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# IMPACT OF PHYSICS-ORIENTED TASKS ON UNDERSTANDING THE CONCEPTS OF ELECTRICAL PHENOMENA

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**Abstract.** *Research on framing the schoolchildren's concepts is supposed to be a scientifically and practically important issue of modern educology. In order the learners should conscientiously grasp the scientific concepts; the process of concept development must be properly organized and carefully controlled. To formulate the concepts of physics, the authors of the article followed the oriented tasks embracing definite didactic operation references. Research suggests that the oriented tasks in the educational process are performed as a guide determining the steady movement toward a positive result. A pedagogical experiment monitors the impact of physics-oriented tasks on understanding the concepts of electrical phenomena. A survey involved 230 ninth-formers presenting different schools of Lithuania. The experiment and its statistical assessment indicate that the oriented tasks help with perceiving the scientific concepts, highlight the schoolchildren's typical mistakes and impose requirements for their correction and improvement.*

**Key words:** *teaching physics, electrical phenomena, concept development, oriented tasks, pedagogical experiment.*

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## Introduction

The reconstruction of Lithuanian education system shows that teaching becomes more and more oriented towards a would-be learner of a modern society based on information and productive thinking. The teachers face the children, his/her experience and its importance encouraging them to study everything that creates preconditions for further learning. This context approaches the tasks the scientific basis for making a decision of which is mental activity of the learners and first of all, investigation into their thinking appropriateness. The relevance of research on the schoolchildren's thinking is demonstrated by the practical needs because school is responsible for fostering a personality able to self-sufficiently acquire and apply knowledge in the present altering society. For the reasons that intense thinking activity closely correlates with grasping concepts and that the understood system of the concepts is the body of power to think through the categories (Lankina, 2005), research on developing the learners' scientific concepts plays an important scientific and practical role.

Teaching concepts is a complex and long-termed process. The concepts are mastered dealing with functionally employed and theoretically concluded visual aids. Usova (1986) highlights the following sources of concept formation: 1) learners' life experience and impressions (spontaneous concept formation); 2) purposeful concept formation in the process of teaching different subjects at school; 3) parallel formation covering other subjects and extra-curricular

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activities; 4) spontaneous formation through reading scientific literature and press, watching TV and listening to radio.

To use the available students' knowledge and to prevent them from committing errors, the process of teaching concepts must concentrate on the above mentioned sources. One of the major reasons for making mistakes is insufficient evaluation of the schoolchildren's engagement in cognitive activity in the process of teaching concepts. The teachers claim that sometimes, in order to master a concept, a provided definition or definitions might be helpful and the learners will know the right way of applying it. However, a concept definition is supposed to be only one of the stages of concept formation.

A number of psychologists and pedagogues were engaged in the ontogenesis of the concepts framed by the schoolchildren as well as in the theory of educational development: L.Vygodskij, P.Galperin, N.Talyzina, V.Davydov, J.Bruner, J.Piaget, B.Inelder, V.Rassel, W.Thompson, J.Laužikas, J.Vaitkevičius etc. They revealed the ways of the learners' thinking through the categories and how these processes of learning could be influenced by certain methods of teaching. The method and the sequence of stages formulating concepts depend on the content of a concept, a general level of the learners' progress, experience and knowledge. V.Davydov (1986) and quite a few other psychologists maintain that children gradually possess the subject-matter of a concept. Moreover, every learner possesses a different pace to complete the process. Acknowledgement of the essential and unessential features of a concept is gradual. Defining a concept is also progressive. It has been established that a verbal knowledge about a definition of a concept mainly does not affect the sequence of acquisition and that the concepts can only be developed through purposefully conscious activity of the learners themselves broadening their content and employing them in the new situations.

M.Klarin (1998) who is a researcher of pedagogical innovations worldwide summarized the results of the psychologists-didactics followers and suggested the following main stages of concept development:

1) name of a concept;
2) contrasting examples (positive vs. negative) including acceptance and rejection of the given concept;
3) features of a concept, significance of the features (identification of essential and unessential features);
4) concept definition based on the essential features.

