International Journal of Occupational Safety and Ergonomics

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tose20

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Published online: 08 Jan 2015.

To cite this article: Jerzy Słowikowski (1998) A Draft of a System of Teaching Occupational Safety and Ergonomics at Universities in Poland, International Journal of Occupational Safety and Ergonomics, 4:2, 221-236

To link to this article: http://dx.doi.org/10.1080/10803548.1998.11076391

INTERNATIONAL JOURNAL OF
OCCUPATIONAL SAFETY AND ERGONOMICS 1998, VOL. 4, NO. 2, 221–236

NOTES

A Draft of a System of Teaching Occupational Safety and Ergonomics at Universities in Poland

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The aim of the study was to develop a set of curricula for teaching Occupational Safety and Ergonomics at colleges and universities of various types, aimed at equipping students with knowledge and skills and at shaping active attitudes towards the practical application of the acquired knowledge in their future working lives. On the basis of the analysis of the curricula at Polish and foreign colleges and universities, a set (canon) of educational contents constituting a common practice in the academic teaching of Occupational Safety and Ergonomics was established. Then, a convenient for teaching this subject classification of university specialisations in Poland was introduced. This led to identifying and defining a taxonomic unit called here an educational profile. Next, curriculum minima for the developed profiles were defined objectively. To achieve this aim, the set of educational contents was ranked by university teachers and specialists in occupational safety and ergonomics. Each part of the educational contents (subject) was ranked on a 10-point scale in relation to each educational profile. The results of this ranking led to formulating sets of educational contents for each educational profile. On this basis, a repertoire of curricula (6 curricula, in 2 hour-by-hour versions each) was prepared, with methodological guidelines for lecturers. The results of the study were presented in the form of a manual for academic authorities.

user designer teaching aims educational profile

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1. INTRODUCTION

1.1. Background

In the course of a working life, every graduate may become a user or a creator (or both) of technology and organisation.

Everyone will become a user of technology and organisation: as an employee (the technological means will be provided) or as a purchaser of the products of technology (he or she will make the choice). In the contemporary, increasingly filled with technology world, graduates should be able to, for their own benefit (health and efficiency) and as examples for others (creating positive role models), consciously shape their own material environment at work (if possible) and outside work (to the greatest possible extent).

A creator of technology and organisation is a person who, during a working life, will—occasionally or on a permanent basis—shape working conditions for others. He or she can do it as an employer (or a specialist working on the employer's behalf) or as a professional designer. Everyone may become an employer, when the knowledge of occupational safety and ergonomics acquired during the studies is an indispensable element in making decisions on both product development strategies and the working conditions in the enterprise.

In the social division of work, a designer is a professional creator of technology and organisation. A designer acts in the various aspects of designing objects, technical systems, and organisation. Knowledge and skills in occupational safety and ergonomics play a special role in a designer's education, because they constitute an integral part of the profession. When (for technological reasons) the technical quality of products becomes similar, the ergonomic factor becomes an essential element of their commercial competitiveness. Furthermore, it is quite likely that solutions inadequate from the point of view of occupational safety and ergonomics may be rejected (i.e., may not be granted permission to be sold or used) under international standards and regulations.

Thus, every graduate should acquire adequate knowledge in occupational safety and ergonomics.

Considering this discussion in terms of a graduate's attitude towards the material environment (Słowikowski, 1997a), it is possible to say that a user of the elements of the material environment (e.g., work tools)

TABLE 1. Objectives of Teaching Occupational Safety and Ergonomics—Basic Dichotomy

Occupational Profile of a Person Taught		Educational Objective		
		General	Detailed	
Social Role	Attitude Towards Artificial Material Environment		Elements	Contents
User of technology and organisation	Passive	Related to outlook	Knowledge	Acquiring basic knowledge of ergonomics to the extent allowing functioning in a modern society.
			Skills	Acquiring skills of noticing ergonomic problems in one's environment and of calling on professionals in ergonomics to solve those problems.
			Attitudes	Shaping an active attitude towards one's material environment and a conviction that it is not unchangeable.
Creator of technology and organisation (designer)	Active	Occupational	Knowledge	Acquiring the knowledge of ergonomics in the scope necessary for performing a profession.
			Skills	Acquiring skills of detecting and solving basic ergonomic problems to the extent necessary for performing one's profession and for calling on professionals in ergonomics to help in development activities.
			Attitudes	Forming an anthropocentric attitude towards shaping man's artificial material environment, that is, a conviction that man's features and requirements are a superior value in relation to the features of a technical object.

who has no influence on them is passive, whereas a designer, whose profession is to shape the material environment and its elements, is active. A dichotomous division of educational objectives made from this point of view is presented in Table 1.

