STUDENTS' COGNITIVE DEVELOPMENT AND TEACHING APPROACH IN ACHIEVING THE OVERALL SCHEME OF COMPUTER SCIENCE TEACHING AND LEARNING

DEZVOLTAREA COGNITIVĂ A STUDENȚILOR ŞI DEMERSUL DIDACTIC DE REALIZARE A SCHEMEI GENERALE DE PREDARE-ÎNVĂȚARE A INFORMATICII

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Articolul conține o schemă generală de predare-învățare a informaticii, atât la facultate (discipline de specialitate), cât şi în şcoală (informatica şcolară). Pentru realizarea acestei scheme generale a fost aleasă strategia învățării prin proiecte. O analiză a aspectelor strategiei menționate şi două experimente pedagogice au permis de a concretiza demersul didactic de realizare a schemei generale de predare-învățare.

Since modern computer studies present nowadays a real science, their teaching is subdued to a natural logic and involves three steps:

1. Perceiving and understanding the phenomena of reality (information objects and processes);
2. Study phenomena modelling tools (information models);
3. Applying the results gained in practice (usually, the result is an information technology).

From those reported above, a computer science general scheme of teaching-learning is deduced, both in college (professional disciplines) and at school (school computer) (fig. 1).

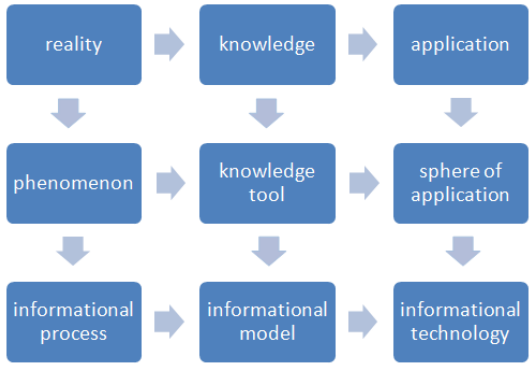

Fig. 1. General scheme of teaching-learning the computer studies.

The general scheme of teaching-learning describes the general organization of the educational process in informatics. Practical realization of this scheme is possible if people know the answer to the question "how?", which is, as mentioned, the basic question of didactics. The exploratory experiment conducted in the 2008-2009 academic year has shown

that such a strategy may be the *strategy of learning through projects*.

We may bring the following arguments in favour of this option:

a) the curricula developed under the Bologna Process requirements for teaching-learning provide a certain number of credit discipline, which measures the workload of student discipline necessary to achieve the aims of the discipline [1]. The hours for one credit (between 25 and 30 hours) are divided into *contact hours,* realized in direct interaction with the teacher, and *hours of independent activity*. One of the important staff training issues (for which no solutions were found still relevant) consists in the existence of a rupture between learning with a teacher and independent learning. Learning through projects allows to "reanimate" the independent work of students: the learning activity carried out in direct interaction with the teacher evolves, naturally, into independent learning activities (during which the student directly interacts with colleagues or virtual group and the teacher). In other words, learning through projects allows assigning a clear sense of self-employment students.
b) In our acceptation, students' skills may be trained and developed only in complex situations. However, learning through projects places the student in many professional situations (quasi): information search situation, a situation to develop collective solutions, situation of public presentation of the results of activities etc.

Since the general computer science teaching and learning scheme, described above, can be used both for teaching computer subjects in college and school, there appear, naturally, the question whether the strategy of learning through projects can be used in teacher and student training.

We bring firstly a few arguments in favour of an affirmative answer to the question above. One can see that in teaching students and pupils have different statuses: the pupil has almost no choice in selecting of their learning contents, while the student has made his/her choice when he/she opts for a speciality while coming at the university.

At the same time, the cognitive development of the person is subjected to the same principles. The author of Genetic epistemology, Piaget J. believes that learning is the result of interaction between subject and his environment. The subject confronted with a series of stimuli in a given situation activates a number of cognitive structures to deal with these stimuli. J. Piaget studied the genesis of these cognitive structures, which he called the *schemes*. A *scheme* is an "invariant organization of behaviour for a class of situations" [2].

For J. Piaget learning, or the development of operational schemes represent a dynamic process of balance searching between the subject and its environment. This process is subjected to two important principles:

a) Assimilation, incorporated into cognitive structure corresponding to the subject of an object or of a situation without changing the structure, but turning progressively, its object or situation. The subject transforms the elements that come from its environment in order to incorporate them into existing cognitive structures;

b) Accommodating: if the object or situation lasts (are not subjected to changes), then there comes an adaptation mechanism that changes the existing structures of the subject in such a way as to make possible the incorporation of elements that represent the learning objects. In this case, the subject is transformed by its environment.

According to J. Piaget the cognitive development is governed / determined by the structural balance and functional interaction between assimilation and accommodation. Interactive activities involving the cooperation of the subjects (pupils, students) can contribute to cognitive development of participants. Through group activities, new knowledge, skills can be acquired, the learning techniques can be refined and cognitive skills developed (thinking, creativity, memory, language, etc.).

W. Dois and G. Mugny [3] have shown experimentally that cognitive development can be fostered by organizing group activities in which the socio-cognitive conflict and the social marking are used. We can talk about a socio-cognitive conflict when, in the same situation, different cognitive approaches of the same problems are produced. In appropriate circumstances the presence of these different points of view can ease their coordination in a new and more appropriate solution for more complex situation than either of the previous methods taken in isolation.