M.Klarin (1998) sees the future of teaching organization as a *patterned practice* enabling *to design orientations*. O.Ušakova (2003) supports and promotes the idea that the orientations applied in schoolchildren's self-sufficient activity can make operate the objects that frequently are paid scant attention but when highlighted become *a new field*. On the other hand, quite often a weak focus is given on stimulating the learners' self-sufficient activity that cannot be efficient in all cases. In order independent work should be completed, a teacher has to help a learner to orient his/her activity i.e. to support with job analysis, outlining, monitoring and evaluation (Brushlinskij, 2001).

On the basis of the introduced propositions, **a presumption** that such schoolchildren's activity should be arranged following a specific task system embracing references and guidelines that reinforce seeking a positive result **can be made**.

**The object of research** is teaching concepts of electrical phenomena applying physics-oriented tasks.

**The goal of research** is to experimentally monitor the impact of physics-oriented tasks on developing the learners' concepts of electrical phenomena.

**Research hypothesis.** An adequate system of tasks used in the educational process as a guided basis including the main didactic operation references should make cognitive activity more intensive at all stages of concept teaching and increase the level of scientific concepts awareness.

**Methodology of Research**

*Theoretical basis*

This survey is based on constructive teaching the propositions and their expression of which have been very popular in recent research on educology. They are supported by humanistic education and full personal development in heightened activity (Brown, Adams, 2001). Constructive teaching emphasizes thinking and underlines that a learner him/herself actively acquires and extends personal knowledge independently from his/her interaction with objects and educators (Wellington 1996, Driver 1989, 1996, Holding et al., 1990, von Glasersfeld, 1991). In terms of constructivism, knowledge is not final, uniform and fails to be conveyed; knowledge is partially personal (subjective) while the meaning is worked out by the learners themselves on the basis of their experience (Arends, 1998). V.Richardson (1997, 2003), a professor of Michigan University, discloses the correlation between constructive pedagogy and the theory of constructive teaching. She explains the employment of constructive pedagogy in scientific research and practice and stresses that a mechanism of the schoolchildren's learning during the classroom activities should be properly examined.

Research involved the oriented tasks (Šlekienė, Jakutis, 2000) devoted to understand the concepts of physics. The tasks were produced on the basis of the propositions made by P.Galperin and his co-authors and expressed an idea that the performed thinking actions arranged in a certain way created an opportunity for efficient control over the teaching process (Gulper, Talyzina, 1979). The tasks were done according to type 2 guided basis containing instructions to deal with new material. Rational coordination of the schoolchildren's reproductive and productive self-sufficient activity shows that any of the tasks is provided with specific guidelines. Depending on the role in the concept formation process, the oriented tasks can be classified in the following way:

- introductory acknowledgement of a concept and the essential features (monitoring, experimentation, assessment of pictures and charts);
- correction of the concept features (conducted experiments, variety of unessential features;
- concept differentiation – comparison of the concept features is drawn and identification with the already known concept is made;
- establishment of the relations between two concepts (experimentation, observation, drawing and assessment of the charts showing the obtained data, formulae analysis);
- concept specificity (assessment of the life experience examples, observation, experimentation );
- concept application dealing with different types of assignments, fulfilling creative tasks.

Depending on the didactic form, the tasks can be exploratory, illustrative and representative (a mixed form of a real and mental experiment), fantalogical (mental experiment) and visual. The tasks apply the orientating methods such as missed and chosen answers, pictures and tables.

Three types of impact on schoolchildren can be distinguished in the structure of the method of oriented tasks: 1) **cognitive** – directed to information processing (the content of tasks) and comprehension; 2) **management** – directed to the procedure of task performance and correction; 3) **motivating** – directed to the learners' active participation, giving meaning to their actions and their cognitive activity.

The tasks are concrete, most of them have been illustrated by drawings or schemes (Appendix). The heading of the task defines the object researched or observed. References are given for the materials or means ("What you will need") or situation description ("What is given"), to the ways the tasks are to be performed, the most rational sequence ("What to do"), how to process and analyse the data of the study. The task is followed by 3 – 6 questions, which activate pupils' mental activity. The questions orientate pupils to focus on the basic features of the researched object, stimulate meaningful actions, generalisation of the results and coming at the conclusions.

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*Methods of Research*

Research involved assessment of scientific literature, pedagogical experiment, surveying, quiz, observation, comparative analysis and statistical examination of data.

