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PREPARING ETI STUDENTS FOR ASSIMILATION OF KNOWLEDGE IN THE FIELD OF MATERIALS ENGINEERING

ABSTRACT

A questionnaire has been circulated among the ETI students on the deficiencies in the system of teaching exact sciences and difficulties usually faced during a course in materials engineering. Since nearly all of the subjects included in the syllabus of the first semester of teaching materials engineering seem to cause some problems, a diagnosis was made and the existing deficiencies and difficulties were discussed. Some changes were proposed as an output of the analysis of the currently existing situation. (ETI - the Faculty of Technical and Computer Science Education)

KEYWORD: *teaching, education, materials science*

INTRODUCTION

Problems with the lack of adequate knowledge and skills have been observed among the ETI students even at the very beginning of the course in materials engineering. The teaching methods used so far are becoming insufficient, as more and more frequently the fundamental information which has been used as a basis for further education is lacking. A growing tendency to abandon self-dependence in knowledge upgrading is observed along with the lack of systematic work. Although materials engineering is one of the main subjects in the course of these studies, at the initial stage of teaching it is also one of the subjects which students claim to be the most difficult in assimilation. The situation is additionally aggravated by the fact that the basic information is re-used many times in further course of the studies, thus becoming an indispensable tool of learning. The level of education in the field of mathematics and physics offered by the system of the secondary schools differs quite notably from that adopted by the universities, and therefore students have some obvious deficiencies in these subjects. This makes understanding and assimilation of the information on materials engineering much more difficult. In some cases, the inability to assimilate this information becomes a very discouraging factor, best reflected in students' preparation inadequate for practical classes and lack of involvement during lectures.

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ANALISYS

The programme of teaching materials engineering has been prepared in accordance with the guidelines developed for ETI studies, with due regard paid to all the expectations that the title of engineer must evoke when conferred to a student. The condition necessary for a student to get credit points for this subject is his active participation in classes and positive marks from oral examinations. The course ends in an exam held at the end of each semester, covering the material taught during both classes and lectures.

The basic course in materials engineering held for the ETI students covers during the first semester the following subjects:

- the main division of engineering materials,
- atomic bonds and how they influence the properties of materials,
- basic problems of crystallography including, among others, systems, lattices, planes, and orientations,
- basic mechanical properties of materials,
- defects in crystalline structure,
- basic phase equlibrium diagrams and practical skill of using them,
- solidification of materials and the related changes in structure.

The key problem in the process of learning materials engineering is systematic work and ability to use the knowledge already assimilated. Without proper background it is not possible to master in a relatively short span of time the whole vast scope of information given to the students during the course.

To cope with at least some of these problems, a questionnaire was circulated in a group of the ETI graduates who had already completed their education in materials engineering. The results collected from this questionnaire depict the deficiencies in substantive knowledge faced at the very beginning of the course and disclose subjects that present most difficulties. The results of the questionnaire are graphically presented below. The representative group of respondents covered 50 persons chosen at random according to the structure of the individual academic years.

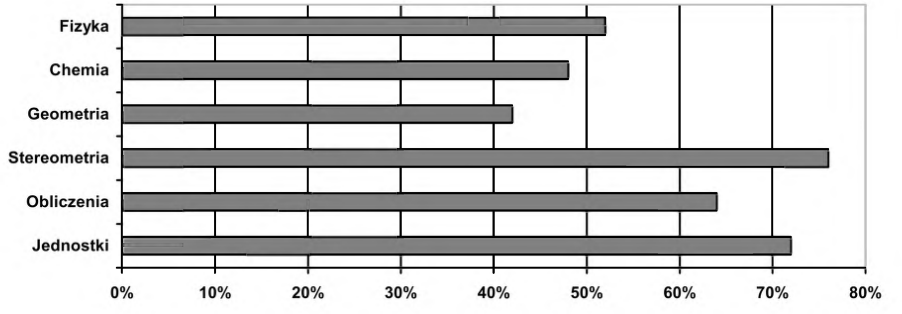

Diagram 1. Evaluation of percent deficiencies in subjects taught at the grammar and secondary schools.