1.2. Task

As there is an unusually varied spectrum of colleges and universities, specialisations, and options (e.g., in Poland, according to official terminology, there are over 80 university specialisations), only such a number of curricula should be developed that all, or almost all, didactic needs are satisfied without multiplying entities beyond necessity (Ockham's razor). Establishing that number and developing an appropriate set of curricula in Occupational Safety and Ergonomics was the aim of this study.

1.3. Terminology

Some of the notions used here, important for establishing the relations between ergonomics and specific university specialisations, are not understood in the same way by different academic communities. In this text, they are defined as follows:

- educational profile—a set of university specialisations with a similar scope of the knowledge and skills taught, and a special for a given profession attitude towards the material environment,
- material environment—a set of objects and phenomena (physical or chemical) that surround man and that constitute the subject or the object of man's (occupational, among others) actions,
- technical object—an object produced by man (a product of technology, artefact), especially a tool, machine, a workstation, or an element of technical equipment of all the nonprofessional activities.

2. METHOD

2.1. Classification of University Specialisations

In order to develop a full and useful for the reduction of the number of curricula for teaching Occupational Safety and Ergonomics classification

of educational profiles, the following classification criteria, including the dichotic division of graduates discussed in section 1.1. were used:

- scope of basic knowledge and occupational skills of a graduate,
- relations with the material environment when performing the occupation (including the relations with the working environment),
- problem dominants in occupational safety and ergonomics in relation to the occupation,
- criteria of science competence,
- criteria of machine competence.

The taxonomic unit of the classification of university specialisations, created on the basis of the aforementioned criteria, is called an educational profile. Table 2 presents features identifying specific educational profiles, created according to the aforementioned principles. Table 3 lists the most important (from the point of view of didactics; Gnitecki, 1991) objectives of teaching Occupational Safety and Ergonomics.

Among the triad of the educational objectives of knowledge, skills, and attitudes, the skills objective, which usually raises the most misunderstanding, was considered particularly carefully. Whereas the intentions of lecturers concerning the knowledge and attitudes of future graduates are fairly clear and homogeneous, questions concerning skills are perceived in quite general terms, even though they constitute the most essential factor distinguishing individual educational profiles. However, to achieve a pedagogical success (or at least satisfactory results), it is necessary to closely relate skills in occupational safety and ergonomics with basic occupational skills of a graduate (Lamonde, 1997).

2.2. Adaptation of Educational Contents

Because of the diversity of educational objectives, individual profiles should also have different sets of educational contents. Therefore, actions were taken to objectively determine curriculum minima for the distinguished educational profiles. To achieve this aim, a two-step procedure was used.

The first step was the formulation of the basic canon of educational contents existing in the general practice of teaching Occupational Safety and Ergonomics. This canon was developed on the basis of national and foreign curricula of the same or comparable scope (Queinnec, 1990; Wykowska, 1996). The set of educational contents was structured using

