Reflection the modern ideas about the content of general education in the school physics textbooks

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Abstract. The article considers the evolution of the general education goals in particular physics education, changes through this process the understanding of the subject «Physics» content. Soviet education aimed at preparing a comprehensively harmonically developed personality through the knowledge paradigm and the content of education was fully consistent with this goal. Later it takes place a rethinking approaches of understanding the content of education and the content of a subject. At the present goals of education are represented in the form of educational results: personal, subject and metasubject, which implies a change in the content of the subject «Physics» in the direction of increasing the importance of methodological, interdisciplinary, evaluative knowledge and strengthening the procedural component. This trend reflects in the textbooks: the procedural component is expanded, there are problems and tasks that involve conducting experimental research in the classroom and at home, solving creative tasks, and completing educational projects. The article substantiates the role of the physics textbook in improving educational outcomes, provides examples of the organization of educational content in school textbooks of physics in Russia and Singapore.

1. Introduction

Currently, the educational environment discusses a number of problems that exist in the System of General Education, in particular, the problems of the goals of General Education, the content of School education in General and the content of academic subjects, including physics, and the requirements for the presentation of this content in the educational literature. The understandable influence of educational goals on the content of the subject determines the need to find new approaches for presenting of this content in the textbook.

2. The Influence of evolution General education goals on the approaches to determining its content

As it is known, first of all the content of education is set by its goals, which are a system-forming component of an integrated methodological system of education, including teaching physics. The main goal of Soviet school education was to prepare a comprehensively harmonically developed personality. And the knowledge paradigm of the content of education was fully consistent with this goal. In this paradigm all students should have the same set of knowledge and skills to apply them to solving
problems. In the post-Soviet period, due to the start of specialized training, the goals of teaching physics are differentiated, although they remain generally within the established paradigm. At the same time, different textbooks are published for classes of different training profiles, taking into account the specifics of the profile. In addition, the methodology of teaching physics is rethinking approaches of understanding the content of education and the content of a subject. Thus, according to I. Zhuravlev and L. Zorina, the didactic model of an academic subject includes two blocks: the main one, which includes the subject content for which the subject is included in the curriculum, i.e.e. subject knowledge, and a block of tools or a procedural block that ensures the assimilation of knowledge, the formation of various skills [1]. Procedural block includes auxiliary knowledge (for physics - logical, methodological, history of science and interdisciplinary knowledge and others), ways of working and forms of organization of the process. N. Purysheva argues that because of auxiliary knowledge becomes tools of assimilation of knowledge only being introduced in the context of learning, they should be included in the main block. In this case a model of the subject content is as it is given in figure 1 [2].

**Figure 1.** Model of the subject «Physics».

Subsequently, N. Kochergina proposed to call auxiliary knowledge extra-subject [3]. We can agree with this conditionally, since, on the one hand, methodological knowledge is included in the group of subject knowledge as a reflection of the methodology of physics and knowledge history of science - as a reflection of the history of physics, and, on the other hand, they perform to a certain extent a service role, contributing to the understanding of the main subject knowledge. Later the types of activities were included in the content of education (among the didactic units) in the main educational program, corresponding to the Federal component of the State Standard of General education in 2004. Accordingly, educational and methodological complexes, including not only a textbook, but also a workbook, a manual for laboratory work, and so on, are widely used in the practice of school education. The textbooks expand the procedural component, there are problems and tasks that involve conducting experimental research in the classroom and at home, solving creative tasks, and completing educational projects. Federal State Standards of Basic and High School General education in 2010 and 2012 [4, 5] represent the goals of education in the form of educational results: personal, subject and metasubject, which implies a change in the content of the subject "Physics" in the direction of increasing the importance of methodological, interdisciplinary, evaluative knowledge and strengthening the procedural component. This change in the goals of physics education is typical not only for Russian national education system, but also reflects global trends in the field of school education. The extent to which the content of education, in particular - in physics, reacts to changes in education goals can be judged by the results of domestic and international studies of the quality of school education.
3. Educational results of Russian students
Let’s focus on study the results of PISA (Program for International Student Assessment), which involves fifteen-year-old students and assesses their level of functional literacy. Functional literacy includes mathematical, reading, and natural science literacy.

A person with natural science literacy "seeks to participate in a reasoned discussion of problems related to natural Sciences and technologies, to take an active civil position on socially significant issues related to natural Sciences, which requires the following competencies: to explain phenomena scientifically; to understand the main features of natural science research; to interpret data and use scientific evidence to draw conclusions" [6].

Table 1 displays the Russian students’ results in the international PISA study.

| Year | Points, Place | Functional Literacy |   |
|------|--------------|---------------------|---|
|      |              | Reading             | Mathematical | Science |
| 2015 | Points       | 495                 | 494          | 487     |
|      | Place        | 26                  | 23           | 32      |
| 2018 | Points       | 479                 | 488          | 478     |
|      | Place        | 31                  | 30           | 33      |

The analysis of the table allows us to conclude that the majority of Russian students do not possess the "key skills of a modern person", and their results is in the middle of the results table. They show especially low results solving metasubject, practical and research tasks using computer simulations and digital sensors. The highest results are shown by students from Asian countries: China, Taiwan, Singapore, South Korea, Japan, and also some European countries as Finland, Liechtenstein, and Switzerland.

