

DEBATE AND DISCUSSION

Interactive dynamic system of didactic means in medical studies

Kukurova E, Kralova E, Bernadic M

*Department of Medical Physics and Biophysics, Faculty of Medicine, Comenius University, Bratislava, Slovakia.
elena.kukurova@fmed.uniba.sk*

Abstract

Didactic means are an integral part of teaching also in the process of healthcare and doctoral education. They are applied not only in teaching of theoretical, but also in that of clinical subjects at medical faculties. The forms and levels of the use of didactic aids are subject to a dynamic process of transformation. They take place in form of conceptions, projects, realizations, results and effects. A part of them represent a domain of professionals, others are affected by basically non-professional teachers. The results and effects are influenced by students. The authors of this study present the didactic means used at the Faculty Medicine of Comenius University (FMCU) in Bratislava. (Tab. 1, Ref. 11.)

Key words: medical education, nursing, didactic means, disease models.

From the period of renaissance up to the modern times of pedagogy, the principle of demonstrative learning belongs among the basic pedagogic doctrines. This principle expresses the necessity of the pedagogic process to be based on sensory perception of objects and phenomena of reality, its pictures (i.e. direct demonstration), or on that of actual imagination and experience of the trainee (indirect demonstration). At the same time it should systematically develop his/her abilities, i.e. perception, observation and fantasy. Our knowledge, as shown by gnoseology begins by sensory perception, which is the basis for general thinking focused on verification of mental conclusions by means of social and historic experience. Therefore also in the pedagogical process, the sensory perception of reality is and always will be the basis for education and knowledge development. Comenius always considered this principle to be the “golden rule” of didactics. He was very consequent in proceeding from an example to the rule and practical use of knowledge. In pedagogical practice, the principle of demonstration is used in every grade and all forms of education by means of various methods and means.

Didactic means represent the measure, by which modern pedagogy of the 21st century increasingly strives to develop a creative approach to problems in individuals. It is to be said that pedagogues are not always successful in their efforts. The main idea is that an individual should not only learn and understand the reality but also to transform and change it on the basis of the accomplished degree of his/her education. Only the forms and methods of education supporting the development of activity of

trainees can enforce their independence and lead to their creative activities, which represent the main goal of modern pedagogic efforts. There is nothing that harms education more than passivity, and mechanic memorising of facts.

The aim is to accomplish a state in which the contents of individual doctoral, master and bachelor studies at the Medical Faculty of Comenius University would develop concurrently with the methods, means and forms of teaching in order to accomplish the required level of knowledge of graduates in accordance with WHO Standards. The world trend in designing the didactic aids is focused on the integration of classical procedures of teaching with the support of multimedial systems and information technologies. Despite the latter fact, the classical two or three-dimensional didactic aids and special tools (e.g. anatomic preparations) have still not lost their didactic value.

The preserved historical didactic aids of Professor, PhD. Viktor Teissler – models of joints (exhibited at the Museum of Department of Medical Physics and Biophysics of FMCU) were designed for the needs of anatomic institutes of medical facul-

Department of Medical Physics and Biophysics, and Department of Pathophysiology, Faculty of Medicine, Comenius University, Bratislava, Slovakia

Address for correspondence: E. Kukurova, MD, PhD, Dept of Medical Physics and Biophysics, LFUK, Sasinkova 2, SK-811 08 Bratislava 1, Slovakia.

Phone: +421.2.59357530, Fax: +421.2.52965400

ties of Charles University in Prague and Comenius University in Bratislava (9). The tradition continued by designing didactic aids in 1970's of the past century, namely for the needs of direct and indirect teaching at the Faculty of Medicine of Comenius University in Bratislava.

The current state of didactic technologies at medical faculties

The didactic means of theoretical and clinical teaching at medical faculties currently form a set of various material devices. They are activated by knowledge of both teachers and students in interaction with the selected methods and forms of teaching.