The two authors mentioned above have studied the relationship between cognitive processes performed by subjects and the cognitive level of the group members reported to the task difficulty and described in the following circumstances, to be taken into consideration when creating groups learning strategy through projects:

a) Partners have approximately the same cognitive level, relatively low compared with the difficulty of the task. In this case the probability of a conflict between the strategies for partners solving is small and therefore the cognitive progress is rather nonexistent. In our opinion, the lack of conflict is rather conditioned by the lack of strategies to solve at those two partners. Because their cognitive level is low compared to the difficulty of the task, this means that the proposed task is not in the proximal zone of subjects' development. The proximal development zone represents the difference between the current level of subjects' development (what subject can realize by him/her self) and the development potential (what subject can do with someone's help);
b) If the group members have an average cognitive level related to task difficulty, they use different strategies, swing, and have hesitations, doubts. In this case, the probability of socio-cognitive conflict appearance is greater and therefore in group situations there are better results than when working individually. Both partners benefit from interaction;
c) If a subject has a low level of cognitive development and the partner has a high level of cognitive development, the result of joint activity will be good, but the subject with the low level of development will not progress. The reason lies in the great cognitive distance between the two judgments. The subject with

the dominant level of cognitive development dominates the interaction, requires his/her own strategy to solve / achieve the task, makes decisions, but can not explain the criteria used to solve the problem to the partner;

d) If a subject has a low level of cognitive development and the partner has a medium level of development then both have progress from their collaboration. The subject with low level of cognitive development progresses, because his/her partner has more hesitations, doubts, and talks over concerns, giving to the low level development student possibilities to express his/herself and take some decisions. Socio-cognitive conflicts occur between partners that determine at the student with the low level cognitive development a dual awareness. He realizes the inadequacy of its system of responses for that very task, but also of the alternatives' existence, which may cause descentration and the search for new solutions.

An essential quality of any project is the presence of a personal motive (internal). The situation when the pupils at school or college students are forced to make "projects" that are not interesting has nothing in common with the strategy of learning through projects. In addition to intrinsic motivation in the project realization there should be an extrinsic motivation, linked to the subjects studied.

The motivation should now appear in the first stage of the project: the formulation of the problem, the situation that will be resolved / made by / while the project. The experience shows that the problem formulation is a difficult stage in realizing a project. Two processes can be proposed for the formulation of issues / topics for projects. A process may be conventionally called "from specific situations to applications of a discipline" and the second process – "from applications of a discipline to specific situations".

In the case of the first method application, the teacher formulates a concrete situation. For school, the situation selection will take into account the age, interests of students in the concrete class. From the formulated situation, the teacher (independently or together with the students) draws more problems. Then they determine which of these problems can be solved by the proposed methods and tools of the studied discipline.

When using the second process it starts from the problematic field that exists in the content of any subjects. From the raised issues there are chosen those that present interest for the students (usually the solutions of such problems solve the day-by-day situations).

The problem appears as a *cognitive obstacle*, and the assumption of the task for -overcoming obstacles and steps taken by students outline the problem solutions.

Overcoming obstacles requires access to certain resources (personal, collective, documentation, etc.). In other words, teaching approach in achieving the overall scheme of computer science teaching and learning can be translated as follows (fig. 2):

We emphasize that the approach from the Fig. 2 was proposed as a unique approach to teaching computer science topics at school and disciplinary training of future teachers of informatics.

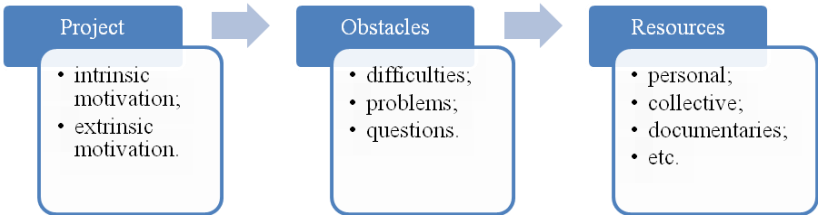

Fig. 2. Teaching approach to achieve the overall scheme of computer science teaching and learning

To demonstrate the possibility to apply this approach and evaluate its efficiency there were made two pedagogical experiments:

1. An experiment at the High School "Dmitrie Cantemir" from Edinet by informatics teacher Irina Zagorcea. The experiment conducted the following objectives:
   - the cultural-historical premises for updating the contemporary education projects method have been elucidated;
   - specific method has been studied as a technology training projects;
   - the impact of projects method on students' cognitive development was studied;
   - conditions of projects method application in teaching informatics were determined.

   The experiment results were generalized in the graduation paper "Using projects method in teaching computer science topics at school " [4].
2. A pedagogical experiment conducted by the author at the Faculty of Technology, Physics, Mathematics and Computer Sciences in the frame of a larger model – the model of initial formation of professionalization of the informatics teachers in the computering environment through inter-actional strategies.

The pedagogic experiment realized in the high school demonstrated that pupils-participants at the experiment obtained a set of specific competences.

The realized experiment at the faculty allowed not only to improve the general level of students training from the experimental sample, but also to develop in themselves a series of cognitive skills of high level (analysis, evaluation, creation).

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