*Sample and Respondents of Research*

230 schoolchildren from 5 Lithuanian secondary schools including Kaunas, Šiauliai, Telšiai, Kelmė and Šiauliai regions participated in the pedagogical experiment.

*Design of Research*

In 2004-2005, the learners' ability to understand and use the concept *electric current* when teaching the chapter *Electricity* enclosed in the 9$^{th}$ form physics curriculum was researched. These concepts belong to the most complex notions of the physics course introduced in basic school. Rudimentary knowledge of electric current is gained yet in primary school during the classes on the world study. The conception of electric current is formed during the physics classes in form 7 and proceeded in forms 9 and 12. It is based on such concepts as *electric field*, *resistance*, *voltage*, *work of electric current*, *power*, *current sources*, *electric circuit* etc. Any of these concepts can be introduced when broadening the content of the concept *electric current.*

The experiment embraced 4 stages: stage 1 - preparation, stage 2 - education, stages 3 and 4 - monitoring. Stages 1, 3 and 4 were the same to all participants of the survey.

The purpose of **the preparatory stage** was to find out the acquired schoolchildren's knowledge of mathematics and physics and to distribute the respondents into two equal groups depending on achievements as well as to introduce the teachers the objectives of the pedagogical experiment and the methodological requirements for getting on with the oriented tasks. During the preparatory stage, two groups - experimental [E] and control [C] were formed.

The **educational** stage which is the core of the experiment was differently presented in the experimental and control groups. Following demonstration or experimentation, the teacher of the control group introduced the content of a concept i.e. explained the essential features of the concept and relations with other concepts. When learning electrical phenomena, the experimental group was offered 24 oriented tasks the part of which could be completed outside the classroom.

According to distributed didactic material, the schoolchildren accomplished the task (observation, experimentation or mental experiment) and independently or in groups analyzed the observed phenomena. When answering the questions included in the task, the learners self-sufficiently highlighted the essential features of the concepts. A teacher's support was minimal. Afterwards, the task was discussed. The other part of the lesson was taught in a similar way (the same amount of assignments was completed) in both groups [E] and [C]. In case of a lengthy practical task (over 10 minutes), more theoretical assignments were completed in the control rather than in the experimental group. The educational stage covered the techniques of lesson observation, analysis of task accomplishment and individual speaking. Therefore, conclusions disclosing the quality and employment purposefulness of the tasks presented in didactic material were drawn.

The goal of the **first monitoring** stage was establishing the level of understanding the concepts used in the chapter *Electricity* and verification of practical tasks impact evaluating the deviations of the results of the test on physics between groups [E] and [C]. The content of the test tasks was chosen following the base level requirements set by the General Programmes of Lithuanian Comprehensive School and Educational Standards. The tasks were tentatively divided into two groups. Group 1 included the tasks dealing with declarative information i.e. knowledge about the content and essential features of a concept whereas group 2 introduced the tasks coping with procedures that explain finding, concluding and applying concept links and relations with other concepts (the ability to analyze, summarize and make conclusions) (Arends, 1998). The fulfilment of any of the tasks was dichotomously coded (1 – right, 2 – wrong). The statistical techniques of data research were applied to assessing the test results.

The goal of the **second monitoring** stage was to evaluate the lability of understanding the concepts, indicating the level of forgetfulness in each of the groups. Three months later, the same learners took an analogical test.

**Results of Research**

The assessment of lesson observation, oriented-task fulfilment and individual speaking with learners disclosed that teaching was targeted at producing clear views and concepts as well as at understanding links and relations between them. The findings of the tests reveal that actual material which is the basis of concept forming is not properly accepted. Research demonstrated that the schoolchildren frequently failed to grasp the content of certain concepts, felt confused about the essential and unessential features, found no difference between the concepts, referred to the wrong views while analysing phenomena and making conclusions.

