

THE PRECONDITIONS OF ECOLOGICAL EDUCATION OF SCHOOL TASKS ON PHYSICS

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Abstract. The article submits the results of research that pursued to establish a number of ecological tasks on physics in natural science education textbooks and to collate the preconditions of ecological education of school tasks on physics in the integrated natural science textbooks and non-integrated physics textbooks of different countries. To fulfil the research, the following methods such as the analysis of literature, the quantitative analysis of the textbooks content, the statistical analysis of empirical data have been applied.

When examining integrated and non-integrated textbooks of different countries, it has been established that the average of ecological tasks varies from 7% in the non-integrated textbooks and up to 12% in the integrated ones. Comparing integrated and non-integrated textbooks of the same form the deviation of comparative rates of ecological tasks varies from statistically irrelevant to statistically absolute. The cases of statistically relevant deviation are fractionally prevailing. The examined non-integrated physics textbooks and integrated natural science textbooks, including the Lithuanian ones, do not basically differentiate evaluating the element of ecological tasks that comprise students' preconditions of ecological education.

Key words: abstract tasks, specific tasks, technical tasks, sociocultural tasks, ecological tasks.

Introduction

Natural science education is an important field of general education in *Lithuanian* comprehensive school being reformed. Under the circumstances of school reorganization natural science education radically changes. This involves teaching content, instructional aids and methods. The content of natural science subjects includes a number of fields of life such as nature, human, economics and culture. Currently, educology and educational practice are intensely searching for new methods of teaching. However, equally important component of each educational situation is "curriculum". "Teaching content is an expressly appointed and the most significant part of humankind culture which is acceptable and integral for pupil's preparation to live and work." (Rajeckas, 1999, p.16). Teaching content is introduced in textbooks and other printed didactical means. Within the reformation period in Lithuanian comprehensive school, new textbooks of all subjects, including those of natural science, have been published.

The preparation process of textbooks is a complex one, and includes representatives of many fields such as the concept authors, editors, make-up editors, analysts, consumers, etc. Therefore, it is being tendered to mark the following preparation stages of textbooks: concept creation, publishing, analysis and evaluation, use (Heyneman, 1990; Johnsen, 1998; Radkau, 2000). Textbooks' analysis can be fulfilled within different stages but most frequently it appears preparing or using a concept (Ketele, Roegiers, 1991). It is being noticed that from the point of view of analyzed textbooks, the stage of usage is more important, though it lacks empirical research about practical usage of textbooks in teaching practise (Rusen, 1998).

Literature review certifies that the analysis of teaching content presented in textbooks is urgent for the educologists from different countries and epochs. The practise analyzing the textbook content indicates two preferential methods of research – quantitative and qualitative (Hrebicek, Altman, 1993; Hubman, Milesa, 1994). A quantitative research method of textbooks

is most frequently based on the analysis of rates and comprehension and sets up preconditions to establish what kind of content prevails in the textbook, for instance, how often one or another term is used, what topic plays a prevailing role, etc. A qualitative research method of textbooks is based on the hermeneutic analysis and enables to determine context, to impart information, etc. However, very often both methods of analysis act interchangeably and supportively (Ketele, Roegiers, 1991; Pingel, 1999).

Analyzing textbooks content it is possible to determine what main functions textbooks perform. Different authors vary in pointing the functions of textbooks, but some of those, such as conveying, solidifying, integrating, evaluation of knowledge, forming competence and promoting sociocultural education could be singled out as the underlying ones (Milesa, 1994; Rusen, 1998; Pingel, 1999). The cases, when a textbook is intended for the implementation of the only function, are very rare. Most often a textbook is intended for the implementation of several functions, emphasizing fundamental and auxiliary ones. Literature review points out remaining different types of textbooks (Heyneman, 1990; Milesa, 1994; Rusen, 1998; Pingel, 1999) and regulates what main auxiliary functions should perform the textbooks of different types. It is being directed that a key function of a traditional natural science textbook is conveying of knowledge, and the main auxiliary functions are such as improving of abilities and competencies, solidifying of knowledge, sociocultural education. Thus, it is relevant to identify if similar conditions are established in Lithuania as well as in other countries under which these functions could be implemented producing textbooks of natural science education.

A separate component of sociocultural education is ecological education. According to the foreign educologists (Tarasov, 1988; Traitak, 1988; Huot, 1989; Jadoule, 1991), who analyze the functions of textbooks, it is important to plan textbooks content in a way to establish conditions for pupils' ecological education. Following their suggestions a textbook has to reflect both a sufficiently detailed and systematic conception of nature not contravening "animate natural resources".

In *Lithuania*, a problem of ecological education is being tackled on two levels: educational and educological. Currently, relevant sociocultural education involving the development of pupils' ecological and ethical culture takes place in Lithuanian comprehensive school and educational practise of natural sciences. The importance is approved by earlier as well as by modern general programmes of Lithuanian comprehensive school that indicate underlying functions of teaching content.

