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Educational Materials and Didactic Tools in Engineering Training Practices

Enikő BITAY,[1] Gyula BAGYINSZKI [2]

[1] *Sapientia Hungarian University of Transylvania, Faculty of Technical and Human Sciences, Department of Mechanical Engineering, Târgu Mureș, Romania, ebitay@ms.sapientia.ro*

[2] *Óbuda University, Donát Bánki Faculty of Mechanical and Safety Engineering, Budapest, Hungary, bagyinszki.gyula@bgk.uni-obuda.hu*

Abstract

Educational materials are closely related to educational (didactic) tools, as they allow their preparation and presentation. The production of technical higher education (engineering training) materials or preparation can be approached from many perspectives. This article deals with some aspects of this.

Keywords*: education, training, didactics, materials, tools.*

1. Introduction

In [1] we dealt with the teaching methods of engineering education, in [2] we drew attention to the curriculum and educational organization aspects of technical higher education, while in [3] we reviewed the role, functions and forms of engineering education practices. In [4] we presented the methodological aspects by choosing a specific field example.

One of the important factors for the educational materials of the practical classes prescribed in the curricula of engineering training is the location, or the physical environment in which these materials are used. If the practical session is organized in a place where it is possible to present the given topic under operational conditions, the presentation can be made more effective by making simpler materials, as the relevant content can be illustrated “live”.

The determining factor is the modernity of the tools and materials used in terms of the quality of the training, but also in terms of the assessment of the competent department or institute. To do this, the material conditions as well as the general and professional standards of the receiving technical environment must be created.

It is also necessary to strive for the educational material prepared in this way to be a universal teaching tool containing not only individual cases, but also variants arising in connection with the given task. Of course, aesthetic design and precise workmanship are not to be overlooked, either.

It makes the solution of calculation, planning and material selection tasks more efficient, and promotes a better attitude of the students if the most important literature, manuals, standards (extracts) and other aids of the given task are "widely available" at the place of the session.

Materials composed of specific, real objects (e.g., intermediate production states of a product) can be much more effective than drawing, photographic boards, or projected images, and can present processes, not just objects, in a more realistic (tangible) way.

2. Multipurpose educational materials

There are materials used in education that can be used in many ways and in multiple forms. For example, this could be a material test specimen that can be used, after grinding, for photos (macroscopic and microscopic versions) or for demonstrating the effect of the technology used (eg. surface treatment). This is not only an educational technology issue, but also an economic aspect. **Figure 1** shows a scheme for the qualification of surface treatment technology, for which

