

DIDACTIC AND METHODOLOGICAL ASPECTS OF TECHNICAL HIGHER EDUCATION

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Abstract

Technical higher education - that is engineering education, unlike the general practice of secondary vocational education - already deals with adult “students”. Although the emphasis on educational tasks in universities is less, the attitude-shaping effect and example of lecturers play a key role. With this compilation, we aim to provide clues for this.

Keywords: *education, training, didactics, methodology, curriculum.*

1. Introduction

In [1] we dealt with the teaching methods in engineering education, in [2] we drew attention to the curricular and instructional aspects of higher technical education, in [3] we reviewed the role, functions and forms of engineering education practices, while in [4] we summarised the teaching materials and didactic tools that can be used in engineering education. In [5] methodological aspects were presented, using a specific example from a specific field. In the present compilation, we focus on some of the more common didactical and methodological aspects of engineering education.

2. Principles of didactics in higher education

The subject of didactics in higher education is teaching, training and learning in higher education institutions [6]. Two thematic areas are distinguished in didactics in higher education [7]: – the first includes the general theoretical problems of higher education and self-training which are common to all higher education institutions, and do not depend on their professional profile; – the second thematic area is made up of questions of training theory which relate to the specialisations or subjects taught in the various courses.

This includes subject didactics (e.g. in technical higher education) and subject didactics, which, although subordinate to general university didactics, applies its principles and develops them in detail.

The latter definition emphasises the developmental nature of subject-specific didactics applying general principles, which is of great importance, for example, in the planning and implementation of practical sessions in specific fields of training. The correct management of the realisation of general and specific training objectives requires that the teaching and training process is subordinated to the didactic principles. These, in turn, are derived from the general norms of didactic activity, from the analysis of the educational process and from the specific laws of the educational process, and are the conditions for achieving the objectives that determine the direction of the activity. Among the didactic principles which play a particularly important role in higher education, the following can be highlighted [7]:

2.1. The principle of the unity of science, education and the development of competences to shape attitudes

High scientific quality of curricular materials - which implies continuous updating and keeping up with the development of the discipline - should

be implemented in such a way that the student can understand, record and thus master them, while at the same time the selection of content should allow for the identification and highlighting of factors that can ensure the approach-forming, competence-developing effect in the educational and training process. An essential factor is learning by understanding as opposed to verbal learning based on memory.

2.2. The principle of conscious and active participation of students in the educational process

The didactic process must be guided in such a way that students fully understand the objectives of the training and their own responsibility in achieving them, develop positive motivation and self-monitoring, and do not become passive consumers of the knowledge they have acquired. However, in a sense they must also be active "creators" of it, e.g. by completing project tasks.

2.3. The principle of regularity

This manifests itself in two ways:

- on the part of the instructor: in well-organised, logical and clear lectures and exercises, in the whole course of the exercise which facilitates the achievement of the educational objectives and the learning objectives;
- on the part of the students: disciplined in orderly, structured and planned work, promotion and development of positive personality traits and preventing academic failure. The regularity of the students' attendance depends to a large extent on the regularity of the teacher.

2.4. Principle of coherence and consistency of the didactic system adopted

A uniform and consistent relationship with all students; consistent application of the requirements set at the beginning of the semester (without mid-semester changes) in all subjects, for all instructors, in accordance with the University-wide policy.

2.5. The principle of visualisation

Adhering to it facilitates understanding of certain problems, increases interest in the subject matter and ultimately helps to develop positive motivation to learn and individual student activity. This means in particular the use of modern teaching (technology) tools and technological equipment.

2.6. The principle of gradual progression from easier to harder

This means arranging the curriculum material in such a way that the basic, elementary and easier knowledge is gradually progressed from the more basic to the more difficult; the knowledge needed to understand new subject units is given earlier. This also develops systematic, logical thinking and reasoning, can develop the habit of continuous learning and indirectly implements the principle of systematicity.

3. Educational objectives and methods at the university

The formulation of "long term" educational and training objectives is necessary in order to enable the trainers of the various disciplines to plan their own courses, their medium and short term activities, and to promote the desired changes in the attitudes and competences of their students. The traditional subject fiche, which consists of a list of topics or literature to be read, does not meet this objective, as it does not specify the competences that students are expected to acquire.

Based on [8] and updating it, the links between university teaching objectives, teaching methods or student activities and the assessment system can be outlined as a kind of guideline, as shown in [table 1](#).

4. Elements of the university educational–personal development process

The University's objectives are pursued through the planned organisation of

- educational and training process, subordinated to the general and specific objectives of the training. The education and training process is based on the following components [7]:
- the curricula (the content of the training),
- the forms and methods of imparting knowledge (the delivery of the training),
- the formulation of attitudes, the development of competences the forms and methods of training
- the organisation and funding of studies,
- the university students,
- university teachers.

The right concept of curricula is essential to achieve the detailed, substantive objectives of training. The development of sound curricula for each specialisation is based on a "specialisation model", which is developed by means of a detailed analysis of the industrial needs of the specialisation, its functional content and the knowl-

Table 1. The links between university educational objectives, teaching methods or student activities and the evaluation system.