The abbreviations in the diagram stand for the following designations:

- physics – general knowledge of physics,
- chemistry – general knowledge of chemistry,
- geometry – the skill of performing operations on 2D geometrical figures,
- stereometry – the skill of performing operations on 3D geometrical figures,

- calculations – the skill of performing calculations,
- units – the skill of converting units used in physics, chemistry and other related fields of knowledge.

From the above it follows that, in prevailing part, the students recognize their deficiencies in mathematics, mainly in the field of stereometry (76%), followed by the skill of performing calculations (64%); geometry ranks the last place (42%). The students ascertain that these deficiencies are a serious obstacle in assimilating and understanding the knowledge of some basic problems included in materials engineering. At the same time, the deficiencies in the general knowledge of physics (52%) and chemistry (48%) considerably reduce the students' capability of understanding the processes which take place in materials and some basic rules that govern laboratory tests. On the other hand, problems with conversion of physical and chemical units observed in 72% of the respondents cause some mistakes which, when introduced to calculations, make work during the classes very difficult.

The second group of questions regarded difficulties in understanding the knowledge related with materials engineering as taught during the first semester of the studies. Students were requested to enumerate subjects that in their opinion are the most difficult ones to master at the initial stage of education and to specify problems within a given subject that are most difficult to understand.

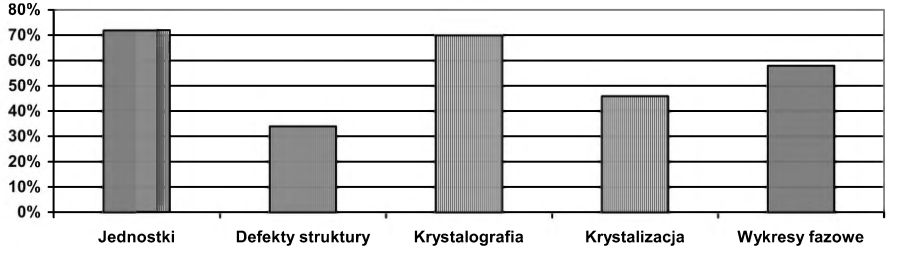

Diagram 2. Subjects most difficult for the students to assimilate (percent values).

From the above it again follows that a large group of the students have problems with conversion of units - a close correlation exists here with the results obtained in the previous group of questions, as it is still the same 72% of the students who previously had problems with this subject when taught at the level of grammar or secondary schools. The subject called "Defects in crystalline structure" has been considered difficult by 34% of the respondents which is the smallest value among all the subjects mentioned above. The problems of crystallography were considered difficult by 70% of the respondents, while various processes taking place during solidification - by 46%. On the other hand, the educational material covering phase equilibrium diagrams was considered difficult by 58% of the students.

This part of the questionnaire was also devoted to finding an answer to the question which specific problems within a given subject the students find most difficult to understand. Therefore the responding students were requested to put an additional remark stating which specific problem or a group of problems they considered most difficult within a given subject indicated by them as difficult to understand. From the collected data the following picture has emerged:

- in conversion of physical, chemical and other units the usual problems regard the prefixes and the corresponding numerical values as well as correlations between the individual units of a given physical quantity,
- in the group of defects in crystalline structure as most difficult were regarded the mechanisms of displacement and propagation of dislocations in the examined material,
- the section "Crystallography" was generally regarded as very difficult; working with crystal planes and lattice orientations was considered equally difficult as making relevant calculations,
- in the subject devoted to solidification processes, as most difficult to understand were regarded the structural changes that occur when the examined material is solidifying, specially differences in the structure of crystallites depending on the type of the solidification front present in each case,
- in phase equilibrium diagrams the problem was analysis of alloy composition as based on these diagrams and practical application of the lever-arm principle and Gibbs phases.

