JOURNAL OF SCIENCE EDUCATION (REVISTA DE EDUCACIÓN EN CIENCIAS) N 2, VOL

4, pp 83-86, 2003

METHOD OF STUDY MODULES IN PHYSICS

MÉTODO DE ESTUDIO DE MÓDULOS EN FÍSICA

Anda Zeidmane

Department of Education and Department of Physics , Latvian University of Agriculture,

Cakstes 5, Jelgava, LATVIA LV 3001, e-mail: anze@cs.llu.lv.

Abstract

The main goal of science education is to find and investigate methods of the teaching science subjects and formation of scientific and technological literacy. The teachers' main goal is to work on use of students brain dominant hemisphere, not focusing on the weak one.

″Module″ is one of the units that a course of study has been divided into, each of which can be studied separately. Study module method' s goal is to provide a certain amount of knowledge and skills, which are realized, integrating separately divided study modules. Within physics study model: 1) the course has been divided into study forms; 2) separate themes have been divided into contents modules: The Title Background Knowledge Problem Additional Information Theme Solution Conclusions; 3) Evaluation method and evaluation scale corresponding to the method of study modules has been worked out for every module of study form.

Key words: modules of study form, modules of study contents, evaluation scale.

Resumen

El objetivo principal de la educación en ciencias es encontrar e investigar métodos para enseñar temas de ciencia y de la formación de conocimiento científico y tecnológico. El objetivo principal de los profesores es trabajar para que los estudiantes logren usar su hemisferio cerebral dominante. "Modulo" es una de las unidades que un curso de estudio ha dividido, cada una de las cuales puede ser estudiada separadamente. El objetivo del método de estudio de módulos es proveer de una cierta cantidad de conocimiento y habilidades, que son realizados integrando módulos divididos de estudio. Dentro del módulo de estudio de física: 1) el curso fue dividido en formas de estudio, 2) temas separados han sido divididos en módulos de contenido:Título conocimiento previo Problema Información Adicional Solución del tema Conclusiones; 3)método de evaluación y escala de evaluación correspondiente al método de módulos de estudio que ha sido trabajado por cada forma de estudio del módulo.

Palabras Clave. Formas de módulos de estudio, módulos de estudio de contenidos, escala de evaluación.

Introduction

Science knowledge is a basic element in modern education. It is indispensable in all areas of life – everyday, social and professional life. In various professions the science knowledge is an essential element. Examples are doctors, farmers, engineers, environmental protection specialists as well as science subject teachers and scientists dealing with corresponding areas of research. That's right! But, in my opinion, the most important role of science education in forming developed cognitive skills, such as interdisciplinary critical thinking, problem solving, decision making, is not enough estimated. In this context, everybody needs science education, but the development of Science education needs international collaboration. The 3rd IOSTE Symposium for European countries established the international team whose task was to prepare the report about the science education state in Europe. It is likely that similar problems are in America.

In the course of my 18 years of work experience with students in Latvia University of Agriculture, the conclusion has been drawn, that many students are capable only of concrete thinking (according to Piaget), many of them lack background knowledge and they are not aware of conscious study process methods, i.e. students "do not know how to learn". Never having achieved success in their studies, students often lose any interest about physics and either believe~~s~~ that the subject is unnecessary or complain~~s~~ that a lecturer's requirements are demanding for them to fulfill. (Due to political change in Latvia, it also have changed the basic education system – students in Secondary schools can choose not to include sciences)

The admission and graduation data at Latvia University of Agriculture are indicative of the critical situation in engineering specialties: 1) **The interest in most of the natural sciences has been recently decreased.** In the selection of University studies young people prefer subjects of a philosophical line. They hope they can apply in the social sciences their own opinion, constructive abilities and imagination more than in subjects in the natural sciences such as mathematics, physics and chemistry (see Table.1).

Table 1.

Admission Data at Latvia University of Agriculture in Economics Specialties (EK), Food Industry (PT), Woodworking (KA), Engineering (T), Rural Construction (B)

(Figer in bracket correspond to the planned number of students who can get a budgetary subsidy)

	1997		1998		1999		2000		2001	
	State financed students	**Additional for fee students**	**State financed students**	**Additional for fee students**	**State financed students**	**Additional for fee students**	**State financed students**	**Additional for fee students**	**State financed students**	**Additional for fee students**
EK(75)	75	**85**	75	**60**	75	**85**	75	**83**	75	**65**
PT (75)	76	**7**	82	**0**	75	**13**	76	**0**	79	**2**
KA (50)	53	**5**	50	**9**	52	**6**	50	**5**	47	**0**
T (100)	86	**0**	100	**12**	100	**23**	95	**0**	90	**9**
B (50)	46	**0**	50	**8**	51	**14**	50	**14**	50	**20**

