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IS THERE THE BEST METHOD OF LEARNING PHYSICS?

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Abstract

The question about the method of teaching and learning physics is one of the most important questions which should worry each teacher. Nowadays teachers and students are offered a great variety of methods. Teachers are advised to organize their lessons (and the whole teaching process) in an interactive way and use active (stimulating, motivating) methods of teaching. These methods are supposed to "force" students to become more active leading them to the precisely defined teaching targets (goals). The author of this article holds the opinion that using only one specific method is enough for students to learn physics successfully. It is the method of learning based on the method of scientific physics - the only most effective method of understanding our Nature. The main tasks of any physics teacher are to help students realize the purposes and the essence of this method as well as create favourable conditions so that students can use this method consciously and more and more independently.

The aim of this article is to present the main idea of such an approach. Therefore the characteristics of the method of scientific physics and the characteristics of the learning process included here are only roughly sketched. We hope that is enough to explain the essence of the presented approach.

1 Question about the method

The question about an optimal method of teaching and learning physics is being asked by both experienced and inexperienced teachers as well as by students preparing to be a teacher. It is not easy to give an answer to this question for it is necessary to take into consideration various teaching goals and the conditions of teaching which are changing dynamically. The legitimacy and relevance of this question results from a rich offer of teaching techniques and methods that teachers have at their disposal. These methods, often having attractive names, are being described and advertised in different publications for teachers and presented at teacher training courses. They are being advertised by producers of teaching aids and by publishers of handbooks for teachers and students. A variety of propositions and concepts concerning methods of teaching stems from the development of technology as well as the research of the way human brain functioning. The new methods benefit from the research in the learning process as well as the research in the realization of tasks in contemporary world conditions.

Teachers seem to be confused about the range of methods and techniques they could use in their physics lessons. These doubts are clearly articulated by teachers perfecting their skills at their postgraduate studies. When they are asked about the methods they practice they usually mention a large number of different "methods". These methods seem to be an eclectic blend of various teaching techniques taken from various teaching courses and publications. They are a blend of different concepts and ideas of teaching. Usually they don't create a coherent and rational strategy of how to achieve a set of goals. They are sometimes internally contradictory. For example, students are expected to be active, creative, from the one hand but at the same time they have to work in specific conditions - the conditions of competition, constant control, evaluation and in limited time from the other hand. The method used by a teacher at this stage is the method of presentation which enables students to master certain skills. Teachers make an effort to convince students verbally how important it is to gain knowledge. Nevertheless students are not given a chance to see themselves all the benefits of applying this knowledge in everyday life. They should be able to discover these benefits through individual, reflective practice.

In the reflective practice of teaching in view of the observed low efficiency in reaching the planned complex educational goals, look for methods and techniques which could to raise the efficiency of learning and teaching. Especially in the situation when this efficiency in achieving complex educational goals is very poor. However, the teacher's attempts to transfer the achievements of current research of human activity to the educational practice usually fails if the whole context of this research is not properly taken into account. Most of such attempts and up in teacher's need to invent his/her own methods which enable to realize the requested programme of teaching.

2 Hypothesis about one optimal method of learning physics.

Nowadays, when a great variety of methods is being widely used I think that, in order to learn physics successfully, it is enough to use only one method. Successful learning means realizing "the curriculum of basic (general) education". The comparison of the model of the scientific physics method (rational-empirical science) and the model of different processes of developing and forming of a human being's competence as well as taking into consideration all known features of an effective individual and social activity of a human being allow me to formulate the following hypothesis.

Let's assume that

the aim of teaching physics is to create conditions for a thorough development of learners in accordance with their natural possibilities and predispositions as well as to shape their general and subject competence (necessary for effective learning and realizing private and professional tasks),

then

in the face of characteristic features of a human being's competence and the features of the scientific method (worked out in the process of scientific advancement) as well as the essence and main goals of education, an optimal method of learning physics is the one which is

a direct transposition of the scientific physics method into the area of education.

Therefore, the basic task of a teacher is to make students aware of the goals and essence of the scientific method. Physics teachers should also do their best to create good conditions for their students to use that method consciously and independently. Educational methods which are common in the teaching practice may become good ways of supporting the teaching and learning processes. The hypothesis about the value of a learning method formulated in this way should be considered to be the basic postulate for teachers teaching physics - the postulate to make a teaching process and scientific research similar.

3 The scientific method of physics

Assuming that the main purpose of this article is to present the hypothesis about one optimal method of learning physics and to signal its main premises I will only try to point out those features of the scientific method of physics which enable us to transfer the content of physics and the scientific method of physics into the strictly educational area.

The development of science is a process in which further research is carried out in the situations when, as the current knowledge proves, there is a necessity and possibility of enlarging and modifying that knowledge. There may also exist a possibility of creating and improving methods and scientific tools.

The analysis of the current situation in the aspect of general attempt to create knowledge (being functional both practically and cognitively) is the first and very important feature of science. We are trying to achieve knowledge both very detailed and more general according to the idea of great unification. It results from a conviction based on the current experience in the realization of the process of cognition that a coherent model of physical reality (which allows to deduce about all its specific aspects) is possible. A characteristic feature of physics is also the analyses of the currently recognized models and theories in an attempt to create methods and theoretical systems which make it possible to see a more general and synthetic image of physical reality. In that process models and theories which have already been recognized are becoming special cases or bordering cases

of new models and theories. Another important feature of physics as a science is its rational-empirical character. In the process of the development of physics there exist two, significantly different although linked with each other strategies. These strategies depend on the current level of knowledge and methods connected with certain area of cognitive (scientific) exploration.