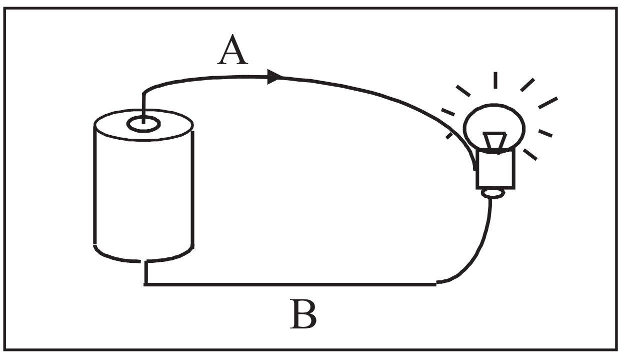


**Figure 1. The task of indicating the electric current in a simple circuit.**

The learners often identify the concept *electric current* as the concept *electric energy*. They claim that electric current turns into light and heat. Though a part of the learners know that the current strength of conductors in a series circuit is constant in every part of the circuit they wrongly state that the current strength in the circuit before the light bulb in line A is stronger than that in line B (Figure 1). They maintain that a part of the current is kept in the light bulb and turns into light and heat, and therefore a weaker electric current passes from the light bulb. Thus, the introduction of the concept *electric current* does not show it being only a directional motion for electric particles to follow. It should be emphasized that the electric particles are in the conductor and to make them follow a directional motion, energy produced by the current sources is necessary.

The majority of the schoolchildren misinterpret the purpose of a current source. They suppose that the current sources directly act as the sources of the electric particles and that a positive terminal of a battery produces positive and negative terminal - negative electric particles. In the 9$^{th}$ form course book on physics, V.Valentinavičius explains the current in the electric circuit and agrees that *'the current in the electric circuit flows from a positive source terminal (through users, adapters) to a negative one (opposite direction of electrons flow)'*. On the basis of the wrong views, the learners accept the text provided in the course book, *'the electric particles leave the current source and speedily follow the wires, reach the users and a part of them come back to the source terminal'*.

The learners encounter difficulties with understanding the core of the concept *electric circuit*. The latter concept most frequently is introduced on the basis of schemes. Thus, it should be stressed that an electric circuit scheme figures a method of combining the elements of the circuit rather than their dimensional position. The schoolchildren found problems with the tasks requiring practical employment of knowledge about the electric circuit. A major part of the students did not

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manage to show a parallel connection between the light bulbs drawn in the picture and a rheostat provided with equipment to measure voltage and current. Another arduous task was drawing up a scheme of such a circuit. A situation when a wire is connected to one plough of source, one plough of light bulb or an adapter were accepted as if they were switched on the circuit.

An interesting point is that the learners better deal with designing the schemes of the electric circuits rather than with drawing the connections of their elements. A large part of the children come up with a scheme before they establish the connections of the electric circuit elements. The interpretation of the introduced situation makes clear that in reality (or in the picture) the elements of the circuit can be placed in such a way so that they cannot be 'integrated' into the adapted visual of the presented electrical circuit.

Quite a few schoolchildren do not grasp the point that if electric circuit is broken, the current is not transmitted in the whole circuit. They maintain that when a light bulb is burnt out, the current flows up to the socket but does not pass through the light bulb.

Not all the learners understand the functions of a rheostat. Having switched on the whole wire of the rheostat, they moved the slide-block and imagined changing resistance; not everyone understood which position indicated the highest and the lowest resistance of the rheostat.

The verification of the interdependence of the current strength, voltage and resistance of conductors shows that the schoolchildren misinterpret the content of the concept *resistance*, feel confused about the functional links and relations between these concepts. They claim that the resistance of a conductor depends on the strength of the flowing current and voltage and that the strongest current passes through the resistor having the lowest resistance although all resistors are in a series circuit. It is supposed to be a mathematical understanding of Ohms Law for a part of a circuit and inapprehension of the causative links.

When mastering the concepts of the electrical phenomena, the impact of the oriented tasks was established evaluating the deviations of the results of the test on physics between the experimental [E] and control [C] groups. The test was taken by the ninth-formers 117 of which represented group [E] and 113 - group [C].

The complexity index of the total evaluation scale is 0.65 while a standard deviation is 0.20. The assessment of the test results shows substantial statistically significant deviations between the answers of the learners from the experimental [E] and control [C] groups. A zero hypothesis $H_0$ about the equality of average is rejected according to significance level $p < 0.0001$ ($t = 7.4 > t_{p = 0.0001} = 4.5$). The average of the results of group [E] is 0.74 and that of group [C] is 0.56. A deviation is in behalf of the experimental group and makes 0.18. Figure 2 displays a boxplot diagram of the test dispersion.

