Development of students’ thinking through the school subject “Work and Technics”

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Development of students’ thinking through the school subject “Work and Technics”

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Abstract
The basic goal of the subject “Work and Technics” in the Bulgarian schools is to introduce the students systematically to the world of technology. At the same time this school subject is developing the students’ general cognitive and thinking abilities.

The conditions which secure the development of thinking are determined by two main factors. They are the subject matter and the methods of teaching which are now in the process of evolution:

1) Various methods for students’ problem-solving have been seriously and responsibly shared and adopted. A special attention is given to the application of variants of the morphological methods.

2) The attitude towards the subject matter is changing. The goal is no longer to teach the students how to make a certain object but to obtain an idea from some basic technological principles to improve modern technological artefacts (the principles of integration, of separation, of self-regulation and others).

Technological education in Bulgarian schools of general education is achieved through several compulsory school subjects and areas of the curriculum which have been constantly changing in the last 10 - 15 years. The introduction to technology of the youngest children (4-5 to 6-7 years old) was presented in a subject area called “Technical Education” from 1974 to 1984. Since 1984 it has been called “Work and Constructing and Technical Activity”. In the elementary schools including children aged between 6-7 and 10-11 there is an independent school subject allocated between 32 and 64 hours in a school year. This school subject had been called “Polytechnic Labour Education” until 1981; from 1981 to 1990 its name changed to “Work and Creation” and since 1990 it has been called “Work and Technics”.

At the higher school level (children between 11-12 and 14-15) the subject has been called consecutively “Polytechnic Labour Education”, “Work and Technics” and finally “Technics and Technology”. It is allocated 64 hours every school year.

The changing of the names and subject matter in the Bulgarian national curriculum is a result of the active search for better ways for teachers to work and how to improve students’ performance. Technological education is considered to be the most complex, dynamic and indistinct subject area of the curriculum.

One of the main reasons for keeping the subject “Work and Technics” in the weekly timetable for the pupils is that it is believed that the activities included in it develop students’ thinking.

As a principle, every practically directed course of education in our schools is connected with the form of wisdom and acumen application to aspects of life. The development of the intellect is perceived as one of the main tasks of “Work and Technics”. The authors of the programme accept that an intelligent person is one who has the abilities for making generalisations and choice and who can foresee things. They also think that those abilities are the basis for purposeful and expedient behaviour. It is also accepted that the intellect comprises the cognitive and thinking abilities of the individual. The manner of thinking in a system is characteristic for the modern intellect when solving complicated “open” problems.
The development of students’ thinking in “Work and Technics” is secured by two main factors. One of them covers the subject matter and the teaching content of the school subject. The other is connected with the different procedures, methods and techniques for teaching.

We must say that we encounter many difficulties when we try to make a precise classification of the different procedures, strategies and methods for the development of students' thinking.

Our methodology is based on the understanding that there is construction thinking, technological thinking and organisational thinking. These three types of thinking are developed through specific activities performed by the students and are described as three different types of tasks to be solved by them:

1) features of construction tasks include:
   - determining the purpose of a product and its requirements;
   - explaining the principles of how it works;
   - determining the form and size of the separate parts;
   - analysis of the different ways of joining the parts and choosing a variant;
   - finishing the construction of an unfinished object;
   - construction using drawing;
   - free construction based on the principle of interaction between the mind and the hands, etc.

2) features of technological tasks include:
   - explaining the technological process by using a modelling technological system;
   - determining of the consequence of the carrying out of the technological operations;
   - analysis and the determination of the techniques for carrying out the different operations;
   - completion of a technological map, etc.

3) features of organisational tasks include:
   - securing and arranging the necessary materials, instruments and appliances;
   - keeping an harmonious and logical order in the workplace;
   - sharing of work with fellow students;
   - organisation of one's own time for the realisation of the different stages of the work;
   - producing a plan for the work of the whole team, etc.

Another way of grouping the procedures corresponds to the six levels of the well-known taxonomy of Bloom(56).

It is accepted that the strategies connected with the level called “knowledge” supply the thinking activity with facts, concrete images and standardised rational approaches for carrying out certain actions. At this level the following activities should take place:
   - the student should trace the changes in the constructional features of a given technical system or object for a certain period of time;
   - the student should repeat the stages of the technological procedure in the necessary rationally grounded pattern;
   - they should state or point to examples of high results that different firms and enterprises from their region take pride in.

At the level called “understanding” we include activities of the type
   - write and instructions;
   - give a definition of the concept of “machine”;
   - decide if the computer is a machine;
   - explain the working of certain technical functions;
   - calculate the cost of the product they make;
   - determine the similarities and the differences between two objects or processes;
   - choose suitable electrical systems that match a certain model, etc.

The level called “application” is achieved through:
   - preparation of a discussion by the students on a topic given by the teacher;
   - independently carrying out of an experiment similar to another;
   - using rules that have been formulated on another occasion;
   - acting on the basis of preliminary prepared models of behaviour, etc.
The strategies included at the level known as “analysis” comprise of:
- an analysis of the construction of a certain object;
- evaluation of the quality of a product;
- a study of the stages of action in certain activities;
- differentiation between the phases and stages of a complex process or procedure;
- research into a certain object following a teacher’s brief directions, etc.

The level called “synthesis” includes a series of complicated combinatory activities among which are:
- free construction on the principle of interaction between the mind and the hands;
- thinking out an advertising campaign for the product they make;
- the production process itself;
- the building of the whole concept under teamwork conditions, etc.