The first strategy was worked out at the beginning of the development of science and it was used in the exploration of less known areas with a relatively small empirical base of data built in the current research. It was not good enough to formulate some model or theories, or to explain certain facts observed from the point of view of models and theories which have already been formulated. This strategy uses, at the rational level, a kind of non-deductive thinking. The results of the empirical exploration of any interesting area of our reality (obtained through observation, experiments and measurements) are collected in the form of an empirical base of data concerning certain area. They are being analyzed in order to establish the relation between them and in order to point out some possible regularity. The working hypothesis about these regularities (that is the statements justified in the light of empirical data recognized as the true ones after fulfilling all the criteria applied in empirical research) become the basis of the planning and realization of further research. Generalized hypotheses with a defined range of application, justified in the light of empirical data, become empirical rules. At certain level of exploration and development of science these statements are regarded as true (in the Aristotle sense with the later modifications of the definition of truth) and they are part of scientific achievements. This strategy, because of the qualities described above, is sometimes called a rational-empirical, inductive-generalizing procedure.

The second strategy, which transfers science into another stage of its development, is the strategy which uses deductive thinking . Because of a high level of empirical knowledge and a number of existing notions (concepts) and tools of descriptions it is possible to create such a relational abstract system with an imposed relation of interpretations, which would enable a description of the real system features or it would enable us to predict its behavior in assumed conditions. And the second strategy is realized in such a situation. This strategy in the process of constructing models and theories requires

an empirical verification which involves formulating (through deduction) hypotheses about the features of the modeled system (justified in the light of accepted assumptions) and it also involves doing empirical research which leads to the affirmation of these hypotheses (and as a consequence it leads to the affirmation of the model or theory from which they have been derived) or to their falsification (in the situation when the empirical results contradict the theses of those hypotheses) and to the rejection of the model or theory. Besides the realization of the above presented strategies and methodological rules of building physical knowledge structures in the development of science, the applications of knowledge of reality and methods of studying those applications seem to be essential. The processes of using knowledge and methods of physics in other branches of science, technology and human activities give us data which are included in general physical knowledge and become inspiration or a starting point for further basic research and applications.

4 From the scientific method to the practice of learning physics.

The reason for formulating the hypothesis about one method of learning physics was a conviction based on the analyses of the processes of cognition of a human being as well as the studies of educational (teaching) practice. Only creating conditions for an initiation of natural processes of cognition (learning) and forming these processes according to one perfect model, which is the scientific method of physics, is the only optimal way of learning physics. This method helps students reach a complete development and form their physical and general competence. The model of learning physics similar to the scientific method of physics comprises five stages of procedure ("a 5-stage model of learning physics"). It takes into consideration some stages of research procedures characteristic of physics and it presents situations and actions important for reaching educational goals.

Stage (1) is the stage of observation, feeling and the stage of making attempts to act in the situations in which, in order to satisfy different needs, cognition, creating and transforming a separate area of the natural world or the world made by a human being seem to be necessary.

Stage (2) is the stage of a deepened analysis of the situation from stage 1, a detailed definition of goals and a planned cognitive or application procedure. It is all done after taking into account the procedures or designing in scientific research.

Stage (3) is the stage of the realization of all the planned practical and cognitive tasks along with the defined standards and the rules of the scientific learning physics of method. Depending on the level of students' educational development as well as their abilities to understand physics, there are realized rational-empirical strategies based on non-deductive reasoning or based on deductive reasoning.

Stage (4) is the stage of synthesis and sorting out the effects of cognition (learning). These effects are simply students' ideas and knowledge about a given area of physical reality, methods of its exploration, creating and transforming.

Stage (5) is the stage of using acquired knowledge, using methods in the situations from stage (1) and in new situations. Situations which need using knowledge and methods should convince students of the value of the realized tasks as well as of the value of acquired knowledge and skills. They should also raise the level of their self-assessment. The situations requiring an application of knowledge and methods are the situations in which one has to diagnose, for example, and explain all the observed states, phenomena, processes or features of the chosen areas or elements of reality. They are also situations in which one has to predict changes or to design and apply a new method or solutions. Some situations need the creation of new areas of reality or they need the modification of the areas which already exist.

Each didactic unit has to include a functional structure having all the 5 stages of students' procedures which are realized consciously.

As a result of the consequent and conscious realization of the procedures in accordance with this model learners that in their minds build a coherent system of ideas and knowledge which become tools (models and theories) in their further activity. Creating and sorting out one's own experience gained at each stage of educational and practical activity and analyzing their effects is in accordance with natural and effective learning which is part of a man' s private and professional activity. Therefore it is a good preparation for such an activity. It is a condition of an individual and social development.

The realization of the process of learning is based on the method, which is a direct transposition of the scientific method of physics into the educational area, enables us to create systemic conditions for achieving superior educational goals defined by "The Curriculum of General Education".

5 Conclusions

The formulated hypothesis about the optimal method of learning physics can be justified not only in the light of assumptions and qualitative theoretical analyses but also in the light of the works on dynamic and creative teaching physics as well as in the light of all the attempts made by the teachers perfecting their teaching skills at their post-graduate studies. However, the application of this hypothesis in the educational practice requires a suitable organizational and material base at all the stages of teaching and a suitable teacher training system. In each physics laboratory there should be standard equipment to do experiments. In their physics laboratories students should also be divided into smaller groups during classes and all the future physics teachers should be the necessary methodological knowledge and practical abilities of exemplifying (in school conditions) some basic rules of research procedures in physics.