2) The numbers of graduates in specialties of the engineering are about only 20% of the number of students who were admitted **(see Fig.1)**

Changing the attitude to science subjects and changing the type of thinking at tertiary level is very complicated (but not impossible). **The main goal of science education is to find and investigate methods of the teaching science subjects and formation of scientific and technological literacy.**

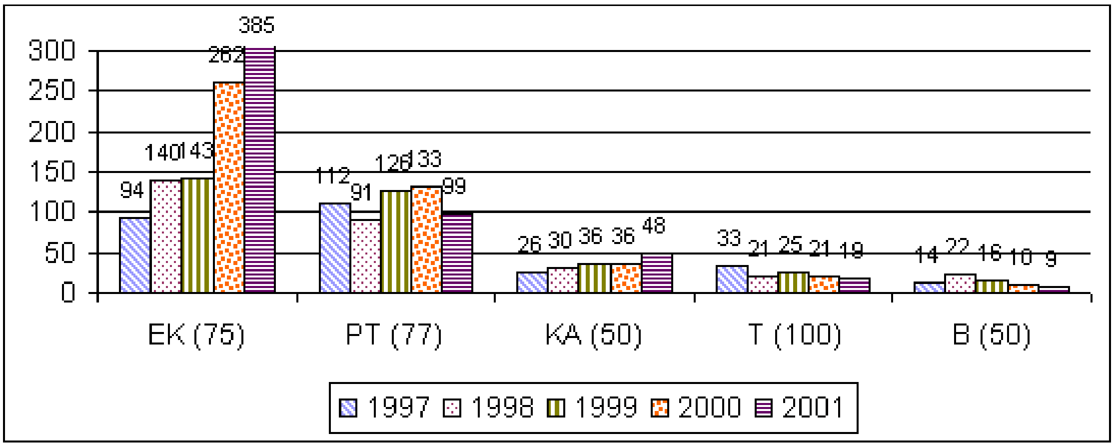


Figure 1. The numbers of graduates in specialities : Economics (EK), Food Industry (PT), Woodworking (KA), Engineering (T), Rural Construction (B)

(Figure in bracket correspond to the planned number of state financed students who can get a budgetary subsidy)

Methods

The ideal paradigm of science education in strongly social context is based on psychological and didactical treatment. There should be balance between governmental and nongovernmental education, formal and informal education, subject oriented and student oriented teaching, algorithmic and non-algorithmic activities, objectivity and subjectivity. (Garejev et al., 1982; Hergenhahn and Olson, 1997)

In teaching any subject, but especially science subjects, the teachers' main goal is to work on students dominant brain hemisphere, not focusing on the weak one. Human brain hemispheres' anatomical structural asymmetry is closely connected with its' functional asymmetry (Piaget, 1963).

Developing left hemisphere, use right hemisphere techniques such as **metaphor** (similarities, connections, personal meaning), **direct experience** (laboratory experiments, real objects, simulation), **visual thinking** (maps, cartoons, drawings, graphs), **evocative language** (sensory imagery, emotions, poetry), **fantasy** (centering, positive attitudes, relaxation), **music** (historical, suggest logy), **multisensory thinking** (touching, tasting, seeing, heating, smelling), **kinesthetic perception** (moving, dancing, manipulating).

One way:

Experience (right. underneath)	→	**Perception** (left. top)	→	**Applied** (left. underneath)	→	**Creative** (right. top)

Or :

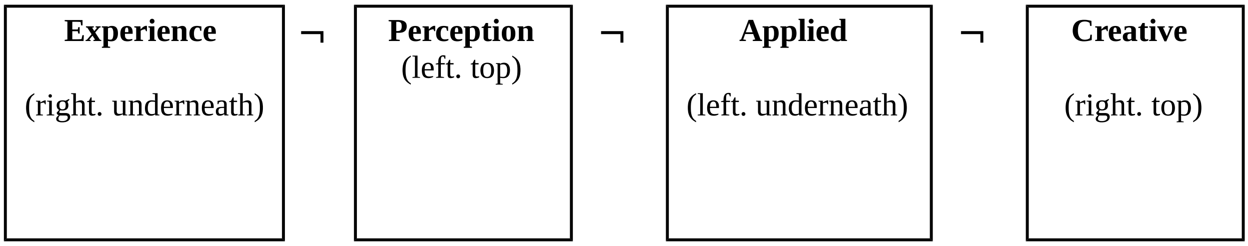


Figure 2. Two ways of organizing teaching process

In order to satisfy the above-mentioned requirements in physics, the course of physics was designed according to **study module** principle. Term **″module″** in the Longman Dictionary of Contemporary English is explained as one of the units that a course of study has been divided into, each of which can be studied separately (Longman Dictionary, 1995).