Through the activities engaged at the level called “evaluation” the students learn how to make high quality evaluations on the basis of “internal standards” (criteria of the students) and “external standards” (criteria given by the teacher). An example of a strategy at this level is:
- students have to state several activities performed at school which have contributed to the development of their thinking and to explain the criteria they used for their selection.

The grouping of activities forces the teacher to search for strategies to draw out students’ thinking in the fields of “knowing” and “realising”. Such a description and differentiation of the strategies and procedures to follow provides the teacher mainly with “what” has to be done with the students but does little to information about “how” to do it. This is why we need a new analysis of the methods for organising the teaching and the working process and particularly the methods for teaching the students how to solve different problems.

We can divide the methods of working by the teachers in to two main groups. The methods of the first group produce working conditions based mainly on guesswork and conjecture. The second group put their stress on the purposefully realised systematised searching for an answer by using standard approaches.

In the first case the emphasis is given to the technique of “emotional infliction” written group competition. Spontaneous reactions and all kinds of ideas are encouraged. The students are also taught to rely on their own acumen to do things. In the second case the emphasis is given to the techniques for systematised searching and for comparing and contrasting different variants. The students are taught to observe and understand themselves as a complex system. We call the first group of methods “intuitive methods”, and the second “morphological methods”. The different variants of the morphological methods in fact are different routes for solving problems in certain situations. They introduce “order and discipline” in the students’ thinking and teacher’s work although in their frames there is enough room for a variety of “emotional” and “intuitive” methods for generating ideas. The goal is to build a specific “morphologically-logical” way of thinking. Through this concept is achieved a systematised studying of the whole spectrum of similar and related questions, phenomena and processes participating in the building of a single complex artefact.

An example for such work can be given using an extract of a lesson with 10 year old students, where the teacher states the following:
- Make free movements with your hand using the shoulder, the elbow, the wrist and the fingers. Have you noticed how many possibilities for movement your hand offers? Try to describe them!
- With your shoulder fixed try to imitate common activities such as eating, dressing, writing, and the cleaning of the blackboard. How are you doing?
- What if the elbow and the wrist are fixed too? Do you need any help?
- The only part of your hand that is free now are your fingers. The only thing that you can do with them is to take your pen. But if you want to move it you have to free your wrist, elbow and even your shoulder.
• Problems of this kind are solved also by the designers of robots. Today we will see how difficult and how interesting their work is. We will construct robots in a similar way to the way they do.
• We will divide the class into three groups. The students who want to work with mechanical construction kit go into group A. Those who would prefer cardboard boxes, paper and textiles go into group B. And the ones who would like to build the model shown on page 21 of your textbook go into group C.
• Let us think what the main problem is that students from groups A and B have to solve.

In the morphological variants the problems are solved mainly by the method of the preliminary listed actions and the method of the preliminary listed questions. In the case of the listed actions students choose between the following directions:
• add something;
• take something out;
• change the materials;
• arrange the separate parts in a different way;
• change the form;
• change the composition, etc.

The method of the preliminary listed questions includes mainly the questions: who, what, where, by what means, for how long, why, in what way, when. These questions determine to a great extent the work of the teacher in some of the lessons. An example for that is the scheme of work shown in table 1.

The questions may be elementary, but also complicated. This can be demonstrated through basic questions on one and the same topic:
1) What do bakers do? (they bake bread)
2) When? (in the morning and at night)
3) Why do they bake different types of bread?
4) Why do they do it in the mornings and during the night?
5) How do bakers bake bread?
6) What do you like about their job and what do you dislike?
7) When do we forget or when may we forget the thing we dislike about their work?
8) Why would we want to become bakers?
9) How can we become bakers?

Questions 1 - 5 are elementary although they require an ability to observe and a flexibility of mind. Questions 6 - 9 are beyond the abilities of the students from the elementary school.

The algorithm mentioned above has the purpose of creating the feeling that we must look for the problem, the results, the reasons, the reasons for the reasons, etc. It is important that students gradually get used to the thought that it is not important just to know the facts and data for an object, process or problem. It is also important to have the abilities for collecting information, summarising this information and drawing conclusions from it.

We have to point out also that in the process of studying we are not only the methods of education but also the content of this education. About ten years ago it was important that students were taught how to carry out different hand operations. They had to master some information about certain instruments, techniques of working and technical objects. Nowadays this is not enough. We consider that it is more important that students gain an idea of some of the major principles that lay the foundations of the development of a modern technological society than it is to know the composition of the different artefacts of today.

<table>
<thead>
<tr>
<th>Taking care of the flowers includes:</th>
<th>When is it needed?</th>
<th>What do we need?</th>
<th>How do we do it?</th>
<th>What money do we need?</th>
<th>What questions can we ask here?</th>
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<tr>
<td>watering</td>
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<td>fertilising</td>
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<td>transferring</td>
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<td>engrafting</td>
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<td>cleaning from pests</td>
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Among the most important principles that can be substantiated at the level of a school subject content that can be shown are the principles of integration, of separation and of self-regulation. At the elementary school level these principles are mastered in the form of different rules. For example:

- people must act in a way that saves time, effort, materials and finance;
- when something is made it must be made strong, comfortable for using, look good and multifunctional;
- when something is made we have to think about the environment that surrounds it, etc.

Another aspect that is now in the process of clarification is the determination of the specific characteristics of the information in the world of technology that fills children’s lives. To describe and master the models of modern human behaviour and work at an adequately entertaining and in the same time in an adequately thorough manner is a real challenge to educators.

References

- Bloom B.S. *Taxonomy of Educational Objectives/ Handbook 1* 1956 Longmans