The use of didactic aids is not a static phenomenon existing only in a single form, but it is strictly dynamic and flexible, having several forms and levels of existence that are subject to continuous transformation. It includes the forms of conception, project, realization, results and effects. A part of it is a domain of professionals; the others are affected by basically non-professional teachers. The results and effects are influenced by students.

The didactic means are an inseparable part of teaching and as such they play a genuine role also in the process of doctoral and healthcare education. Their task is to approach, reveal, detail and review the knowledge acquired verbally or by description in form of knowledge, skills, habits, standpoints and developed abilities.

Material didactic means used in and beyond the teaching process at FMCU in Bratislava, assigned as didactic technologies, can be divided as from the aspect of meaning into basic and special means.

Basic didactic aids, especially in the teaching of theoretical disciplines include the following:

- Preparations, samples, collections (anatomy, histology),
- Models demonstrating the principle or the structure of organs (nursing),
- Two-dimensional aids enabling to depict particular phenomena within the human body in particular or graphical forms, while being presented either directly (pictures, schemes, photos), by the use of didactic technologies (slides, computer or multimedial projectors) or by that of various types of projectors (medical physics, biophysics),
- Acoustic aids – mechanical, optical (films), acoustic recordings (sound-tapes and video recordings), digital (CDs, computer programmes) (pathological physiology, medical physics and biophysics, clinical disciplines),
- Texts (textbooks), working aids (atlases, tables), supplementary literature (all teaching subjects forming the curriculum of doctoral, master and bachelor studies).

Special aids of teaching reflect the character of individual medical specialisations. This group includes the following:

- Preparations of laboratory animals,
- Autopsy of human body (anatomy, pathological anatomy, forensic medicine),
- Laboratory techniques (chemistry, microbiology, hygiene),
- Experimental measurements (physiology, pathological physiology),

– Special laboratory examinations used in the teaching of clinical subjects.

The use of didactic material means, i.e. teaching aids and didactic technologies in the process of teaching coincide especially with the didactic principle of demonstration, increase the effectiveness of teaching process, enable an individual approach to students, respect their differences and support their memory, since the more varied the teaching, the more effective is the extent of remembered facts (3).

Interactive teaching supported by computer technologies

The development of computer technologies has included a number of aids into teaching. One of their possible uses is e.g. the motivation of students by demonstration of teaching programmes simulating various problems and situations in the study of various clinical matters.

One of further possibilities of using the information technologies in the theoretical and practical teaching is the use of possibilities provided by internet. By use of internet the students can widen their scope of knowledge, or confront it with the latest results of medical research, therapeutic procedures and information on current modernization of teaching process at any schooling institution all over the world.

The designing of teaching programmes supported by information technologies within the algorithm of pedagogic and graphic preparation, deployment, programming, checking-up, and feedback has currently become uneconomic. This is to say that the designing of high-quality teaching programme is a very difficult, demanding and multi-disciplinary process that requires a participation of pedagogues, didactic specialists, graphic designers, programmers, psychologists or even other specialists in order to fulfil the conditions affecting the character of the final product (interactivity of variability of the didactic function, processing of informational presentation). Therefore a preference is given to commercially available teaching programmes.

Modelling

The modelling became one of the main research methods of medical experiments. It represents a decisive manner of recognising the objective reality and principles of natural phenomena and processes in nature and society as soon as in the second half of the past century. The modelling has succeeded in achieving remarkable results in technologic and natural sciences, especially in physical, mathematical, biological and medical sciences (Tab. 1) (4).

Models (one, two or three-dimensional) form a significant part of didactic technologies also in pedagogical sciences. They have not ceased seeking the measures of modernisation. Modelling in pedagogical process in medical sciences does not serve only as a didactic measure of demonstrative clarification of physiological functions and pathophysiological situations originating within the body or clarification of physical and biophysical process, but also demonstrates one of the most important methods

Tab. 1. Animal models of diseases and pathological states (Institute of Pathologic Physiology FMCU).