TABLE 2. Identifying Features of Educational Profiles—A Review

Educational Profile		Occupational Profile of a Graduate		
Symbol	Name	Description of Occupation	Subject of Occupational Influence	Comments
P1	Natural Sciences and the Arts (excluding P2 and P3)	Person with master's degree in any university specialisation	People	A graduate of nontechnical studies is, in principle, a user of technical objects. A graduate neither designs technical objects or organisation, nor manages an enterprise.
P2	Management	Manager	People and organisational structures	A manager manages projects, enterprises (organisations), or both on the strategic level. In relation to people and technical objects, a manager acts from the position of the megasystem.
P3	Medicine	Physician	People (health)	A physician's tasks are, among others, prevention, performed—in the context of occupational safety and ergonomics—by influencing the material environment of man-patient, including the working environment, and the environment in which medical treatment takes place.
P4	Organisation of Production	Methods engineer	People, organisational structures, and technical objects	A methods engineer acts in the area of using ready-made technical objects (tools, machines, and devices) and creates (designs) new technical objects (instruments and workstations).
P5	Machinery. Construction Machines and Machine Tools	Mechanical engineer	Technical objects classified as construction machines and machine tools	The Construction Machines and Machine Tools class includes — technological machines, — transportation machines, — power-producing machines.
P6	Machinery. Information Machines and Devices	Engineer designing technical objects used as means of conducting a dialog between man and a technical system	Technical objects classified as information devices, machines, and systems	Introduction of the Information Machines and Devices category became necessary because of the actual state and the striving to produce user-friendly objects.

TABLE 3. Characteristics of Educational Profiles—A Review

Educational Profile		Objectives of Teaching Occupational Safety and Ergonomics		
Symbol	Name	Knowledge	Skills	Attitudes
P1	Natural Sciences and the Arts (excluding P2 and P3)	Acquiring basic knowledge of ergonomics to the extent allowing functioning in a modern society.	Acquiring skills of detecting problems in occupational safety and ergonomics in one's environment, especially the working environment, and calling on suitable specialists to solve those problems.	Shaping an active attitude towards one's material environment, including the working environment, and a conviction that it is possible to transform and improve it.
P2	Management	Acquiring knowledge of occupational safety and ergonomics to the extent necessary for making strategic decisions regarding one's professional actions.	Acquiring skills of evaluating the importance of occupational safety and ergonomics for the operation of an enterprise and the competitiveness of its products on international markets and the skill of making strategic decisions in this respect.	Forming sensitivity to the problems of occupational safety and ergonomics—important elements of modern management.
P3	Medicine	Acquiring knowledge of occupational safety and ergonomics to the extent allowing taking (together with suitable partners) actions aimed at shaping the material environment of man-patient, including the working environment and the environment in which medical treatment is taking place.	Acquiring skills of cooperating with partners in order to shape the material environment of man-patient, including the working environment and the environment in which medical treatment is taking place.	Shaping an active attitude towards man's material environment and a conviction that it is possible to transform it in the desired direction.
P4	Organisation of Production	Acquiring knowledge of occupational safety and ergonomics to the extent necessary for designing workstations and work organisation.	Acquiring skills in diagnosing and designing workstations and work organisation, meeting the requirements of safety and ergonomics.	Forming sensitivity to the problems of occupational safety and ergonomics in evaluating and designing workstations and work organisation.
P5	Machinery. Construction Machines and Machine Tools	Acquiring knowledge of occupational safety and ergonomics to the extent necessary for designing or using technical objects of one's speciality.	Acquiring skills of detecting and solving basic problems of occupational safety and ergonomics in one's speciality.	Shaping an anthropocentric attitude towards the designed or evaluated object, that is, a conviction that man-user's (man-operator's) features are at least as important in the designing or evaluating as technical characteristics.
P6	Machinery. Information Machines and Devices			

a two-level division into 9 thematic blocks (modules) and 92 detailed subjects assigned to them.

Selection, from the basic canon, of contents that would be suitable to particular educational profiles was the second step of the procedure, aimed at adapting educational contents to particular educational profiles. To avoid arbitrary decisions, unavoidable in the case of an author's selection of contents, an appropriately selected group of respondents was surveyed. This method had often been successful (Lovén, Eklund, & Odenrick, 1991). The survey consisted in ranking educational contents: The usefulness to particular educational profiles of individual detailed subjects was evalutated on a 10-point scale. The ranking was conducted among academic teachers lecturing in Occupational Safety and Ergonomics at technical, agricultural, medical, art, and pedagogical colleges and universities. There were 19 respondents.