Educational Objectives	Teaching Methods / Student Activity	Evaluation / Feedback
Knowledge		
<p>Student have to:</p> <ul style="list-style-type: none"> - have a basic knowledge of their subject terminology - be familiar with the basic laws and concepts of the subject - understand the usability of their subject - know the fundamentals and applications of the subjects related to their subject 	<ul style="list-style-type: none"> - lectures; compulsory literature; practical work; demonstration, etc. - lectures; compulsory literature; practical work; demonstration, etc. - links with research, industry, professionals in the field; experiments, projects (where and when appropriate) - general studies; reading of 'background' literature 	<ul style="list-style-type: none"> - multiple-choice exams; correct use of terms in papers; seminar debates, etc. - correct references to relevant laws, concepts, etc.; justifications, proofs; essay writing, etc. - evaluation of reports on project work, etc. - synthesis of information from different sources
Skills		
<p>University education should enable students to:</p> <ul style="list-style-type: none"> - to express their ideas in writing in an adequate manner - present clearly and concisely - be able to formulate judgements and opinions independently - understand how to acquire information effectively - be able to think imaginatively and in abstract categories - understand how to interact with colleagues and other professionals in relation to their future career - develop adaptability to changes in knowledge and attitudes (both in general technical developments in the field and new insights in your own field) 	<ul style="list-style-type: none"> - papers (essays); laboratory reports, etc. - presentation of papers; discussion and debate in seminar groups; consultations, etc. - encountering and recognising contradictions; confronting opposing views; using the seminar to explain the student's assumptions, etc. - use of libraries, internet, leaflets, abstracts, etc.; preparation for studies, projects; open-ended experiments - research projects; wrestling with unsolved problems; using scientific concepts in proofs, discussions, debates - peer, combined projects; role-playing, group debates to elucidate group interactions - exposure to new ideas, concepts (not accepting everything as 'fact') 	<ul style="list-style-type: none"> - their informative assessment - criticism from other students - e.g. "compare and contrast" questions in exams; evaluation of arguments made, etc. - informative comments on performance; "open book" exams - quality of written work (possibly publications); grasp of problems; appreciation of originality - peer evaluation of the student's behaviour and behaviour of other students - post-graduation monitoring
Attitudes		
<p>The sense of purpose in university education is designed to promote in students:</p> <ul style="list-style-type: none"> - enthusiasm for learning - a scientific need for accuracy - an awareness of the moral, economic and scientific problems of society 	<ul style="list-style-type: none"> - reading literature of your choice; extra-curricular activities (e.g. professional clubs and classes...) - contact with teachers and researchers who embody this precision; continuous monitoring of own results - general cultural studies; projects; sociology, economics, faculties... 	<ul style="list-style-type: none"> - expanding extra-curricular activities; identifying new problems for their own research work - rewarding punctuality in exams with a mark - impressively, based on the student's written work and seminar discussions

edge, characteristics, technical and economic aspects required, with particular attention to the most effective implementation of the engineering tasks of each industrial post (e.g. in dual training).

Curricula, based on the "degree model", delimit the range of knowledge, skills and competences required for students to complete a degree course, in terms of theoretical and practical preparation.

The curriculum based on the "department model" outlines the whole knowledge and skills necessary for students graduating from that given department, in theoretical and practical aspects as well. Consequently, the academic curriculum specifies the number and frame of theoretical subjects, special subjects, complementary subjects, human subjects, quantity of the necessary practice, the global quantity and correct proportions of the instructional contents in such a way that those fit into the whole and divided sections of the training period.

The study plans are defined in their final form:

- the number of subjects to be taught and their logical sequence in each semester;
- the number of hours of lectures and practicals in each subject;
- the basic requirements (examinations, mid-year grades, signatures) and the credits to be obtained;
- the number and duration of the work placements or internships to be carried out in production.

The study plans are used as a basis for the development of the so-called framework curricula for each subject, which define the teaching content in each subject that is essential for the course. The individual lecturers and tutors draw up the detailed curricula for each subject on the basis of these framework curricula.

The teaching process must be flexible and adapted to the people involved, to the specific and changing circumstances of each subject, each of which has its own methodological characteristics.

The material basis for the teaching and training process is adequate, with modern laboratory equipment, the provision of textbooks and notes, well-stocked libraries and reading rooms, modern lecture and practical rooms and laboratories, well-organised workshops and dormitories. The correct organisation of the course of studies is equally important, and includes:

- grouping students according to criteria that ensure rapid integration of the community and the development of a sense of collective responsibility for the learning outcomes;

- developing a reasonable timetable for compulsory classes, taking into account the economic use of students' time;
- the proportionate distribution of semester requirements (complex and detailed);
- reasonable examination scheduling;
- careful, detailed overview of the content of the curriculum.

In [9] it is pointed out that nowadays there is a steady emergence of university students who are younger than the Internet of mass public services. For them, the use of the Internet and computers, the versatile use of multimedia and mobile devices are a natural part of everyday life. They first encounter the internet and digital technologies as children and from then on, their use becomes a dominant part of their lives. All this is of course significant.

This has a significant impact on their perception of their role as students and on the way they think about higher education.

Of course, engineering education must be organised with this in mind, but it is also important to bear in mind that the development of "technical acumen" and practical skills is only a virtual process. In a virtual environment, using 'online' methods or distance materials cannot be effective and efficient.

The authors of [10] aim to help higher education institutions to apply strategy management methodologies that have been tried and tested in other sectors and industries and which are relevant for higher education institutions, and to improve their strategy management practice in general. This will be facilitated by practice-oriented descriptions of the methods and examples from higher education.

5. Conclusions

Without the active attitude of students, their self-aware attitude to learning and their motivated participation in the teaching and training process, the teaching staff cannot achieve the desired results. However, it is also the teaching staff community that is responsible for the whole training process, its content and scope, the methods used to achieve the training objectives, ensuring that it is properly organised, and for managing and exploiting the cooperation of young people. This requires committed teachers who are aware of the objectives and tasks, and who have the necessary scientific, pedagogical and moral skills.

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