Method	Objective	Animal
Anesthesia	stages of general anesthesia	guinea pig, rabbit
Cannulation	surgical procedure	rabbit
Nephrectomy	surgical procedure	rabbit
Appendectomy	surgical procedure	rabbit
Gastroenteral anastomosis	surgical procedure	rabbit
Dehydration	general pathophysiology	rabbit
Hyperemia	general pathophysiology	frog
Anaphylactic shock	general pathophysiology	guinea pig
Asphyxia	respiration insufficiency	guinea pig
Bronchial spasms	bronchial asthma	guinea pig
Embolism of pulmonary artery	pulmonary embolism	rabbit
Anaemia	acute and chronic post-hemorrhagic anaemia	rabbit
Hypertrophy of heart	pressure and volume overload of heart	dog, rabbit
Heart failure	adaptation of the heart due to volume overload	rabbit, dog
Cardiomyopathy	cardiotoxic effect of cytotoxic drugs	rat
Fibrillation and flutter of atrii and ventricles	heart rhythm disorder	rabbit
Acute infarction of myocardium	ischemia of myocardium	dog, rabbit
NO-deficient hypertension	vasoconstriction	rat
Haemorrhagic shock	shock	rabbit
Proteinuria	nephroses after sublimate	rat, rabbit
Nephritic syndrome	functional kidney disorder	rabbit
Gastric ulcer	ulcers due to stress	rat
Experimental jaundice	obstruction of gall ducts	dog
Experimental appendicitis	inflammation, stages	rabbit
Experimental adrenalectomy	insufficiency of adrenal glands	rat, rabbit
Tetany	neuromuscular excitability	rat
Diabetes mellitus	immunisation, chemical DM	rat
Audiogenic epilepsy	epileptic process	rat

of scientific acquisition of knowledge. It can substitute or supplement the system *in vivo* being extraordinarily interesting in all theoretical and clinical disciplines. It has a special role in stomatologic studies.

Individual properties of biologic systems, especially their structures in physical and biomedical models are usually depicted as electrical parameters, although also mechanical and computer models are known. Currently, analogue biomedical models are used enabling to depict a dynamic picture of living systems (8).

Analogue electric models of some of physical, biological and physiological processes are based on functional analogy. It resides in a simplified interpretation and reduction of real physical, biological or physiological processes by selection of a particular phase or by particular problem. This is bound with an appropriate physical parameter within the electrical circuit with various properties of functional elements. It can work e.g. in a

model of radioactive decomposition, model of intake and discharge of fluids or model of active electric properties of biological tissues. Models can simulate on the basis of the principle of different dynamics of charging and subsequent discharging of capacitor via the resistance within the electric circuit. Physically, it is the same circuit, however with a bound different interpretation of the appropriate discipline. A simple model of a cardiovascular system can express e.g. hemodynamic parameters in form of electric parameters: arterial blood pressure as electric voltage, blood flow as electric current and hemodynamic resistance as electric resistance.

A set of electric models can be variably, according to the needs and requirements of particular branch of study supplemented by additional original apparatuses and apparatus set-ups. In dermatology e.g. they can be represented by devices measuring the barrier resistance of the skin, indicator of hygroscopic

properties of the skin, AC-DC converter or low-frequency transistor amplifier.

All physical models and devices of own production have been continuously tested since 1985 in the tuition at FMCU in Bratislava and successfully presented at exhibitions of didactic technologies in Slovakia as well as abroad (4).

In this way, their functional variability enables to observe the monitoring of both, the dynamics of the changes in biological signal, as well as computer capturing and archiving of experimental data for their later use, computer processing and analysis with graphical outputs. During direct teaching the students compare the results of their own experimental measurements with the results acquired from models by use of analogue or digital electric measuring apparatuses, and process them statistically (7).

Anatomic illustrations and pictures form a separate chapter of history of artistic and medical pictures. They focus not only on the relationship and approach to the knowledge of human body, but they also picture the knowledge of its structure or parts. Pictures or schemes depicting reality enable to perceive directly the text and to master its proof. Pictures in anatomy play both didactic, as well as instructive roles, and become an instruction in the approach to and procedure in autopsy. They mediate information also to laymen since they overcome the language barrier and often express the thoughts by means of a simple graphic form, the explanation of which would need many pages of text. Regarding the artistic aspect, anatomic illustrations give evidence of the artistic opinion of the period of their origin. They depict gradual changes in artistic techniques as well as in the scientific approach to depicting the human body.