3. RESULTS

3.1. Empirical Material

As a result of the ranking, a matrix of data was obtained, linked to each of the 92 detailed subjects included in all six profiles. Data were statistically analysed in order to obtain average values, which were a numerical expression of the respondents' opinions. To present the results in a concise form, data were averaged again within each thematic block, which allowed to reduce the matrix of data to 9 (thematic blocks) $\times$ 6 (educational profiles) = 54. This is presented in Table 4. Although the diversity of the respondents' group contributed to the "flattening" of the final value of the generalised judgement during the statistical analysis, the range of ranks was quite wide, from the minimum value of 2.1 (profile P3: Medicine, thematic block 9: Ergonomic Design) to the maximum value of 7.9 (profile P5: Machinery. Construction Machines and Machine Tools, thematic block 4: Anthropometric and Biomechanical Factors). This evident diversity of ranks, presented graphically in Figure 1, allowed to effectively select subjects and to reduce the educational contents to a minimum in relation to each educational profile (Słowikowski, 1997b).

TABLE 4. Average Values of Ranks

Profile	Thematic Block									Average
	1	2	3	4	5	6	7	8	9	
P1	5.8	4.8	5.2	3.1	4.2	3.7	4.5	3.3	2.6	4.1
P2	5.9	7.2	7.1	3.1	4.0	4.0	5.2	5.0	4.3	3.8
P3	4.9	4.9	4.3	4.1	7.0	4.4	6.5	4.1	**2.1**	4.7
P4	6.5	7.1	6.4	5.6	6.5	5.8	7.3	6.3	5.5	6.3
P5	6.1	6.6	4.3	**7.9**	6.2	7.0	6.8	6.2	7.6	6.5
P6	6.8	5.9	5.0	7.3	5.3	7.2	5.4	5.9	7.3	6.2

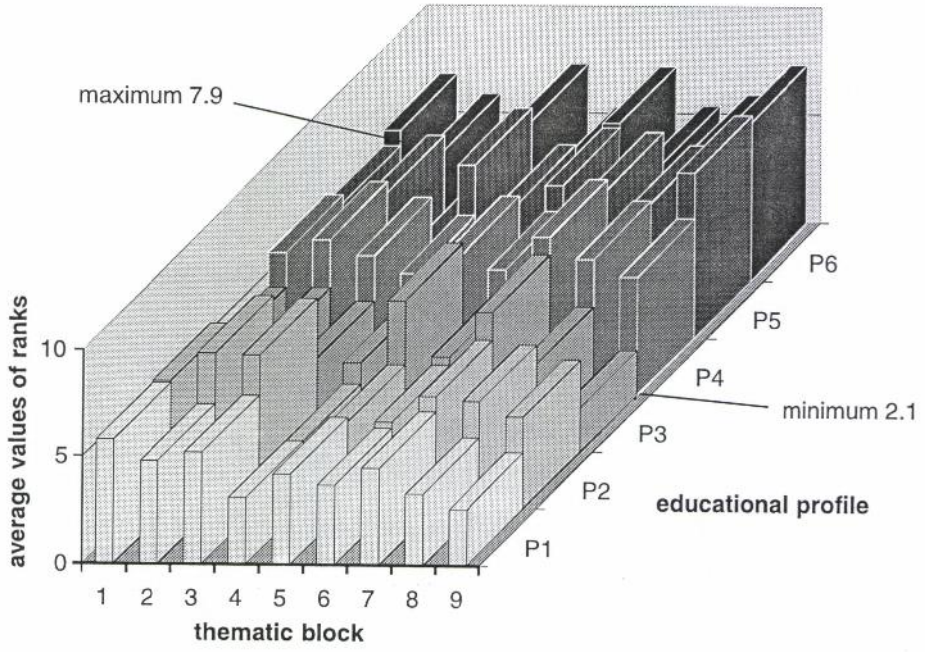

Figure 1. Results of ranking the educational contents—average values of ranks.