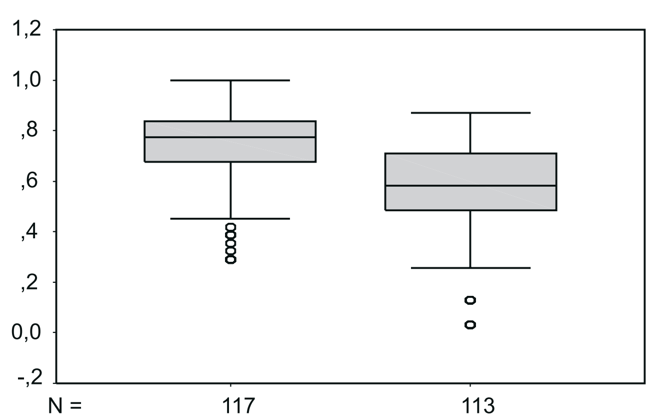


**Figure 2. The boxplot diagram of the test dispersion.**

Comparative evaluations of the test results achieved by 117 learners of the experimental group [E] and by 113 schoolchildren of the control group [C]

The diagram illustrates that quartile measurement of the test results of group [E] learners describes the spread of the 50% sample meanings and is more limited than that of group [C]: quartile measurement of group [E] is 0.15 (0.84 – 0.69) while that of group [C] is 0.24 (0.73 – 0.49). The obtained data indicates that 50% of group [E] students' answers are closer to the medium meaning and more homogeneous than those of group [C].

To make a more detailed interpretation of the results, a factorial assessment was carried out. The key components technique was applied using VARIMAX rotation. Three interpreted factors the individual spread of which is more than 10% were distinguished. Such classification of the tasks into factors complies with the requirements imposed by the factorial assessment.

Factor 1 consists of the group including 7 tasks relatively called the **knowledge reproduction** tasks. They require establishing the quantity expressed by the indicated formulae and noting the measurement units of these quantities. The factor explains 27% of the test information; a minimal coefficient of correlation with the other tasks of the latter factor is 0.63 and CRONBACH ALPHA is 0.89. A comparison of the factor tasks results of the experimental and control groups draws that a statistically significant deviation in behalf of the experimental group has been received. A zero hypothesis $H_0$ about the equality of average is rejected according to significance level $p < 0.001$ ($t = 3.7 > t_{p = 0.001} = 3.3$). The complexity of the tasks in group [E] is 0.89, in group [C] – 0.77 and deviation is 0.12. Figure 3 shows the dependence of evaluation frequencies (percentage in total) of the experimental [E] (continuous line) and control [C] (dotted line) groups on the comparative evaluations of the completed tasks of factor 1.

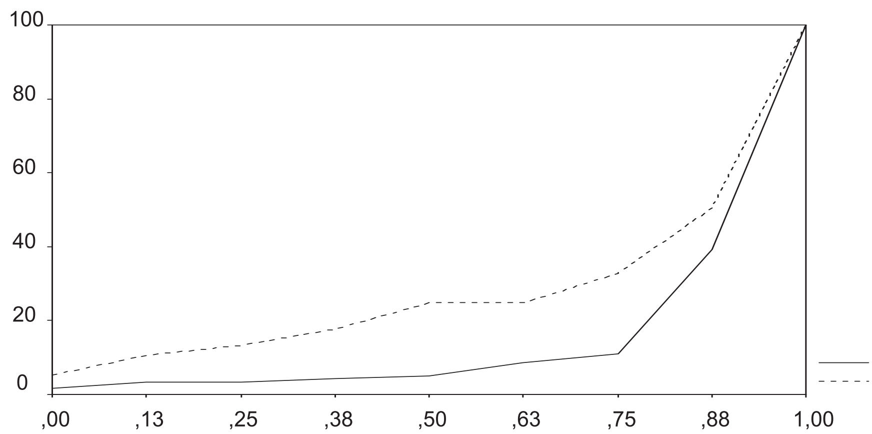


**Figure 3. Comparison of the completed tasks of factor 1 (knowledge reproduction)**
(experimental [E] ( __ ) and control [C] (….) groups)