The author has worked out a structural scheme of the study modules method, where the process is divided into **study form modules (see Fig.3).**

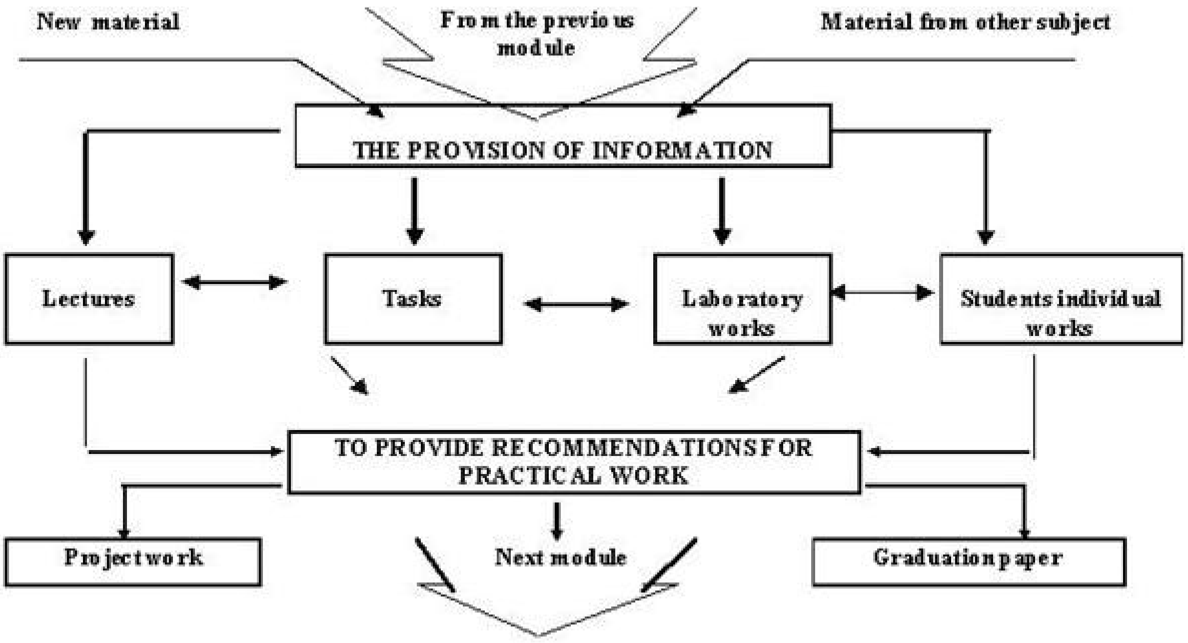


Figure 3. Structural scheme of **study form modules.**

The most important in the theme acquisition is supposed **THE PROVISION OF INFORMATION** which includes previously learned material (**"from the previous module"**), the **material from other subject**, necessary for the given theme and **new material**. For the processing of the given information integration of different **form** of study modules (**lectures, tasks, laboratory works, students individual works)** can be used. The most important task is **TO PROVIDE RECOMMENDATIONS FOR PRACTICAL WORK**, which could be used in annual **project work**, **graduation papers** or , in the **next module** (the next theme). The above mentioned corresponds to the division of study process into forms of study modules

In order to optimize the study process in physics the following should be observed: 1. The course should be divided into separate themes, the sequence of which is appropriate to the logic of the given science; 2. To avoid dogmatism in studying the theme, the problem is formulated for every theme using essential facts or natural phenomena and the ways to solve this problem are searched. 3. General regularities should be reflected in problem solving. 4. Additional facts, phenomena and processes, which could be concluded from these regularities, should be analyzed.