3.2 Selection of Educational Contents

The average values of ranks for particular profiles are presented in Figure 2. Empirical material indicates that profiles P1, P2, and P3 are clearly situated in the group in which ranks are placed on the lower level ("soft ranks"), and profiles P3, P4, and P5, on the higher level ("hard ranks"). Two methodological conclusions that concern the principles of reducing the elements of the set of educational contents follow:

1. It is impossible to adopt one, common level (the values of a rank), below which all the subjects should be rejected.

Explanation: in the case of any common value of this level either the majority of the subjects of the profiles ranked as "hard" would be unfoundedly rejected or all the subjects of the profiles ranked as "soft" would be unfoundedly retained.

2. Two reduction levels should be applied, the lower one for "soft" profiles P1, P2, and P3 and the higher one for "hard" profiles P4, P5, and P6.

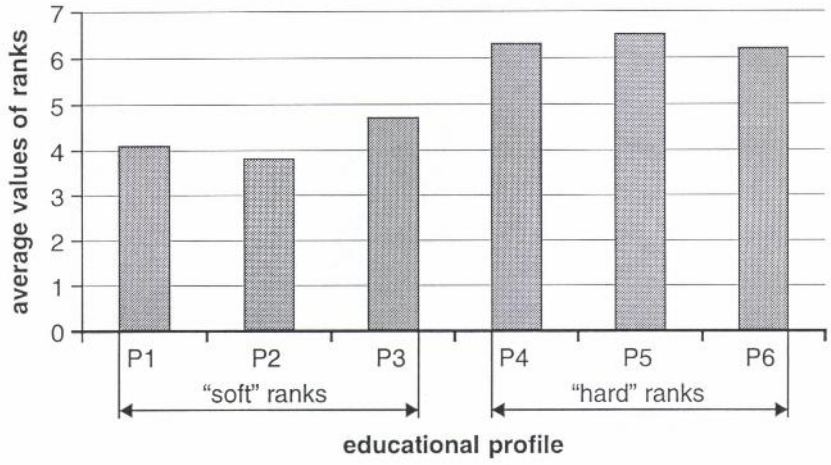

Figure 2. Average values of ranks for particular profiles.

On the basis of the extremes of the isolated values of ranks and the conclusions formulated above, the empirical principle for the selection of the elements of the set of educational contents (subjects) was formulated, according to which the height of the reduction levels was established in a way that allows to reject about a quarter of the subjects. This principle can be expressed in the form of the following formula:

$$N_0 = (0.24 \pm 0.12)\, N$$

where N_0 is the number of rejected subjects, N = 92 is the total number of subjects in the set.

Using the aforementioned principle and accepting two levels of reduction led to establishing the following values of these levels:

- for profiles P1, P2, and P3, subjects ranked $x \leqslant 3$ are rejected,
- for profiles P4, P5, and P6, subjects ranked $x \leqslant 5$ are rejected.

The results of this operation, conducted according to the aforementioned principles, are presented in Table 5.

TABLE 5. Educational Contents Rejected as a Result of the Ranking

Measures	Profile					
	P1	P2	P3	P4	P5	P6
Rejected ranks (including)	3	3	3	5	5	5
Number of subjects	35	21	27	21	12	25
Percentage of subjects	38	23	29	23	13	27

As a result of applying the presented procedure, educational contents in particular thematic blocks was established for all educational profiles. The time proportions between blocks, which are, to an equal degree, the result of the values of ranks, were established as well. In this way, a balanced and fairly objective basis was created for the formulation of curricula.

4. DISCUSSION

4.1. Evaluation of the Method

The assumed and accepted diversity of the group of respondents entails two consequences, especially important when interpreting the results: considerable differences in the answers and the "flattening" of the average absolute values of ranks. Standard deviations of the values of ranks can be the measure of the lack of conviction (range) of the opinions of the respondents as a group. These average deviations for particular thematic blocks are presented in Figure 3.

