

Natalia Wanda Skinder<sup>1</sup>

Barbara Mianowska<sup>2</sup>

Wanda Śliwa<sup>3</sup>

<sup>1</sup> Polytechnical University, Wrocław

<sup>2</sup> Secondary School, Zabkowice Śląskie

<sup>3</sup> Pedagogical University, Częstochowa

## EDUCATIONAL GOALS IN THE CHEMISTRY TEACHING

**Abstract:** The taxonomy of educational goals comprising two types: cognitive and upbringing goals, is proposed. Each of these types is divided into four cumulative categories, A, B, C and D, arranged in a hierarchic way, from the simplest to the most difficult ones.

The tridimensional model of the educational content analysis becomes today a paradigm of teaching process [1,2], therefore the taxonomy of educational goals attracts an increasing attention, educational goals being one of dimensions of this model (Fig. 1).

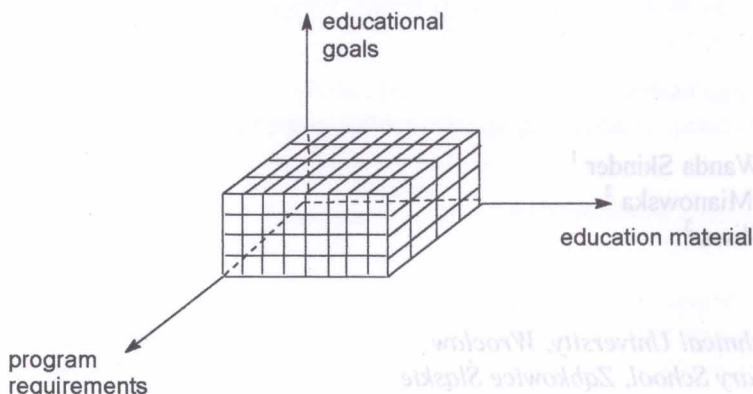


Fig. 1

The tridimensional model of the educational content analysis [1]

This taxonomy should be simple, logical, functional and compatible with the present state of the methodological knowledge in pedagogics; it ought to be considered from the theoretical and practical points of view.

Taking it into account we propose a more precise terminology in this domain, corresponding to the ABCD taxonomy founded in 1970 by Niemierko [3,4]. Thus, we introduce the term education, connecting two definitions: teaching-learning and upbringing.

The definition „education” was earlier introduced to chemistry didactics along with a proper justification, by Soczewka [5]. He writes: „The education is a process where functions made by pupils and the teacher in a manifold feedback are acting. The choice and the system of these functions depend on development of personality laws and are defined by educational goals, in subjects and out of subjects.

The education is a many-sided and maximally integrated process, involving the whole of educational and organizing activities; its result are achievements of pupils in the given subject, as: information, abilities and changes of the personality.

All intellectual and motoric acquests form an integrated system whose cohesion and stability depend on the satisfaction of cognitive and practical needs, imposed by the existence laws” [5].

Thus the education consists of two complementary processes: cognitive and upbringing ones.

The cognitive process, i. e. in the case of chemistry the training of mind and of hand ( intellectual and manual activities) is a fundamental process in the school education.

The upbringing, i.e. the formation of the personality, that is a cultivation of the character, is closely connected with the education. Upbringing, on the base of alternative pedagogics is a fundamental goal of the education [6].

So, the idea of the present-day teacher and of new educational systems is such steering of the cognitive process of the pupil for he becomes not only a wise and creative man, but also a honest man, full of love and of democracy [7].

Therefore, in the modern school, simultaneously to the cognitive process, the upbringing as its crowning achievement should proceed. Having this in view, we propose the following taxonomy of educational goals, presented by us at the Expert Seminar „European Cooperation in Chemical Education”, Jabłonna near Warsaw 1988 [8] (Table 1).