Hence a conclusion can be drawn that even at the very beginning of the course in materials engineering students have problems with practically most of the subjects taught, and additionally also with some fundamental operations performed on the units without which any attempt at starting a new subject must end in failure. At the same time, there is a close relationship between the difficulties faced when teaching materials engineering and the deficiencies in knowledge inherited from the previous stages of education.

The symptom most alarming seems to be the fact that 72% of the respondents are aware of the gap they have in their knowledge of how to make the conversion of units and continue with difficulties in understanding the problem also when taught during the studies. Making up for these deficiencies during the classes of materials engineering is very problematic since the abundancy of information which has to be assimilated leaves no room for additional explanations. This means that the students are expected to rely on their self-education rather and upgrade the knowledge and skills by themselves - an idea nowadays abandoned more and more frequently. The lack of adequate skills in making calculations has also an adverse effect on the entire course of education, since calculations of various types are often used in materials engineering, specially during classes and work in laboratory.

The second subject which poses considerable difficulties is crystallography – 70% of the students are not capable of understanding various systems and crystallographic lattices, not to mention the indentification of planes and lattice orientations. In crystallography, most of the phenomena take place on the crystal faces, and therefore mistakes in graphic interpretation of the individual cases must naturally lead to miscalculations. The whole knowledge which the student is required to possess is based mainly on the fundamentals of stereometry and geometry, but since students claim to have some deficiences also in this scope, it is a natural consequence that understanding of crystallography must pose some problems, too.

Phase equlibrium diagrams and their analysis seem to be of minor concern for someone who has a general knowledge of physics and chemistry. Nevertheless, since at the grammar and secondary schools they teach physics and chemistry mainly as a theoretical knowledge, an average ETI student is not capable of making unaided a practical use of the theoretical knowledge once acquired. This means that the tutors responsible for teaching of materials engineering must devote a lot of time to making students aware of how to obtain relevant information from the examined phase equilibrium diagrams.

Similar problems are also encountered in analysis of the structural changes which occur during solidification. The solidification as a process of strictly physical nature is easily

understod by someone who has got some practical backgrounds in the field of physics. However, in the case under discussion, the students have only some theoretical knowledge without any reference to practical applications, and therefore it is necessary to spend a lot of time on explaining this part of the educational material. The phenomena of displacement and propagation of defects in the form of dislocations observed in the structure of the examined material are difficult to master on the same account, that is, due to the lack of the fundamental knowledge of physics.

CONCLUSIONS

To sum up, it can be stated that most of the problems faced in the basic course of materials engineering are due to some deficiencies at the previous stages of education. ETI students are often graduates from the secondary schools of profiles completely different than the exact sciences. Hence problems must arise as regards practical application of the theoretical knowledge acquired in mathematics, physics and chemistry. Nominally, when the course of materials engineering starts, the course of mathematics, physics and chemistry assigned to this subject should already have been completed. In practice, however, the students continue with being given some pieces of information which, though new, are firmly rooted in the knowledge already acquired. Many students cannot cope with this problem even at this stage, which results in failure and natural selection. Therefore, from the point of view of teaching materials engineering, it would be recommended to make the stereometry and geometry included in the course of mathematics with increased number of practical classes to develop the skill of calculations. At the same time, leveling of knowledge during the studies should be regarded as a last recourse. The grammar and secondary schools should rather be informed on the problems currently observed and requested to introduce some modifications to their programme of teaching exact sciences, allowing for a stage when the theory would be interwoven with practice. The greatest problem which the students have to face is how to apply in practice the theoretical knowledge once acquired. An analysis of the currently used academic handbooks is rather optimistic, as most of the information is disclosed in a way that makes it relatively easy to assimilate. As regards the tutorial staff encharged with the task of teaching materials engineering during the studies, a solution to at least some of the problems might prove to be the use of the methods that would promote among the students the idea of self-education and self-dependence by making them aware of the fact that knowledge acquired in this field will be used all the time in further course of the studies. At the same time one should remember about maintaining a proper equilibrium between this subject and other subjects taught parallel to materials engineering.

LITERATURE

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