6 tasks of factor 2 are called **graphical quantity-based** tasks. They represent the assignments analyzing the schemes of a series circuit and require establishing the current strength in the circuit, voltage between different points of the circuit and resistance of a part of the circuit. The factor embraces 16% of the test's information, a minimal correlation coefficient is 0.57 and CRONBACH ALPHA is 0.91. In terms of the tasks of the latter factor, an absolute deviation between the results obtained by groups [E] and [C] in behalf of the experimental group was established. Picture 4 depicts the dependence of evaluation frequencies (percentage in total) of the experimental [E] (continuous line) and control [C] (dotted line) groups on the comparative evaluations of the completed tasks of factor 2. A zero hypothesis $H_0$ about the equality of average is rejected according to significance level $p < 0.0001$ ($t = 5.6 > t_{p = 0.0001} = 4.5$). The complexity of the tasks in group [E] is 0.71, in group [C] – 0.47 and deviation is 0.24.

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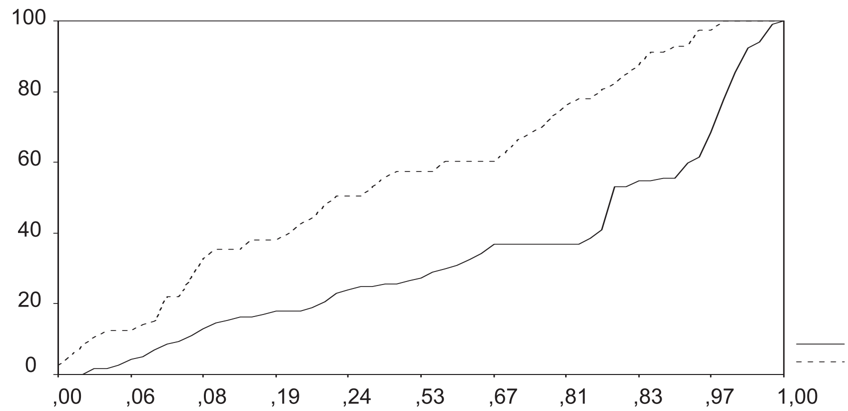


**Figure 4. Comparison of the completed tasks of factor 2 (quantitative graphical tasks)** (experimental [E] (__ ) and control [C] (….) groups)

Factor 3 includes 6 **quality-based** tasks. To correctly accomplish the tasks, the ability to analyze the features and to understand the causative links as well as knowledge of making conclusions is essential. The factor covers 14% of the spread, a minimal coefficient of correlation with other tasks of the factor is 0.37 and CRONBACH ALPHA is 0.76. The latter group of the tasks reflects even a higher absolute deviation in behalf of group [E]. Figure 5 presents the dependence of evaluation frequencies (percentage in total) of the experimental [E] (continuous line) and control [C] (dotted line) groups on the comparative evaluations of the completed tasks of factor 3.

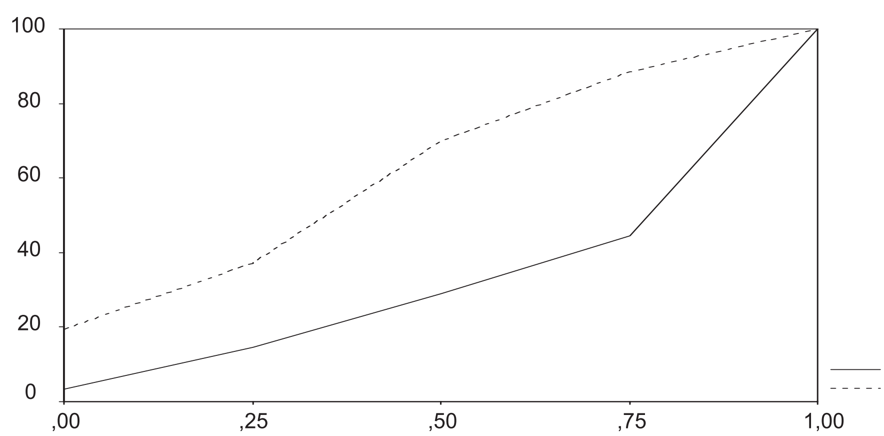


**Figure 5. Comparison of the completed tasks of factor 3 (quality-based tasks)** (experimental [E] ( __ ) and control [C] (….) groups)

A zero hypothesis $H_0$ about the equality of average is rejected according to significance level $p < 0.001$ ($t = 7.6 > t_{p = 0.0001} = 4.5$). The complexity of the tasks in group [E] is 0.75, in group [C] – 0.47 and deviation is 0.28.