The study of models of animal diseases and pathologic states is a part of preliminary clinical education of medical students and at the same time an introduction to scientific experimental work. Experimental work with animals must be in compliance with the law of protection of animal used for experimental and scientific purposes codified in 1986 by the European Council in the European Convention. The Institute of Pathological Physiology of FMCU have designed more than 35 experimental models used in the teaching of medicine (Tab 1). The majority of experiments are recorded on didactic videos. The methods of animal model preparation, the description of pathologic mechanisms and results of investigations are described in textbooks. The work with experimental animal models must be correlated with appropriate clinical pictures, the fact of which is achieved by the connection with EuroTransMed (European postgraduate education of physicians).

Results

In 1990's, the theoretical institutes including Anatomic Institute, Institute of Histology and Embryology, Institute of Medical Physics and Biophysics, Institute of Pathologic Physiology and Third Stomatological Clinic designed and presented together their modern didactic aids and signed them for international exhibitions of didactic technologies on the appeal of SLOVDIDAC. By this deed FMCU has been registered in the

annals of domestic and foreign exhibitions, including those in Thailand, Mexico, Switzerland, Germany and Cyprus. The set of exhibits was always supplemented by a large-scale film presenting the Faculty of Medicine of Comenius University in English and a special poster presenting the faculty to the whole world (5, 6).

Our Faculty of Medicine organized our own exposition at the international exhibition of teaching aids and didactic technology MEDACTA' 95 in Nitra. In coincidence with the latter the conference on Technologies of 3rd millennium Education should be mentioned that took place at the same time. The problem of education technologies in the 3rd millennium represented its core topic together with theoretical basis and practice forms and methods used in the teaching process. The objective of the conference was to highlight new technologic possibilities that in the subsequent decades in connection with human power will enable extensively to make all forms of education optimal.

In recent years, the Faculty of Medicine of CU has introduced itself as one of exhibitors with their own independent exposition, always under the auspices of the Embassy of Slovak Republic in respective states of Europe, Asia and America. The core of exhibits was formed by those belonging to institutes that follow in alphabetical order:

- Institute of Anatomy with exhibits of a set of anatomic bone preparations – human skeleton (bones of leg, arm, knee joint, vertebrae), corrosive preparations of kidneys – kidney vessels, series sections of human brain (frontal, sagittal, horizontal).

- Institute of Histology and Embryology with exhibits of historic preparations of human tissues, embryologic preparations of human tissues, corrosive preparations of subtle vascular architecture of rat kidneys.

- Institute of Medical Physics and Biophysics introduced a set of teaching texts on biophysics and computing technologies in Slovak and English, teaching videos, electronic models of physical, biological and physiological processes and historical exhibits that are a part of museum collections of the Institute.

- Institute of Pathologic Physiology presents a set of videos, experimental models of diseases (anaphylactic shock, experimental infarction of myocardium, fibrillation and flutter of heart ventricles, gastric ulcer in rat, audiogenic epilepsy in rat, bronchial asthma, etc.), modern teaching texts (e.g. Hulin's Pathophysiologic Letters with Synoptic Conspectuses (11)).

- First Stomatologic Clinic presents demonstrative aids: Models of resin teeth manufactured by teachers of FMCU, procedures of caries treatment (models of preparations of caries cavities and fillings), treatments of caries on the chewing surface of molars (procedure of preparation and making amalgam filling), preparation of cavity and preparing of complex occlusive buccal filling, treatment of caries lesions on smooth surface, treatment of caries on adjacent surface of back teeth (preparation of amalgam filling), treatment of caries on adjacent surface of back teeth (complex three-plane cavity and amalgam filling), treatment of caries on adjacent surface of front teeth (preparation of cavity and filling), treatments of caries on adja-

cent surface in front teeth, extending to the cutting edge (preparation of cavity).