It should be noted that the tasks of natural science education, including physics education, which formulated in The Federal State Standards of Basic and Secondary General education in 2010 and 2012 fully meet international requirements and require students to master a scientific approach of solving various problems; the ability to formulate hypotheses, design and conduct experiments, evaluate the results; the ability to compare experimental and theoretical knowledge with the objective realities of life; to master the ecosystem cognitive model and to apply in order to predict environmental risks for human health, life safety, and environmental quality [4, 5].

It is important that significant changes in the content of control and measurement materials of the Unified State Exam have been in recent years. They include tasks that test students' ability to give examples of practical application of physical knowledge and physics laws, the ability to distinguish hypotheses from scientific theories, and draw conclusions based on experimental data; to give examples showing that: observations and experiments are the basis for hypotheses and theories which allows to verify the truth of theoretical conclusions and physical theory makes it possible to explain known natural phenomena and scientific facts, predict still unknown phenomena; to use the acquired knowledge and skills in practice and everyday life [7]. However, as follows from table 2, the average Exam mark in physics does not change over time, i.e. the academic results of students in physics do not change much.

| Year | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|------|------|------|------|------|------|------|------|------|------|------|
| Mark | 51.5 | 47.3 | 53.5 | 45.4 | 51.2 | 52.9 | 53.2 | 53.2 | 54.4 | 54.5 |

It is quite natural to assume that the existing methods of teaching physics and traditional educational literature do not fully meet the new goals of education and do not allow us to solve the tasks set.
4. Goals of General education and content of physics textbooks

Currently, pedagogics defines didactic requirements for modern educational and methodical literature for students. These include the following requirements:

- strengthening the interactive character of design educational content;
- changing the orientation apparatus, which should include questions and tasks aimed at forming students’ procedural and evaluative knowledge; worldview and value orientations, which implies strengthening the intersubject and suprasubject contexts of knowledge and the formation of reflexive knowledge;
- creating opportunities for the conscious design of an individual way of mastering the content of education, which involves the choice of various tasks by students [8].

High education achievements of Singaporean students make the need to analyze Singapore physics textbooks as [9]. It is essential that the textbook is not a reading book, but a guide for studying the subject content, which is used to organize the work of students both at home and to a greater extent in the classroom. This is facilitated by a clear allocation of didactic blocks: motivation-target, content, procedural and control-diagnostic. So, the study of each Chapter is preceded by a consideration of a specific real life situation and the formulation of a cognitive task based on it, the solution of which will be obtained in the process of studying the educational material (Chapter Opener). Each paragraph begins with a presentation of the education results that should be obtained as a result of studying the material presented in it (Learning Outcomes). These results serve as learning goals, and they are formulated in relation to the student (for example: "You will have to learn to distinguish between scalar and vector quantities"). Questions that make students understand important concepts and ideas (Let's Explore) are given.

The content block includes, in addition to a brief summary of theoretical material, the links which indicate relationships to previously studied material. It helps students to understand intra-subject connections (Link), a brief record of typical errors, important information that will help students avoid problems (Take Note), and short-answer questions that allow students to immediately eliminate gaps (Quick Check).

The procedural block of the textbook is of great interest. It includes simple experiments and demonstrations that help introduce students to the research process and consolidate what they have learned (Investigation), generalization of the main ideas and concepts at the end of each Chapter, which allows students to compress information (Key Ideas), links to Internet resources such as simulation and videos that help students understand the material (ICT Link), tasks on working on the Internet (IT Learning Room), exercises that form the ability to answer questions (Let's Review).

A large number of experimental tasks for measuring quantities, performing observations and research, for example, observing convection in water and air, studying the thermal conductivity of solids and liquids, the process of thermal radiation, and so on are presented directly in the textbook.

The control block contains a large number of different tasks that are performed individually or as a group and support the learning process (Try it Out), allow students to repeat and consolidate the content they have learned (Test Yourself), and perform self-control (Get it Right).

The procedural component in Russian physics textbooks have also strengthened of recent years. So, physics textbooks for the grades 7-9 of by N. Purysheva and N. Vazheyevskaya [10] contain self-test questions after each paragraph and the answers to these questions require in most cases productive activity and are focused on identifying the meaning of physics concepts and explaining phenomena; special tasks aimed at generalizing and systematizing knowledge; and a system of tasks, about half of which are related to performing experiments and research. In addition, the textbook includes tasks that involve working with digital applications and using information from Internet. Along with traditional tasks, students are offered tasks which stories are based on the phenomena and technical devices that students encounter in their life.
These trends are also typical for high school physics textbooks by N. Purysheva, N. Vazheevskaya and D. Isaev [11]. It is significant that the textbooks focus on the formation of methodological knowledge and skills of students. This process begins with the first lessons in grade 7 and continues throughout the years of studying physics. This methodological idea is implemented primarily in structuring the content of the physics course: in basic school, the material is grouped around physical phenomena and the main method of study is a physical experiment, but in high school the material is grouped around physics theories and the physical picture of the world and the simulation method is added to the experiment. Also, the level of experimental, graphic, and other skills of students is constantly increasing. All this allows you to get the education results, including metasubject results, set by the Federal State Education Standards.

5. Conclusions
Thus, the article shows that one of the factors influencing the achievement of education results by students is the quality of textbooks. Of course, the textbooks presented above reflect the initial stage of improving physics textbooks and bringing them into line with modern requirements for education literature. There is a lot of work to be done in this direction.

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