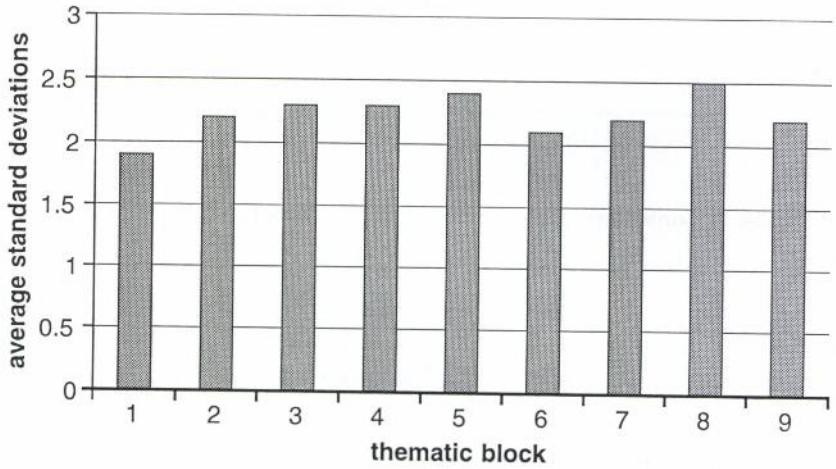

Figure 3. Lack of conviction of the respondents' opinions in relation to thematic blocks.

Figure 3 shows that the smallest differences in evaluation were expressed by the respondents when thematic block 1 (Ergonomics— Basic Concepts) and 7 (Working Environment and Hazards) were ranked. It confirms, to a certain degree, the status and the social perception of ergonomics. Namely, it is presented (and perceived) as a useful and even a noble idea (utopia?) which, in reality, boils down to the reduction of more serious hazards (and perhaps more comfortable seats).

The greatest variation of opinions was noticed in subject 8 (Ergonomic Diagnostics) and subject 5 (Physiological Factors). It is certainly a surprising fact, because these are the most popular and most common subjects in ergonomics, sometimes even identified with the whole discipline. We can assume that this is so because of difficulties in the relative evaluation of the importance of these issues for varied educational objectives in particular educational profiles.

Average standard deviations for particular educational profiles are presented in Figure 4. This figure shows that evaluations were least varied in the case of profile P3 (Medicine) and profile P6 (Machinery. Construction Machines and Machine Tools).

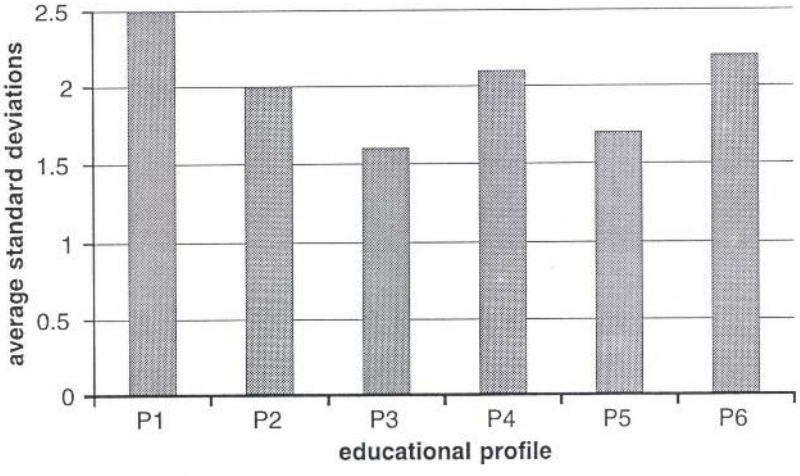

Figure 4. Lack of conviction of the respondents' opinions in relation to educational profiles.

Conviction in opinions was probably caused by the fact that they are well defined scientific disciplines. The greatest variation of evaluations, that is, lack of conviction on the part of the respondents as a group, occurred in the case of profile P1 (Natural Sciences and the Arts) and profile P6 (Machinery. Information Machines and Devices). In the first

case, this is probably the result of lack of experience in taking up the subject Occupational Safety and Ergonomics at colleges and universities. In the second case, it is a sign of a "soft" definition of this group of machines, its young age, and its continuing rapid development.

On the basis of those conclusions, inspiring to further reflection on the self-awareness of professionals in the field of occupational safety and ergonomics, it is possible to say that the method used is precise enough to objectively distribute educational contents in relation to particular educational profiles.

