DIDACTIC DESIGNING OF RESOURCE SUPPORT FOR TRAINING ENVIRONMENT

Elena Vakhtina, Alexander Vostrukhin

***Abstract**: Designing of the training environment with expected qualities is considered as a multidimensional technology of Didactic design, which represents the aggregate of methodology and designing tools, and also methods and designing organization means. The functional model of the training environment development as a Didactic system and the tool of its realization – the logic-semantic model of a Didactic cycle are presented in the article. These models orient a teacher in search of new ways of solving training problems in the changing conditions of the educational practice. Didactic designing of educational resource for the interdisciplinary training module "Microprocessor technics" is offered as an example.*

The scientific novelty of the offered decision consists in allocation of the teacher activity elements in the process of designing an educational resource: constant interaction with professional environment of activity in the form of researches and (or) applied development, selection and systematic ordering of a material from various sources of the information, adaptation of this material to the learning process, creation and development the means of training.

***Keywords:** environment-based approach, didactic design, didactic system, didactic cycle, didactic multidimensional instruments, educational resource, training module, microprocessor technics, microcontroller, programming*

***ACM Classification Keywords:** J.2 Physical Sciences and Engineering – Electronics, Engineering, 1.2.6 Learning – Concept learning.*

Introduction

Educational practice for the last 15-20 years has essentially changed technically and technologically. Internet-technologies as the global information resource and communication means created unique conditions for the connection of national education systems in uniform educational space in which the concept systems of standards and technologies are formed. As the educational practice is realized in the educational environment, it is possible to affirm that this environment as the pedagogical system has stepped on the new qualitative level – information-educational. The Information-educational Environment (IEE) differs from the traditional one, first of all, by presenting new tools, formation the other space of students and teachers interaction. It is known, that this "interaction" is the subject of pedagogics as a science. The necessity in understanding the changes of pedagogical reality impels scientists to address for studying its sociocultural conditionality. It explains the increased interest of teachers, psychologists, sociologists for the training environment: factors, technologies, threats and IEE possibilities are studied.

Didactic Designing is a Systematic Approach for the Projecting of the Training Environment

So-called environment-based approach (E. Glaserfeld, J. Dewey, J. S. Manuylov, L. I. Novikova, V. A. Yavsin, etc.) [1 – 5] was developed in pedagogy. It can be considered not only as a conceptual direction but also as technology of the mediated management of the person formation and development process. It is known that the

environment, on the one hand, is an essential condition of the person development, and, on the other, is itself subject to change under the influence of human activities. Design is a special project activity, which is directed on the subject environment formation with certain functional and aesthetic qualities. The natural continuation of design development is replenishment of its basic directions: Industrial, Architectural, Landscape, Textile and others with Didactic design (D-design). There were all conditions for its occurrence: level of modern science and technics development, requirements of professional and educational societies. Vivid example of D-design establishment is formation of the educational environment within the limits of universal cultural space of the Internet. There is the integration of engineering (engineering methods of constructing and designing), system-activity (technological) approach in pedagogic and achievements of pedagogical sociology and psychology. Behaviourism (B. F. Skinner) [6], cognitive psychology (B. S. Bloom., J. Piaget, R. C. Clark) [7 – 9], social constructivism (L. S. Vygotsky, J. S. Bruner, A. S. Palincsar) [10 – 12], connectivism (G. Siemens) [13], the theory of contextual training (A. A. Verbitsky) [14], didactic multidimensional technology (V. E. Steinberg) [15], etc. can be considered as the basic theoretical and methodological harbingers of D-design.

Design in education extrapolates methods and means of design culture to all levels of vocational training with the purpose of their optimization [16]. We understand “Didactic design” as a technology of projecting the training environment (didactic environment) with the specified functional, socio-economic, ergonomic and aesthetic qualities. Didactic environment is a specially organized, aimed at the creation of a complex of didactic conditions facilitating the acquisition by the students of the certain knowledge and skills in a specific academic discipline, in which the objectives, content, methods and organizational forms of training become mobile and accessible for change (V. S. Lednev) [17]. Note that the objectives, content, methods and organizational forms of training are the elements of the Didactic system (D-system), i.e. the changes are taking place in the framework of the D-system.