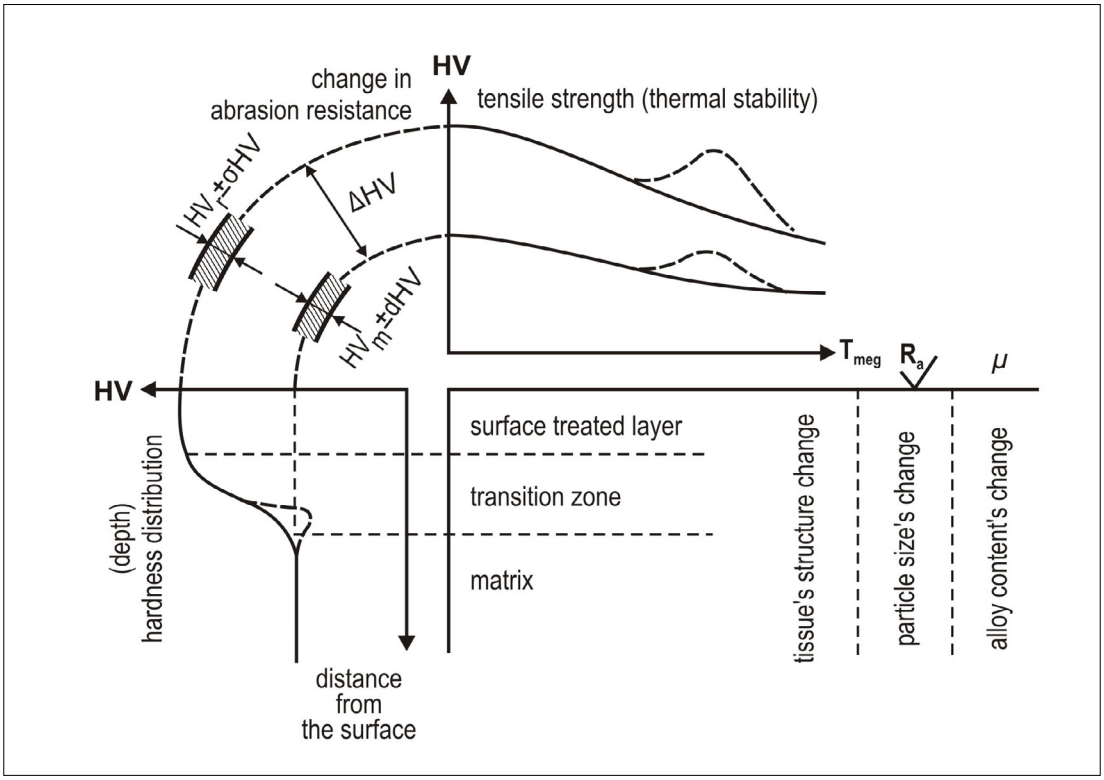

Figure 1. *Surface treatment's layer classification scheme.*

the following may be performed on the material test specimen:

- light microscopic examination of tissue structure and particle size,
- electron microscopic phase and alloy analysis,
- depth hardness measurement.

An additional series of test specimens can be used to characterize the tensile strength (heat abrasion resistance) through hardness measurements. The example shown in **Figure 1** can also function as a kind of experimental design recommendation for students, if they prepare a scientific paper, dissertation or diploma thesis on such a topic.

In the case of processes that are difficult or too costly to implement, it is advisable to use several forms of documentation at the same time:

- taking a series of photos,
- video recording,
- computer data collection,
- preparation of other registers (specific to the applied method or equipment) that can be recorded on paper and/or electronically.

This can be accomplished through appropriate faculty-laboratory collaboration, which provides awareness of which moments in the process need to be captured for proper evaluation.

Programs and applications can be created for calculation, planning or measurement evaluation tasks by the instructor, students, external experts or even demonstrators. For applications of this nature, the main consideration should not be to "decorate" the program, but rather to provide practicality and error-free running.

3. Didactic tools and functions

In terms of educational (didactic) tools, we can reduce the number to four by systematizing the functions. This is because didactic tools increase the efficiency of the training process by making it easier for learners to:

- get to know reality,
- acquire knowledge of reality,
- shape emotional relationships with reality,
- develop a reality-transforming activity.

Most classifications of didactic tools do not take into account all four functions. The emphasis is usually on getting to know reality through sight and hearing, which is also reflected in the well-known term "audiovisual devices". Really effec-

tive didactic tools use all the senses. However, the latter three functions are usually ignored, although they make it easier for students to find out about reality and to shape reality (**Figure 2.**) **[5, 6]**:

The general division of educational (didactic) tools distinguishes six categories:

1. Verbal tools (printed teaching aids):
   - Teacher's aids: manuals, textbooks, task collections, (specialist) journals, whiteboard texts and sketches, subject tests, bibliographies;
   - Student aids, textbooks: compulsory and recommended literature, workbooks, worksheets, printed activity guides, manuals, dictionaries, text collections, planning aids, sample books, (specialist) journals, practical (measurement) guides and protocol forms.
2. Simple visual tools:
   - Teacher demonstration tools: natural objects, material sample collections, preparations, work products, boards, posters, experimental tools, imitations, application tools, tactile tools, measuring tools, sections, test specimens;
   - Student experimental tools: manipulation tools, test tools, laboratory kits, models, application tools, measuring tools.
3. Visual devices for the registration, storage and transmission of images: camera, microscope, endoscope, computer, data carrier.
4. Auditory technical devices for the transmission of sounds and noises: media players.
5. Audio-visual devices combining sound and image: cameras, media player, television, monitor; audio film (8, 16 and 35 mm) digitizing and archiving devices.
6. Tools to automate the educational process: language laboratory, computer, registration and reproduction tools.