Defining the projection priorities of teaching content Lithuanian educologists particularly emphasize interaction between human and nature in the educational process. They also indicate that a crucial point is unity between human and nature that is only reached by having knowledge of nature. Therefore, ecological education covers not only ecology but also, mainly, the questions about human protection and his/her abilities to survive in the cultural media (Vaitkevičius, 1997; Rajeckas, 1999). The organized content of teaching used according to the following requirements creates opportunity for ecological education in educational practise.

Teaching content, that is presented in Lithuanian textbooks and used in comprehensive schools, has been recently started to study. Textbooks content in Lithuania was researched by such educologists as Rajeckas, 1999; Laužackas, 2000; Lamanauskas, Ragauskiene, 2001, etc. Moreover, textbooks content was researched on the institutional level – in 1998 a centre for studying textbooks content was established in the pedagogical institute. The centre was created considering the practical experience of Georg Eckert institute in Braunschweig (Germany), which has been researching textbooks content on the international level. A Lithuanian study centre that researches textbooks content helps authors, researchers, teachers and other willing in writing and promoting textbooks people. Though, the educologists of the centre most frequently are involved in studying social sciences textbooks. Therefore, natural science textbooks content practically remains untouched.

Natural science content as well as that of other subjects is collocated in textbooks and other printed instructional aids. The structure of natural science textbooks in different countries is

mainly the same and consists of a theoretical part and practise. It is possible to pursue sociocultural integration in both either a theoretical content part of natural science textbooks or a practical part. Suchlike structure of the educational material presentation is typical for both Lithuanian and foreign countries' integrated natural science textbooks and non-integrated physics textbooks. Each problem on physics deals with a particular phenomenon or object. In the process of planning teaching content it is not complicated to create a technical or sociocultural context for most of the tasks on physics. In turn, sociocultural content tasks may carry ethical, historical, ecological contents. Considering the crucial priority of contemporary planning of natural science that is interaction between human and nature in the educational process the issue of evaluation if the content of tasks on physics creates sufficient premises for ecological education in physics textbooks used in Lithuania comes to the fore. It is important to ascertain how physics textbooks used in Lithuania are different from or similar to those of natural science used in other countries if comparing the premises of ecological education. The object of the research is ecological content of tasks on physics of non-integrated physics textbooks and integrated natural science textbooks in different countries. *The goal of the research is to establish* the amount of tasks on physics of ecological aspect in natural science textbooks and simultaneously compare the premises of ecological education in the school tasks on physics used in different countries in the integrated natural science textbooks and non-integrated physics textbooks. To reach the goal the following methods of the research such as the analysis of literature, the quantitative content analysis of textbooks, the statistical analysis of empirical data have been applied. The named types of analysis were carried out applying the SSPS 8.0 data processing software.

The methods of research

To carry out the research the following chosen physics textbooks (forms 7 to 10) are being used in Lithuania (Valentinavičius, 1996, Valentinavičius, 1997; Valentinavičius, 2001), Belgium (Clippelier, Frans, Hofkens, 1991), Great Britain (Lale, Daniel, Duke, 1997), Spain (Baeza, Delgado, Galindo, 1995; Garsia, Ebede, 1998), France (Hebert, 1989; Bouland, Caurvet, 1997), Russia (Pinski, Razumovski, Dik, et all, 1998; Gurevič, 1999), Germany (Heepmann, Klopert, Kunze u.a., 1990; Hampel, Haupt, Heepmann, 1984; Geiger, Hampel, Haupt u.a, 1984; Heepmann, Kunze, Mckenfuss u.a., 1992). The mentioned natural science textbooks are being applied to schoolchildren aged from 10 to 15. The teaching content of natural science textbooks dedicated to pupils of this age is the least differentiating.

The research indicates that integrated teaching is very important seeking to set teaching content to the particular surroundings (Motiejūniene, Vildžiūniene, Lekevičius, 1996). It is supposed that preconditions for ecological education in the integrated textbooks should be more beneficial than in the non-integrated ones. Therefore, research involves the tasks from the chapters on physics included into the integrated natural science textbooks and those into the non-integrated physics textbooks. When choosing textbooks the latter criteria of the sample were applied: a) to accept the textbooks of the countries having continued experience of integration; b) to include the textbooks of the countries having no experience; c) to choose textbooks published in different time (from 1984 to 2001). Moreover, along the choice of textbooks the criterion of random sample has been applied. 5634 tasks on physics taken from the researched natural science textbooks compiled a database of research. The examined tasks on physics have been divided into three categories: abstract, specific technical, specific sociocultural tasks (table 1). Each of the tasks in a physics textbook has only abstract model mentioned with no specific true-life content and belongs to one or another school or country, (a block, a globule, a solid, etc.) has been acknowledged as an abstract one and subsumed within a group of abstract tasks. One of them is being applied in physics textbooks in Great Britain schools and formulated as: "A solid can be either resilient or ductile and measured in stretching it? What does it mean to be resilient? What does it mean to be ductile?" (Lale et al. 1997, p.5)