4.2. Principles of Adapting Curricula to Local Conditions

The objectives of teaching Occupational Safety and Ergonomics, established for particular educational profiles, should be achieved with the use of various forms, that is, didactic measures, dependent on many factors, when the basic amount of knowledge specified in the curriculum minima is retained. The choice of an appropriate educational profile and the adaptation of a corresponding curriculum to real conditions should be made according to the following principles:

- Differentiation with respect to university specialisation. A particular educational profile includes, according to the classification of the principles presented in section 2.1., up to several university specialisations. It is then necessary to communicate educational contents ascribed to a particular profile in the forms close to educational contents and methods accepted within a given university specialisation.
- Differentiation with respect to local conditions. The same university specialisations realised in various institutes differ due to the fostering of the options and approaches to the subject specific only to those institutes. When adapting curricula, this variety of options and specialisations should be not only respected, but also used as an innovative factor in the didactics of the basic occupational subjects and the subject Occupational Safety and Ergonomics.
- Differentiation with respect to sector. The same university specialisations may be realised in colleges and universities related to different sectors (e.g., machinery may be taught in technical, agricultural, mining, or military colleges or universities). For the sake of the didactic process, this fact should be taken into consideration.
- Differentiation with respect to lecturers. It is a general rule that the didactic process is more successful when the lecturers are real authorities

TABLE 6. Repertoire of Educational Curricula of Teaching Occupational Safety and Ergonomics

	Educational Profile																	
	P1			P2			P3			P4			P5			P6		
	Number of Hours per Subject																	
Thematic Block	**15**	**30**	**60**	**15**	**30**	**60**	**15**	**30**	**60**	**15**	**30**	**60**	**15**	**30**	**60**	**15**	**30**	**60**
Ergonomics—Basic Concepts	2	2		2	4		2	2			2	4		2	4		2	4
Legal Work Protection	2	3		2	5		2	4			2	6		2	4		1	4
Psychosocial Factors at Work	2	3		2	5		1	3			2	4		—	—		1	4
Anthropometric and Biomechanical Factors	1	4		1	2		2	4			4	8		6	10		4	8
Physiological Factors	2	5		1	4		3	6			4	8		4	8		4	6
Psychological Factors	2	2		1	2		1	2			4	6		6	10		8	12
Working Environment and Hazards	2	4		2	4		2	3			4	8		2	6		2	6
Ergonomic Diagnostics	1	6		2	2		2	6			4	8		4	8		4	10
Ergonomic Design	1	1		2	2		—	—			4	8		4	10		4	6
Percentage of Practical Training	0	25		0	0		0	33			33	33		50	50		50	50

with their own achievements in the field. Lecturers comfortable in their specialisation are conducive to applying the principle integrating the teaching of occupational safety and ergonomics with the teaching of the basic occupational subjects within a given university specialisation.

5. CONCLUSIONS

Thanks to the procedure described in this paper, which consisted in the establishing of the classification of university specialisations and the applying of the ranking method in the selection of educational contents for particular educational profiles, a repertoire of curricula in Occupational Safety and Ergonomics was developed, sufficient to satisfy almost all the needs at the undergraduate and graduate levels in Poland. This repertoire, including a concise set of methodological parameters, is presented in Table 6.

As it can be seen in Table 6, the most modest (15-hr) curriculum was developed only for profiles P1, P2, and P3 as a necessary minimum. In the 15-hr curricula, separate practical training classes were not planned due to the lack of time, although the lecturer, to communicate knowledge, can use this form of teaching.

The 30-hr curriculum can be recognised as the most popular. It can be carried out with satisfactory results in the case of all profiles. Within the curriculum, practical training was planned. Its proportion in relation to lectures (excluding profile P2) is from 1/3 to 1. It allows not only to communicate knowledge, but also to master the skill of coping with ergonomic problems in the students' working life.

For the profiles with the engineering dominant, P4, P5, and P6, within which the mastering of special skills is the basic issue, the 15-hr curricula would be unacceptable. Sixty-hour curricula were, therefore, introduced, in which in addition the proportion of practical training comes to half of the time devoted to the subject. It allows to professionally prepare a student to responsibly shape working conditions for other people.

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