Educational technology tools (media) can be organized as follows **[7]**:

1. Printed teaching aids (books, aids, worksheets).
2. Auditory information carriers (media recorders and players; digitizers and archivists of records, audio tapes, audio cassettes).
3. Visual information carriers (cameras and media players; digitizers and archives of slides, framed slides, transparent transferable models, audio and silent films).
4. Audio-visual media (Internet video channels and portable media players, web conferencing platforms; digitizers and archivists of sound films, audio slides, video discs, video cassettes, video cassette tapes).
5. Learning experimental tools.
6. Teacher demonstration tools.
7. Educational technology tools.
8. Training packages, distance learning materials.
9. Computers and learning aids.

Didactic functions		Tools (examples)
getting to know reality	• in natural form • in substitute form • in a generalized form	• natural objects, pictures • replacement objects, pictures • models, models, blueprints
acquisition of knowledge of reality	• communication of knowledge • communication of knowledge by technical means • communication of knowledge combined with independent work	• printed texts • boards, projected images and presentations • textbooks, textbooks and worksheets
shaping emotional relationships with reality	• community education • music education • fine arts education	• printed texts, electronic media • music players • works of fine art, copies, electronic media
developing a reality-transforming activity	• language and symbolic skills • research skills • technical skills	• educational equipment, language laboratories • laboratory materials, devices, equipment, simulators • work tools, machines, instruments, models

Figure 2. *Didactic functions and tools*

The list also includes the names of information carriers that are considered “obsolete”, but it is an important task to digitize, archive and, of course, use materials that are still “salvageable” (sometimes irreplaceable) and otherwise useful in training.

3. The role of video technology and informatics

The main higher education functions of the use of video technology as the most interesting and (perhaps) more engaging tool and media can be summarized as follows:

- Development of self-knowledge (self-image), personality and ability development. Playable video shows students how they behaved in a particular teaching, intervention, or experimental situation.
- Experiments, presentation of very fast or very slow physical events, microscopic events. With video we can “freeze” the image, and easily replay the recording or some of its moments over and over again.
- Live broadcast. With the help of an online educational platform, we can present a lesson, a complicated experiment, etc. in a “live broadcast”.
- Recording documentation. A longer event can be recorded in its entirety and can be projected with or without editing, in detail or in its entirety.
- Micro-learning. A simplified but realistic situation that provides favourable conditions (especially for a beginner) teacher is to acquire new teaching skills or improve what they have already learned.

Two basic areas need to be considered in the pedagogical application of informatics (computer science): hardware and software developments. Hardware development can be considered specific in terms of pedagogy in the sense that this process is fundamentally determined by “global” economic and scientific needs **[8]**.

Development aspects of computer programs (software):

- the basic pedagogical goal of the program: education, vocational training, career guidance;
- the content of the program: the planning and organization should be characteristic or a good fit into the process of educational work;
- main didactic tasks: helping certain areas of education, training:
  - motivational, demonstration, simulation, modeling, practicing, systematizing, applying, problem-solving, measuring culture development, monitoring, self-monitoring, performance evaluation, teaching-learning process diagnostics, educational effectiveness examination programs **[8, 9]**;
- targeted users:
  - educational and/or administrative and economic management of the institution, teachers, lecturers, large groups of students, small groups of students, individual students.

Of course, the appropriate hardware background must also be provided for the use of programs for small groups of students as well as for individual students. The best possible conditions for accessing and using such a computer park should be available.

4. Conclusions

The instructor himself is the main source of information, he organizes and directs the media, he receives feedback from the students, on the basis of which he can intervene in and correct the educational process. Educational (didactic) tools help to make the sessions visual, provide information, enable students to improve their skills and gain practice, develop their intellectual abilities, and master the practice of scientific research.

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