Content of teaching physics provides the basics of technical knowledge. According to the programme requirements, operation of some devices or mechanisms is being explained in the theoretical part of physics course. However, to increase schoolchildren' knowledge about technique is also possible with the presentation of tasks on physics of technical character. Each of the tasks, that explains the technological true-life process taking place in the proximate ambient pupil's environment or describes the functioning of a device or a mechanism has been attributed to the group of technical tasks.

Sociocultural tasks have been subdivided into two groups: a) tasks studying ecological problems, b) historical-technical tasks. Some sociocultural tasks reflect the heritage of ethical culture. Physics, as an educational subject, lays definite premises for the acquisition of such indicated regions as peoples' trade, business or technologies on the countryside and industrial estates of the country. Tasks on physics describe earlier used country's technique (windmills, watermills, weirs) and traditional means of communication (carriages, sledge, wherries, etc.).

The ecological tasks on physics form pupils' ecological culture and help to enhance natural interaction of nature, fauna, technique and human with immediate habitable environment.

The results of research

The research of the tasks in the textbooks indicates that the integrated textbooks compile less abstract tasks than the specific ones (table 1). It has been established that the abstract tasks in the integrated textbooks make an average of 38%, and specific tasks – 62%. The situation in the non-integrated textbooks is respectively 56% and 44%. Having checked a hypothesis about the deviation of comparative rates of the specific tasks of the integrated and non-integrated textbooks, it has been determined that deviation is statistically not relevant.

Table 1. The percentage rates of the abstract technical and sociocultural tasks in the integrated and non-integrated physics textbooks of different countries

Country of a textbook, year of publication	Abstract tasks	Specific tasks	Specific sociocultural tasks		
			Ethnic – historical	Ecological	In total
<i>Integrated textbooks</i>					
Russia, 1998	52	30	11	7	18
Germany, 1990	21	49	14	16	30
France, 1989	62	25	4	9	13
Germany(1), 1984	48	30	9	13	22
Germany(2), 1984	20	51	15	14	29
Germany, 1992	32	45	13	10	23
England, 1997	44	37	15	4	19
Spain, 1995	31	41	16	12	28
France, 1997	37	37	8	18	26
<i>Non-integrated textbooks</i>					
Lithuania, 1996	50	28	14	8	22
Lithuania, 1997	50	30	15	5	20
Lithuania, 2001	45	37	11	7	18
Spain, 1998	61	14	11	14	25
Belgium, 1991	71	18	4	7	11
Russia, 1999	54	34	8	4	12

The calculated statistical data is $t = 4.43$. Seeing $t > 3.9$, the reliability level is $p < 0.01$. Thus, we can state that the rates of the specific tasks in the integrated textbooks differ from comparative rates of those in the non-integrated textbooks. Whereas a number of the specific tasks in the non-integrated physics textbooks are lesser than that in the integrated natural science ones, we can assert the specific tasks being more appropriate to the researched integrated textbooks.

The research has ascertained that the technical and sociocultural tasks remain in the integrated textbooks as well as in the non-integrated ones. A part of the sociocultural tasks in the researched textbooks is the least, which is on average – 23% in the integrated and 17% in the non-integrated textbooks. Statistically relevant difference between the tasks of the integrated natural science textbooks and non-integrated physics ones was discovered in the group of technical tasks. The precondition, that the technical tasks prevail in the integrated tasks, has been statistically proved.

A number of ecological tasks in the researched integrated and non-integrated textbooks of different countries are small comparing their amount with a number of tasks on physics in the textbooks (table 1). The average of comparative rates of the ecological tasks in the integrated natural science textbooks is 0.12, and in the non-integrated physics textbooks – 0.075. The average of comparative rates of ecological content in the non-integrated physics textbooks used in Lithuania is 0.067 which doesn't statistically differ from that of the same content in the non-integrated textbooks.

To implement more detailed comparative analysis of ecological tasks of the integrated and non-integrated physics textbooks of different countries, statistical relevance with a help of ecological tasks in the non-integrated and integrated textbooks and the deviation of comparative rates correlating the interacted textbooks from various categories was examined (table 2). It was allowed to perceive some variations of integrity in the following two groups of textbooks.