Implementing the above mentioned with the help of study module method, the course in physics was divided into separate themes and the contents of every theme was distributed among study modules **(see Fig.4). 1.** The **TITLE** of the theme. **2**. **BACKGROUND KNOWLEDGE** is based on the conclusion, that studying is efficient only when a student can refer new information to the previous knowledge. The goal of this module is to indicate, which questions should be known in order to follow the solution of the scheme successfully. Thus this module is structured into methods, concepts, and regularities. **3.** In the module **PROBLEM** it is important to formulate the problem, including: 1) motivation, why this problem exists or why it is not sufficient with background knowledge to acquire the given theme; 2) concise and clear formulation of the problem, so that the module theme solution could solve this problem. **4**. The module **ADDITIONAL INFORMATION** is considered as the continuation of module BACKGROUND KNOWLEDGE. If the questions included in BACKGROUND KNOWLEDGE can not supply with the solution, then there is necessity to study **new methods** or come to an agreement about **new concepts**. This module contains also **regularities**, which are not learned before, but which will be necessary for the solution. **5.** The module **SOLUTION OF THE THEME** a logic solution of regularities is presented which is based on background knowledge and additional information and that leads to the solution of the problem. **6.** The module **THE RESULT** is necessary to review a theme solution once more shortly formulating concepts and laws, and classifying them according to causal relationship or analogy, thus encouraging the process of memorizing. **7.** The perception of an individual is always selective and everyone in his/ her lifetime has created the evaluation criteria, according to which all new information is classified into significant, less significant and negligible. Consequently, the module **CONCLUSION** is considered to be of great importance.

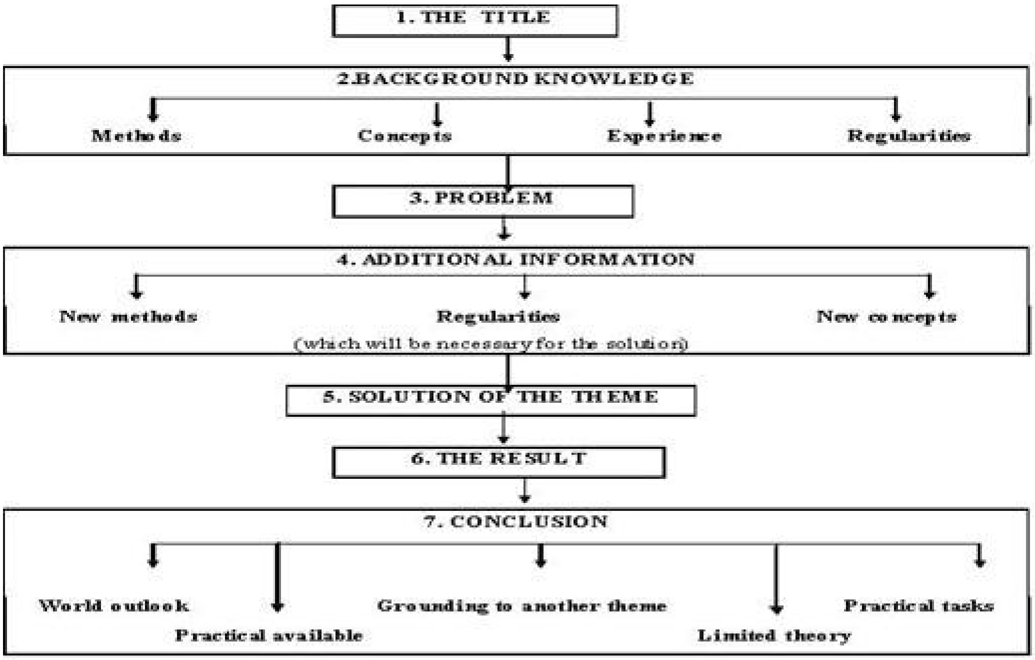


Figure 4. Structural scheme of **study matter modules**

Structural scheme of study matter modules show the cognitive learning way , but according to Figure 2, a student can choose the order of study modules.

Example is:

DYNAMICS

BACKGROUND KNOWLEDGE

Methods
Phys. – use abstract relationships
Math.- work with vectors

Concepts
*force *impulse
*force momentum *inertia
*close system *weight

Experience
to change speed → does it mean – increase velocity → it can be done with power

Regularities
Newton's First Low
Newton's Second Low
Newton's Third Low

PROBLEM

Kinematics answer to question "**How** does it move?". **Dynamics** must answer to question: "**Why** does it move?"
I Direct task of Dynamics – definite the motion of bodies, depending from outside forces.
II Reverse task of Dynamics – definite forces, which activate the bodies motion, knowing the kind of motion.