V. P. Bespal□ko writes that "... everyone Didactic process has quite certain basic opportunities over quality of formation of students knowledge, skills and experience during given time" [18]. This means that if we aim to receive results of training of a required level and qualities, we should develop the D-system, which functioning will ensure the necessary orientation and intensity of pedagogical process.

Let's consider the model of D-system development (Figure 1). The process of the D-system development occurs over the spiral trajectory. There are four phases in the process: modeling, designing, constructing and operation [19, 20].

In the first phase "modeling" – on the basis of changes of conditions and factors of professional activity and occurrence of the new requirements to preparation of the specialists the changes of components of the working prototype-1 of D-system are predicted, and the model of the following prototype-2 is created [21]. In the second phase "designing" the contents and technological blocks of academic discipline (module) within the framework of the prototype-2 are developed. The third phase "constructing" provides check-approbation of the prototype-2 (the didactic project of academic discipline/module) and its correction on the basis of the received experimental data. The fourth phase "operation" consists of three stages: introductions, works and assessment of the D-system prototype-2 in educational process. It is necessary to note, that the scheme presented on the Fig.1 corresponds to functional model ADDIE (Analyze, Design, Develop, Implement, Evaluate) most popular in pedagogical design.

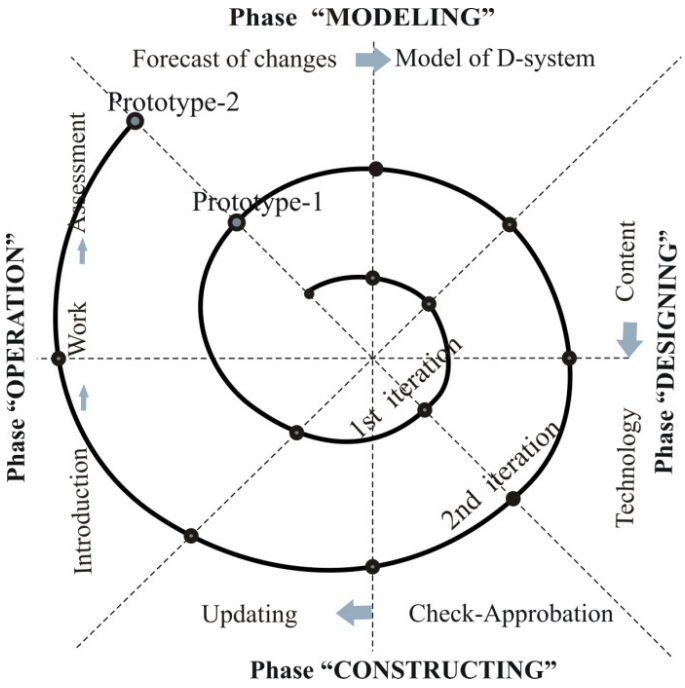

Figure 1. The spiral scheme of D-system development

The cyclic nature of the design process (analysis, forecast, project) and the cyclic functioning of the designed objects (the content of training and the technology of its mastering) determined the cyclic organization of D-design [22]. As a tool for D-design can be used the developed by us logic-semantic model of Didactic cycle (D-cycle) Figure 2. For its creation we applied the Didactic Multidimensional Instruments (V. E. Steinberg) [15].