By means of their teachers, scientific and other workers, the Faculty of Medicine of CU in Bratislava offers a current review of results of scientific, research, pedagogic work and public services in form of publications, lectures and own expositions. Under the auspices of most significant authorities it presents itself annually at conferences and exhibitions. World events, as e.g. WORLDDIDAC – the most known and most significant activities take place.

International exhibitions as e.g. SLOVMEDICA-SLOVFARMA-SLOVREHA include also outputs of scientific current programme in form of scientific publications (3) Professionalism & Progress & Health Support (2000). The publication informs the public on a review of current scientific and pedagogic activities taking place at medical faculties. The presented exhibitions include also the exhibition of current medical scientific, pedagogic and scientific popular literature of authors working for FMCU in Bratislava.

The exhibition Bibliotheca-Pedagogy-Intermedia that takes place at the Exhibition and Congress Centre of INCHEBA regularly includes also an exhibition of education and didactic technology Pedagogica and an international book fair Bibliotheca. The exhibition Pedagogica is focused on the education of young and adult people. The Faculty of Medicine of CU was present also at these exhibitions by presenting successfully their own separate exposition or by contributing to the exposition of CU.

The successful propagation of modern methods of teaching at the Faculty of Medicine of CU was for the first time awarded in 1995 at the exhibition of teaching aids and didactic technologies MEDACTA in Nitra by Golden and Silver MEDACTAs. The Faculty of Medicine of CU was awarded at international exhibitions NOVTECH'96 and NOVTECH'97 in Žilina by certificates of merit for the best solution of a research problem.

The Faculty of Medicine is an owner of a Diploma issued by international medical exhibitions in 1999 in Nicosia (Cyprus)

for the teaching set of electronic models supported by teaching texts in English. A number of professors were awarded for the best scientific or popular scientific medical publication at Grand-Prix 2000 and 2001 (1, 2).

References

1. **Ďuračková Z, Bergendi L, Čársky J (Eds).** Voľné radikály a antioxidanty v medicíne II. (Význam voľných radikálov v etiológii niektorých ochorení). Bratislava: SAP, 1999, 315 p.
2. **Ďuriš I, Hulín I, Bernadič M (Eds).** Princípy internej medicíny. Bratislava, SAP 2001, 3150 p.
3. **Kukurová E et al (Eds).** Profesionalita & Progres & Podpora zdravia, Fragment z dejín LFUK, Bratislava, E&J s.r.o., 2000, 172 p.
4. **Kukurová E et al.** Biologicko-experimentálne zameranie praktickej časti výučby biofyziky na lekárske fakultách — koncepčná zmena vyplývajúca zo súčasného stavu a perspektív rozvoja biofyziky. Bratisl Lek Listy 1985; 87 (4): 496—503.
5. **Kukurová E et al.** Set of educational materials for MEDACTA'95, Nitra, 1995.
6. **Kukurová E et al.** Set of educational materials for WORLDDIDAC'95, Bangkok, Thailand, 1995.
7. **Kukurová E, Kráľová E.** Pracovné listy k vybraným biofyzikálnym porovnávacím experimentom pre integrovanú výučbu. Bratislava: Asklepios, 2003, 56 p.
8. **Kukurová E, Kráľová E.** Lekárska fyzika a biofyzika pre medicínsku prax. Bratislava: Univerzita Komenského, 2004, 264 p.
9. **Teissler V, Križan Ž.** Vybrané kapitoly z fyziky (Úvod do biofyziky). Bratislava: Veda, 1955, 354 p.
10. **Holzerová J et al.** Experimentálne modely chorôb. Bratislava: UK, 2003, 112 p.
11. **Hulín I.** Hulin's Pathophysiological Letters with synoptic conspectuses. 1. issue, Bratislava, Faber SAP 1999, 123 p.

Received January 31, 2003.

Accepted February 12, 2004.