ADDITIONAL INFORMATION

New methods

Regularities

New concepts

I Linear Motion
Centre of mass
Force
Mass
Impulse
Work
Power
Kinetic energy

II Rotational Motion
Moment of Force
Moment of Inertia
Momentum of Impulse
Rotational Motion's Work
Rotational Motion's Power
Rotational Kinetic Energy

5. SOLUTION OF THE THEME

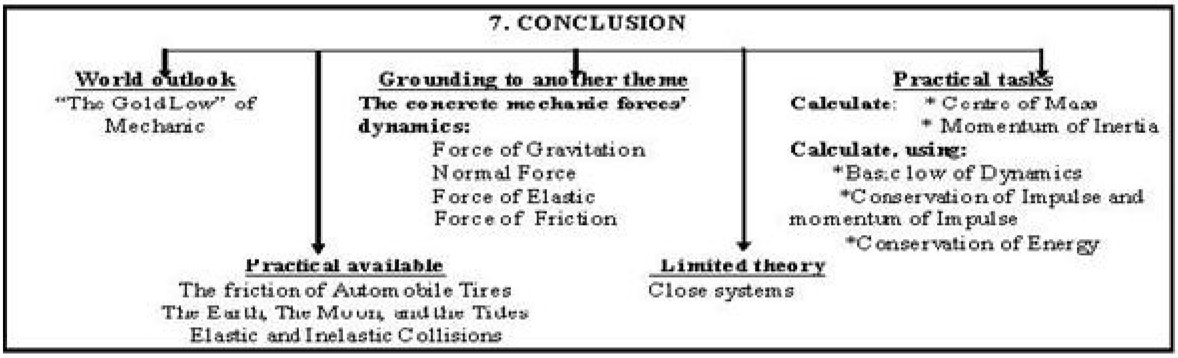
I Linear Motion
Basic Low of Linear Dynamics
Conservation of Impulse
Conservation of Mechanical Energy

II Rotational Motion
Basic Low of Rotational Dynamics
Conservation of Momentum (impulse)
Conservation of Energy

THE RESULT

Concepts	Linear Motion	Relation between motions	Rotational Motion
Measure of Relationship	**Force:** $\vec{F}$ (N)	$\vec{M} = \vec{F} \times \vec{R}$	**Force momentum:** $\vec{M}$ (Nm)
Measure of Inertia	**Mass:** m (kg)	$I = m \cdot R^2$	**Moment of Inertia:** $I = \int r^2 dm$
Measure of Intention of Motion	**Impulse:** $\vec{K} = m \cdot \vec{v}$, $d\vec{K} = \vec{F} \cdot dt$	$\vec{L} = \vec{K} \times \vec{R}$	**Momentum of Impulse:** $\vec{L} = I \cdot \vec{\omega}$, $d\vec{L} = \vec{M} \cdot dt$
Work	$A = \int_0^s F ds$		$A = \int_0^s M d\varphi$

Power	$N = \frac{dA}{dt} = F \cdot v$	$N = \frac{dA}{dt} = M \cdot \omega$
Kinetics' Energy	$W_k = \frac{m \cdot v^2}{2}$	$W = W_k + T$; $T = \frac{I \cdot \omega^2}{2}$
Relatives	**Linear Motion**	**Rotational Motion**
Basic Low of Linear Dynamics	$\vec{a} = \frac{\sum_{i=1}^{N} \vec{F}_i}{m}$	$\vec{\varepsilon} = \frac{\sum_{i=1}^{N} \vec{M}_i}{I}$
Conservation of Impulse and Momentum of Impulse Conservation of Energy	$\sum_{i=1}^{N} m_i \cdot \vec{v}_i = \sum_{i=1}^{N} m_i' \cdot \vec{v}_i'$ $\sum_{i=1}^{N} W_i = \sum_{i=1}^{N} W_i'$	$\sum_{i=1}^{N} I_i \cdot \vec{\omega}_i = \sum_{i=1}^{N} I_i' \cdot \vec{\omega}_i'$ $\sum_{i=1}^{N} W_i = \sum_{i=1}^{N} W_i'$



The assessment method is relevant to the chosen study module method, and **evaluation scale** is relevant to every study module. The evaluation scale is based on: 1) which qualifications are provided by the corresponding study form module; 2) which qualification is pointed out, using control in corresponding study module (the study process is continued also during assessment). Every study module evaluation scale is graded into 10 units, and for every fulfilled task the student received a certain number of points, which reflect corresponding qualification - memory, thinking and work capacity (algorithm, **see Table 2**)

Since evaluation is in every module separately and the volume to be evaluated is rather small, the student gets a pass in the test if the students has obtained 2/3 of the maximum number of points. At the end the students have to take integral examination, which summarizes all knowledge and gives real a picture of the subject. (Jones and Childrens, 1990)

Table 2.