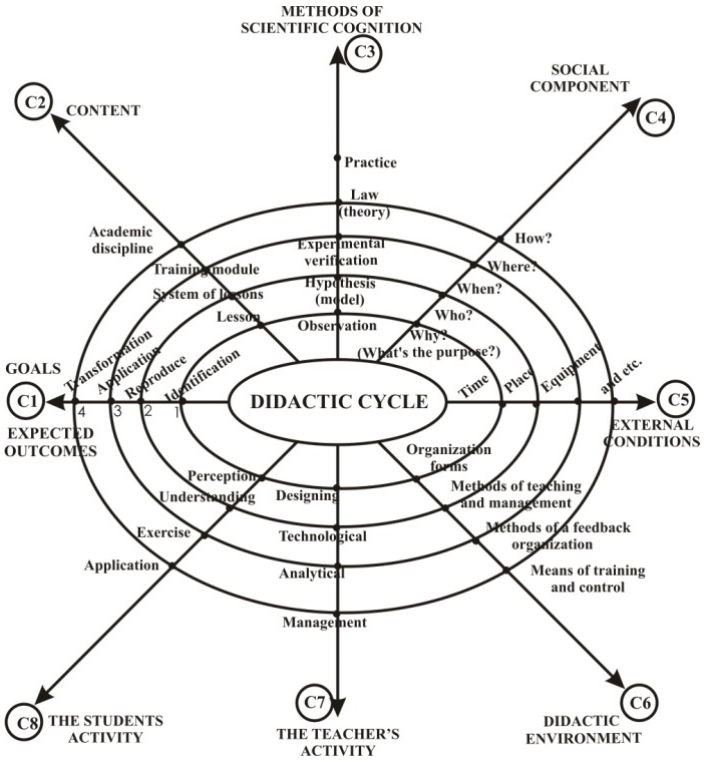

Figure 2. The logic-semantic model of D-Cycle

Under the D-cycle, we mean content-organizational unit of the educational process, preserving its essential characteristics. Depending on the "scale" in the study process of academic discipline highlight the following D-cycle: a separate lesson, the system of lessons over the topic, module, and the discipline as a whole. Since the D-cycle is the complete part of the learning process and at the same time is a fragment of cognitive activity, then it presents all components of the educational process in the appropriate "scale". From this it follows that in the basis of the model of «D-cycle», there should be objective, inherent for the cycles of different "scales" essential characteristics. To highlight them, we have combined two of the universal cycles: knowledge and management. Knowledge cycle: from the alive contemplation to the abstract thinking and from it to the practice, this defines the structure of the study process. Management cycle begins with statement of the training activity purposes and ends by the evaluation of their achievement results. As a result, we received two blocks of essential characteristics: the first is the "formation of content ", which includes the goals axis (C1), content of training (C2), methods of scientific cognition (C3), with the allocation of a social component (C4), for the harmonious coordination with the second "procedural block", which includes external conditions (C5), didactic environment (C6), the teacher's activity (C7) and the students activity (C8) Figure 2.

Designing of an Educational Resource for the training module "Microprocessor Technics"

We used the model of D-cycle as a tool for implementing the spiral scheme of D-system development on the example of an educational resource for the training module "Microprocessor Technics" [23]. This ER is a component of training environment which determines professional development of the engineer student.

We consider the training module as the functional unity of the content of training and technology of its mastering. The actuality of the module is especially high due to several reasons:

1) It is interdisciplinary and potentially innovative. Innovations in the technician and technologies are created now on an interdisciplinary basis as a result of integration of knowledge from various areas;
2) It is actually innovative. The last achievements of engineering and science are embodied in its content. Studying of this content involves using of information technologies.

However, now the experts in the field of vocational education [24, 25] mark a backlog (Educational Gap) in technologies of engineering education from a level of technologies in modern technical and information spheres of activity (including "microprocessor systems").

Phase "Modeling"

As known, modeling of the educational module on the basis of the prognostic results of training expressed as competences, is finding a solution of a "back task" in the conditions of interaction of the competency-based approach with other approaches developed in pedagogic and psychology. We will consider one of solutions of the problem. Concerning the purpose and results of training we will lean on the competency-based approach; the content of training – on the system-based approach; the organization of the training – on the technological and person-centered approaches; means of training – on the system-based and structure-based approaches.