Table 1  
The ABCD taxonomy of educational goals [8]

Type	Level	Categories of educational goals
Cognitive goals	I Information	A - recall of information B - recall of information with understanding
	II Abilities	C - application of information in typical situations D - application of information in new situations (solution of problems)
Upbringing goals	I Actions	A - participation in action B - taking on actions
	II Attitudes	C - disposition for action D - formation of the system of actions

This taxonomy, according to the meaning of the definition of education, includes two types of goals: cognitive and upbringing ones. Each of these types is classified into four cumulative categories, A, B, C and D. They are arranged in a hierarchic way, i.e. from the simplest and easiest (A) to the most complex and difficult (D).



These categories are cumulative, what means that the goals of the higher category include those of the lower category, e.g. the goals of the B category include the realized already goals of the category A, and the goals of category D include those of A,B and C categories. This is well illustrated by the model proposed by Soczewka (Fig. 2), consisting of four cubes of matched size, where the biggest box, corresponding to the highest category of goals, the category D, contains all remaining smaller boxes, corresponding to A,B and C categories [9].

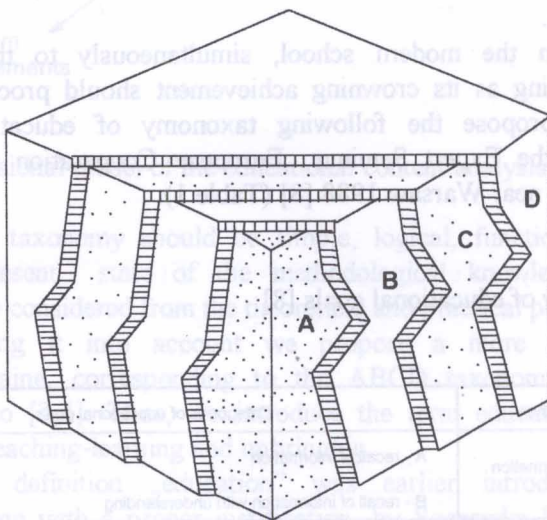


Fig. 2

The model showing the cumulateness of the categories of educational goals [9]

The categories of educational goals are divided into two levels. The goals of A and B categories belong to the level I (the lower level), and those of C and D categories form the level II (the higher level) [10].

The lower level of educational goals in the cognition are informations and in the upbringing - actions, and the higher level in the cognition are abilities and in the upbringing - attitudes.

This classification for chemistry teaching may be presented as follows:

- A- recall of information and participation in action
- B- understanding of information and taking on actions
- C- abilities learned and the internal need of the activity
- D- new abilities and the system of actions

Moreover, in the presented taxonomy the cognitive and upbringing goals, although closely integrated, maintain a certain autonomy in their mutual relations.

The detailed classification of cognitive educational goals in the chemistry teaching was proposed in 1983 [11], and was successfully applied in the research [2] and in testing measurements [12-14] (Table 2), while the upbringing educational goals are still waiting for their more precise schematization.

Level of attainment	Categories of goals									
	10	9	8	7	6	5	4	3	2	1
Cognitive	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action
	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action
Upbringing	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action
	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action	recall of information and participation in action

Fig. 3

Relation between the categories of cognitive educational goals and the realization of educational goals in chemistry teaching.

Table 2  
Cognitive educational goals of the curriculum, referring on the basis of the ABCD taxonomy

Table 2

Cognitive educational goals of the chemistry teaching on the basis of the ABCD taxonomy [1]

Entry	Categories of goals			
	The level of information		The level of abilities	
	A Recall of information	B Understanding of information	C Application of information in typical situations	D Application of information in new situations
1	knowledge of facts	understanding of terminology	ability of making observations	ability of abstracting (of generalizing)
2	knowledge of ideas	understanding of definitions and ideas	ability of making experiments	ability of specifying
3	knowledge of definitions and laws	understanding of laws and statements	ability of choosing and mounting of apparatus	ability of discovering of cause-result relations
4	knowledge of symbols and chemical formulas	understanding of chemical reactions and formulas	ability of planning of the experiment	ability of checking (verification of hypotheses
5	knowledge of classification	classification according to a criterion	ability of identification and comparison of substances	ability of explaining of new (untypical) phenomena
6	knowledge of occurring of substances and phenomena	explaining of laws, definitions and phenomena	ability of solving of chemical calculations	ability of justification of hypotheses
7	knowledge of properties of substances	interpretation of phenomena, laws and definitions	ability of operating with chemical symbols	ability of making chemical complex calculations
8	knowledge of reactions	transformation of formulas	ability of handling with models	ability of designing and making new experiments
9	knowledge of reaction conditions	reading of tables and plots	ability of constructing tables and plots	ability of conclusions per analogy
10	knowledge of applications	making abstracts (summaries)	ability of application of laws and statements	