Table 2. Statistical indexes of the deviation of comparative rates of ecological content in the integrated natural science textbooks and non-integrated physics textbooks

Non-integrated textbooks (country of a text book, year of publication)	Integrated textbooks (country of a textbook, year of publication)								
	Russia, 1998	Germany, 1990	France, 1989	Germany (1), 1984	Germany (2), 1984	Germany, 1992	England, 1997	Spain, 1995	France, 1997
Lithuania, 1996	0.12	2.89**	0.11	3.13**	2.59**	0.12	3.60**	2.03*	2.88**
Lithuania, 1997	0.89	3.13**	2.82**	2.11*	3.55**	3.04**	1.87	3.33**	3.53**
Lithuania, 2001	0.01	3.01**	1.06	1.06	3.10**	0.56	1.90	2.13*	2.77**
Spain, 1998	3.10**	0.11	2.01*	0.12	0.25	2.01*	3.44**	0.21	2.05*
Belgium, 1991	0.01	3.01**	1.63	2.25**	3.10**	1.00	.67	2.13*	2.77**
Russia, 1999	1.63	3.10**	2.11*	3.05**	3.65**	3.14**	0.09	2.46**	2.85**

$p > 0.05$; * $p < 0.05$; ** $p < 0.01$

The deviation of comparative rates of the ecological tasks in the group of the integrated and non-integrated textbooks vary from statistically irrelevant to statistically absolute when

correlating them with one another (table 2). It has been found that from 54 cases of likening statistically irrelevant deviation between the deviation of comparative rates of the ecological tasks in different textbooks' groups is established 20 times.

In four cases (grey marked boxes) the deviation of comparative rates of ecological tasks is relevant when higher rates of ecological tasks remained in the non-integrated physics textbooks. It is obvious, that the cases of statistically relevant deviation marginally are predominating (30 cases).

Conclusions

Abstract and specific tasks prevail in the researched integrated natural science textbooks and non-integrated physics textbooks. However, technical tasks predominate over sociocultural tasks within the group of specific tasks independently from the integrity of a textbook.

Statistically relevant deviation between the integrated natural science textbooks and non-integrated physics textbooks has been found in the group of technical tasks. The premise that technical tasks in the integrated textbooks are more frequent was statistically confirmed ($t = 2.77^{**}$, when $^{**} p < 0.01$).

A number of ecological tasks in the researched integrated and non-integrated textbooks of different countries are small (an average differs from 7% in the non-integrated textbooks and up to 12% in the integrated textbooks) in comparison with the amount of overall tasks on physics in the textbooks.

The deviation of comparative rates of ecological tasks relating them together in a group of the integrated and non-integrated textbooks varies from statistically irrelevant to statistically absolute. The cases of statistically relevant deviation marginally prevail.

Ecological tasks in the researched integrated natural science textbooks make about 50% of sociocultural tasks but in the non-integrated physics textbooks there are less ecological tasks that is about 33% of all sociocultural tasks.

The results of the research indicate ecological tasks and formed pupils' premises of ecological education of different countries (including Lithuania) in the researched non-integrated physics textbooks and integrated natural science textbooks being mainly conventional. Having evaluated the amount of ecological tasks in the researched integrated natural science textbooks and non-integrated physics textbooks of different countries, it becomes obvious, that a number of tasks devoted to ecological education make approximately about 10% of all tasks without reference to integrity of a textbook. Ecological education is a burning though supporting function of natural science textbooks. The results of the research indicate that approximately 10% of tasks are advisable for the implementation of chosen additional function for natural science textbooks content planning. It is supposed that the results of this research should be purposeful for the supporters of physics textbooks and other natural sciences in the process of planning teaching content.

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Резюме

ЭКОЛОГИЧЕСКИЙ АСПЕКТ В СОДЕРЖАНИИ ШКОЛЬНЫХ ЗАДАНИЙ ПО ФИЗИКЕ

Пальмира Печюляускене, Альфонсас Римейка

В статье приводятся результаты исследования по определению количества заданий по физике с экологическим содержанием в школьных естественнонаучных учебниках, а также сравнения экологического учения в содержании заданий по физике в интегрированных с естественнонаучным уклоном и неинтегрированных школьных учебниках физики в различных странах.

В качестве методов исследования применялись: анализ литературы, количественный анализ содержания учебников и статистическая обработка эмпирических данных.

Установлено, что в школьных учебниках различных стран задания экологического содержания составляют в среднем от 7% в неинтегрированных до 12% в интегрированных учебниках. Из сравнения в группах интегрированных с естественнонаучным уклоном и неинтегрированных учебников физики, разница относительных частот заданий экологического содержания варьируют от статистически незначительного до статистически абсолютного значения. Незначительно доминируют случаи с разницей статистически значительного значения.

Исследование интегрированных с естественнонаучным уклоном и неинтегрированных учебников физики в различных странах, в том числе и в Литве, показало, что по количеству заданий экологического содержания и по экологическому учению, между собой мало отличаются.

Ключевые слова: задания абстрактного содержания, задания конкретного содержания, задания технического содержания, задания социокультурного содержания, задания экологического содержания.

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