The training purposes at the competency-based approach are set by the competences which are formed by studying of different disciplines (modules) of educational program. These competences are defined as the result of decomposition of the universal and professional competences and they are formulated in narrower terms of knowledge's, skills and experience. In other words, the disciplinary competences represent the results of training expressed through such components as knowledge's, skills and experience.

To gain the competences on the training module "Microprocessor Technics" the student should *know*:

– Appointment and scope of microprocessor devices;

- The basic types of microprocessors and architecture of computers;
- Microprocessor systems and microcontrollers;
- Programming languages the Assembler and (or) C;
- The integrated medium for creation and debugging of programs.

Should *be able:*

- To carry out the proved choice of the microprocessor (microcontroller) for the solution of an engineering problem in the field of measurement, management and automation of technological process;
- To project the microprocessor device (its hardware and software);
- To debug its work.

Should *own*:

- Skills of working out the microprocessor device for the solution of an engineering problem in the field of measurement, management and automation of technological process.

The competency-based approach orientation on the results makes comparable only qualifications, whereas the content of education including separate discipline (module) is defined by each university on its own, as Y. E. Babichev notices [26]. The competences orient a teacher on selection in the contents of discipline (module) of the practice-focused problems developing the student in the professional and social plan.

Phase "Designing"

As the integration mechanism providing transition of the content of training from a product of social experience to the personal experience, we used pedagogically designed educational resource (ER) – training-methodical and hardware-software complex (Figure 3). Training-methodical part of ER includes the textbook reflecting structure and the content of the training module [27]. Hardware-software block of ER consists of developed programs and hardware for their realizations – microcontroller test bench (laboratory) [28], allowing to develop practical skills of solution of creative engineering tasks.

Figure 3. Educational Resource for the training module "Microprocessor Technics"

About selection of the textbook content. Solving this question, we based on factors known in the pedagogics, determining the content of training: the purpose and personal activity in the training process.

The purposes of the considered educational module are described above. Each of them corresponds the block of the content. We will define the dominant purpose which will unite these blocks. As in the future almost all technical devices will work under control of the microprocessors, which work on the basis of a software, so it becomes a necessary part of engineering activity. However mechanical and electrical students do not have special skills in programming. Programming is often compared with art - its ability "to inhale life and intelligence into a dead semi-conductor crystal". Therefore it is necessary to study the programming first of all. The textbook, in which the questions of programming in the Assembler language of the AVR-microcontrollers of Atmel Corporation were considered, has been written for this purpose. We will explain such choice of the content.

The microcontroller (MC) of the AVR family of Atmel Corporation represents the single-crystal micro-computer with the restricted (reduced) instruction set. It is intended for management by various objects and processes. MC contains the processor, the memory, parallel and serial ports of data input-output, a set of the peripherals: timers/counters, analog-to-digital converters (ADC), pulse-width modulators (PWM), analog comparators (AC), etc. It is possible to construct on the basis of MC a multipurpose program-controlled digital system with inclusion of a minimum quantity of additional components.

According to the data of Internet quizzes (http://radioded.ru) AVR microcontrollers by Atmel Corporation are the most popular among hardware designers. By the ratio of price-efficiency-power consumption they are world leaders and industrial standard. Programming of these MC can be carried out in two languages the Assembler and C in the medium of AVR Studio, which is free and always accessible on site of Atmel Corporation (http://www.atmel.com).

There are a lot of manuals about AVR microcontrollers now where you can find examples of structures of different devices. However, the majority of them do not implement typical functions of information and measurement systems. Examples of programming of such functions, like conversion of physical properties and quantities into digital code, data input from sensors and keyboard, data output on the indicator, formation of managing signals by executive devices, etc. are carried out in the our teaching manual in order to fill this lack.