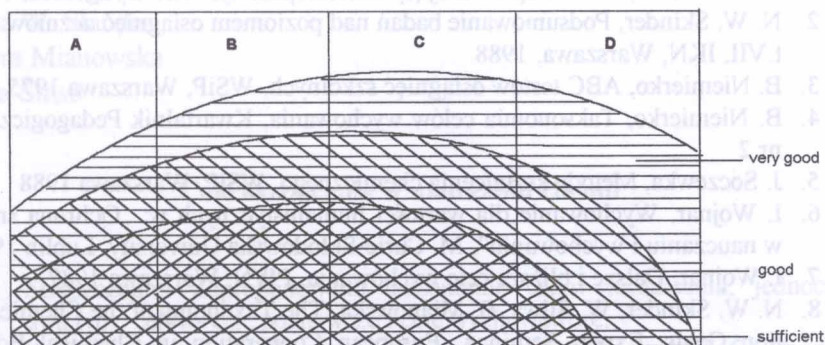


The chemistry is a subject where various upbringing educational goals can be very well realized [15-17] as wrote in 1932 Jan Harabaszewski, the author of Polish chemistry didactics [18], pointing out that the chemistry is a subject of general education and its position in the school education is of a fundamental importance.

We see that indeed the upbringing goals can be realized in the chemistry teaching; they are for example: cleanliness, exactitude, honesty, accuracy, economy, inquisitiveness, truthfulness, courage, comradeship and patriotism [17].

The formation of character is very important in the school education, especially now, when exactly the chemical knowledge should give a hope that the battle against the environment pollution will be won. Therefore it is of importance to educate the inquisitive man, responsible for his activities and having regard to other people and to the whole Nature, whose part, albeit the unique one, he is. One ought to know that the human existence depends only on the wise, economical use of natural sources and of their protection.

Therefore the valuation of achievements of the pupil should show not only the degree of realization of cognitive goals, but also that of upbringing goals, on the principle that the better the mark, the higher categories of upbringing goals are realized (Fig. 3).



A - recall of information and participation in action

B - understanding of information and taking on actions

C - abilities learned and the internal need of the activity

D - new abilities and the system of actions

Fig. 3

Relation between marks of pupils' school achievements and the realization of educational goals in chemistry teaching [1]

Proposed here by us the ABCD taxonomy of educational goals has a simple and logical structure and is in accordance with the definition of education and with rules of didactics measurement; it differentiates in a sufficiently sharp and uniform way A, B, C and D categories of educational goals and expresses the integration between cognitive and upbringing goals.

Moreover the above classification is functional because on this basis one can state if a given function, belonging to a corresponding category of cognitive or upbringing goals has been made or not. This is of importance in the checking and evaluation of achievements of pupils and for chemistry students [19], as well as in the research in didactics [1,20].

We hope that the ABCD taxonomy proposed by us will bring the end to the unlogical, false classification of educational goals into educational, cognitive and upbringing ones and that it will raise the range of upbringing goals in the process of chemical education, and can be the theme of Master's theses treating with chemistry teaching.

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Natalia W. Skinder  
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### Cele kształcenia w nauczaniu chemii

**Streszczenie:** Zaproponowano taksonomię celów kształcenia, łączącą dwa typy celów- cele poznawcze i cele wychowawcze.

Każdy z typów dzieli się na cztery kumulatywne kategorie A, B, C i D, ułożone hierarchicznie, od najłatwiejszych do najtrudniejszych.