Evolution scales for separate study form modules and corresponding qualification security.

Study form modules	Carry out task	**Points**	Qualification	**Symbol**	**Value**
Theory	Basic concepts known	**3**	memory	**M**	**3M**
	Basic regularities known	**3**	memory	**M**	**3M**
	Regularities proof and coming out	**2**	thinking	**T**	**2 T**
	Qualitative task	**2**	thinking	**T**	**2 T**
	AMOUNT	**10**	**4T +6M**		
Tasks	Separate known and unknown value aware the problem, design of task	**3**	thinking	**T**	**3 T**
	Founding basic regularities	**2**	thinking	**T**	**2 T**
	Algebraic coming out	**3**	thinking	**T**	**3 T**
	Numerical calculation	**2**	work capacity	**W**	**2W**
	AMOUNT	**10**	**8 T +2W**		
Laboratory works	To work out	**2**	work capacity	**W**	**2W**
	Explain business routine	**1**	thinking	**T**	**1 T**
	Accounting results and mistakes	**2**	work capacity	**W**	**2W**
	Conclusions	**1**	thinking	**T**	**1 T**
	Theoretical test	**4**	memory + thinking	M+ T	**2M+2T**
	AMOUNT	**10**	**4 T +2M+4W**		
	Understanding problem, design of task	**2**	thinking	**T**	**2 T**

Individual works	Choose formula	**1**	thinking	**T**	**1 T**
	Numerical calculation	**2**	work capacity	**W**	**2W**
	Profile	**3**	thinking + work capacity	**T +W**	**1,5 T +1,5W**
	Basic regularities theoretical foundation	**2**	thinking + memory	**T +M**	**1T +1M**
	AMOUNT	**10**	**5,5S+1 M+3,5W**		

MAXIMUM AMOUNT: 198,5 T +79M + 92,5 W

Results

The basic conclusions of the investigation have been approved in practice with students in Latvia University of Agriculture physics studies according to the study module method that have been applied for 4 years at the Faculty of Rural Engineering and for 3 years at the Technical Faculty. By d**istributing study contents into study form modules and controlling success in studies in separate modules,** the students are offered the opportunity to become aware of their knowledge and skills, to make the most of the existing and acquire new ones. Using study module method 85 % students have successfully acquired physics material, 70 % of them are assessed with "excellent" and "good". **(see Table 3)**

Table 3

Average result in separate study form modules

(figure in bracket correspond to the % of number of students)

	Results in integral examination			
	Not admitted to the exams **15 %**	**Pass-mark** **26 %**	**Good result** **38 %**	**Excellent result** **21 %**
Module	**Average mark in each module**			
Theoretical colloquy	2.4	5,5	6,8	7,9
Task' s colloquy	2,1	5,0	6,1	7,5
Laboratory work	4,1	7,5	7,5	8,3
Individual work	5,7	9,2	9.3	9,6
Sum	**3,6 < 6,7**	**6,8**	**7,4**	**8,3**

Conclusions

The advantage of the study process model of study module method in comparisons with other study process models is:

1) systematic approach to course design and its contents;

2) coordination of all study forms in every module and among modules;

3) structure flexibility of study process;

4) opportunity to find solution of the theme, to be able to see the essence and to be aware of application of the results;

5) effective assessment system.

The feed-back is provided by an evaluation model and evaluation scale corresponding to every study form module, which shows:

1) what qualifications the corresponding study form module provides;

2) which qualification is given priority to, using control in the relevant study module.

Physics will be studied successfully if integrated knowledge of subjects is acquired, which is implemented integrating the acquisition of material in separate study modules.

Bibliography

Garejev V., Kulikov S., Durko E. Method of Study Modules. Journal: Вестник высшей шлолы, № 8, 1982.- 30 – 33 P (in Russian) .

Hergenhahn B.R., Olson M. H. An introduction to Theories of Learning. Fifth edition. Printed in USA, by Prentice- Hall, Inc. Simon & Schuster, New Yersey, 1997.- 502 P.

Jones E.R., Childrens R.L. Contemporary College Physics. University of Sourth Carolina. Addison – Wesley Publishing Company. 1990.- 956 P.

Longman Dictionary of Contemporary English. Longman Corpus Networtk. Printed in Great Britain by Clays Lid Bungay, Suffolk, 1995.- 1668 P.

Piaget J. The Psychology of Intelligence. Totowa, New Jersey: Littlefield, 1963.- 412 P.