It is impossible to disagree with the opinion of the experts in the field of microprocessor technics - V. B. Brodin and A.B. Kalinin, that "the professional systems of designing should be used as training means, because the use of purely educational means deforms a designing technique and leads to necessity of the subsequent restudying". Therefore we use the Assembler language as the basic tool for the professional working out of programs. This language provides detailed elaboration at level of instructions, what allows using resources of the crystal as much as possible. The Graphic Assembler (Algorithm Builder) is adapted for MC AVR (http://www.algrom.net). The program is developed as algorithm; its logic structure becomes evident. Visibility of logic structure reduces probability of mistakes and reduces time of working out.

Phase "Constructing"

We have considered the fact that students receive a different level of education at the same content of training. A. A. Verbitsky explains it like, if the training content is defined by products of social experience, that the education content defines that level of development of the person, his subject and social competence, which is formed in the process of fulfillment of training-informative activity and can be fixed as its result at present time. In his concept of contextual training he offers at preparation of specialists "consistently model the content of

professional activity of specialists with of its subject-technological side (a subject context) and social side (a social context) in forms of students' activity" [14].

Therefore we offer to study programming in the training module on a concrete example of an automatic regulator of temperature (temperature regulator) – the microcontroller test bench. Temperature is the most often met quantity which is controlled in various technological processes. It is not of the principle difference what quantity to control. Distinction consists only in sensors of corresponding quantities and actuation mechanisms. On the basis of a temperature regulator the realization of the basic typical functions of control systems is possible: input of the information from the sensor and the keyboard, processing of the information and its output on the indicator, the control by an actuation mechanism, and fulfillment of various laws of automatic regulation.

Phase "Operation"

A student is given an engineering task – to develop the concrete device. Solving this problem he should use fundamental and applied knowledge from various adjacent areas: physics, computer science, electronics, metrology, automatics etc. Getting a practical result in the form of the working device is showing that the competences claimed by modern engineering activity are formed.

As a result of introduction of the ER "Microprocessor Technics" in the learning process of StSAU and STIS a number of measuring devices for non-electric quantities (temperature, humidity, dielectric permeability, frequency of rotation, etc), which are patented in Russia, are realized on its basis during degree designing and participation in competitions "UMNIK" and "START" (2010-2013) .

Assessment of support efficiency for training environment by means of the ER "Microprocessor Technics" were carried out over results of its work in learning process of students by criteria, selected in [22]: 1) Indicators of changes in integrative qualities of students knowledge: $К_e^{av}$ efficiency, $К_s^{av}$ system a city and $К_r^{av}$ knowledge reliability and their selective dispersion σ_e^2 , σ_s^2 and σ_r^2 ; 2) The parameter defining cognitive activity was the indicator of performance by a students' group of all learning projects during a semester $П_a$.

After the mathematical processing of the experimental data we received positive growth of relevant criteria's indicators.

Conclusion

According to the key idea of social constructivism, which lies in the fact that knowledge cannot be transferred to the student in finished form, and you can only create pedagogical conditions for their successful mastering. These conditions are shaped by the training environment, systematic designing of which is implemented by the didactic multidimensional technology. Functional model of this technology has a cyclical organization: modeling, designing, constructing and operation. The logic-semantic model of D-cycle can be used as a tool.

ER as a component of the training environment should be developed in unity of training module content and means for its mastering (studying, training, control and self-control). Only in this case, students obtain necessary and sufficient pedagogical support for their training activities.

The ER "Microprocessor Technics" developed by the authors is a system of actual content represented in the textbook in form of practice-oriented task with didactic support of solving and tools - programming environment and language, the set of programs of typical functions of information-measurement systems and microcontroller

test bench (laboratory). So, questions of innovative products development in education in frames of D-systems of new generation can be solved by means of didactic design.

In general, educational resources developed for formation of competence in the area of design and applications of microprocessor-based equipment are in demand in modern engineering education. Each of existing Russian and foreign scientific schools offers its own solution for design of resources like that. The best ones will be determined by conformity of their didactic opportunities with modern requirements of engineers' preparation and ergonomic requirements.

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