nature, functions and technologies of developing training tools, and in addition, the types of classes within which these didactic systems can be implemented are defined.

A feature of the fifth section of SICL is its construction. It differs from the third and fourth sections because it is the peculiarity of the formulation of the didactic task at the final stage that determines the corresponding specific types of classes for each of the stages. These include a final lecture and a business game - both of these types of classes are presented as integral didactic systems.

The sixth section of SICL provides a summary table of the relationship between the stages of training and the elements of the didactic system. Based on it, an algorithm for designing a holistic didactic system adequate to the conditions of the didactic task is constructed. The section presents options for a training system that allows you to implement the developed SICL and thereby ensure the required quality of training.
The seventh section gives an idea of a computerized textbook, where using a specific example SICL is implemented in its unique didactic capabilities. Such a textbook is the core of SICL, which reflects the current state of the most important elements of the content of training - theoretical knowledge and knowledge derived from them about the algorithms for performing actions. In addition, the computerized textbook is considered the core of SICL because the system of training testing is included in it, which guarantees the unconditional formation of competencies among students. The creation of computerized textbooks will allow educational institutions to efficiently solve one of the key social and economic problems facing modern Russia: accelerated modernization of education in all its forms (full-time, part-time, part-time), and especially when distance learning technologies are used, including open learning education. [7]

5. Conclusion
The paper generalizes the experience of using SICL to create training courses for students of technical areas and specialties. The author’s experience of implementing an additional professional educational program for advanced training and professional retraining of higher education teachers “Development of the content of professional education, improving its quality in inextricable connection with science” was used. The creation of SICL for academic discipline begins with the statement of the didactic task and continues with the formation of the didactic system (a system of methods, means and forms of training). The didactic system (DS) takes into account the conditions of the didactic task and the laws of learning.

The article presents theory and methodology of SICL for three groups of learning stages: lecture (presentation), work (bringing to the required level of mastery of educational issues) and final (bringing to the required level of mastering of the content of topics, sections and parts of the academic discipline). The stated positions can be used to create a computerized textbook that forms the basis of SICL.

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