The learners of both groups largely succeeded in fulfilling the tasks of factor 1 requiring declarative knowledge. They easily introduced the given formulae expressing the physical quantities and the units of their measurement.

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The tasks of factors 2 and 3 were more complex for both groups of the schoolchildren, although the learners of group [E] rather than those of group [C] achieved better results.

The assessment of a series electric circuit suggests (task 10, factor 2; Figure 6) that about 50% of the learners of group [C] accurately calculated the current strength (10.1) and total resistance (10.4) of the circuit.

***10.*** *The resistances of resistors are equal:* $\boldsymbol{R_1 = 2\,\Omega, R_2 = 3\,\Omega, R_3 = 1\,\Omega}$.
*Voltage between places AB* $\boldsymbol{U_{AB} = 2\ V}$.
***10.1. The current strength in the circuit I = .............. A.***
***10.2. Voltage between places BC*** $U_{BC}$ = .............. *V.*
***10.3. Voltage between places CD*** $U_{CD}$ = .............. *V.*
***10.4. Resistance between places AD*** $R_{AD}$ = .............. Ω.
***10.5. Voltage between places AD*** $U_{AD}$ = ............ *V.*
***10.6 Which of the resistors transmits the strongest current?***
*A* $R_1$; *B* $R_2$; *C* $R_3$; *D* ***equal in all places.***
***10.7. Use the marks to indicate the flow of the electrons in the scheme.***

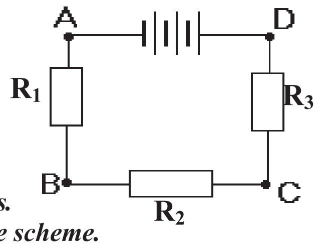


**Figure 6. The task of analysing a series circuit.**

However, a more complicated task was establishing voltage between the different places of the circuit (10.2, 10.3, 10.5). The complexity coefficient of these tasks varied from 0.35 to 0.39 in group [C].

The learners of group [E] better analyzed a series circuit. The results of this task are better. Moreover, the spread of the answers is more limited. The current strength in the circuit was correctly discovered by 74%, voltage between different places of the circuit - by 70% of the group [E] respondents. Such situation reveals that the methods of making a series circuit were better mastered by the learners of group [E] rather than by their colleagues from group [C].

A part of the schoolchildren quantitatively correctly established the current strength in a series circuit (10.1) but were confused dealing with the question which resistor transmitted the strongest current (task 10.6, factor 3). Only 28% of the respondents of group [C] and 56% of those of group [E] mastered the consistent patterns of making a series circuit i.e. understood that the current strength is equal in all parts of a series circuit. The majority of the learners were wrong claiming that the strongest current passed through the resistor having the lowest resistance ($R_3$).

97 % of the respondents of group [E] and 83 % of those of group [C] correctly connected the light bulbs to the batteries in a series circuit as it was indicated in the picture. However, only 35% of the learners of group [E] and 23 % of those of group [C] properly connected three light bulbs to the batteries in a parallel circuit (task 12, Figure 7) as it was shown in the picture. A large part of failures was expressed by doing a mixed circuit i.e. the light bulbs drawn in the upper line were connected in a series circuit and then combined with the third light bulb making a parallel circuit. Depending on a position of the light bulbs elicited in the picture, making such an electric circuit was easily accepted. In order to successfully complete this task, it must be accepted that an external view of a scheme, the number of the current users and their location have no sense. Hence, a major part of the schoolchildren still needs to work on the principle of doing a parallel circuit: in order to make a parallel connection, the ramification of the circuit needs to be produced.

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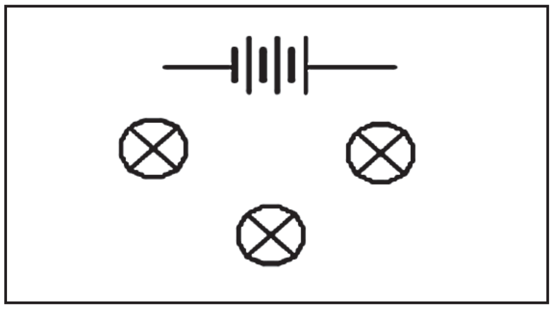

**Figure 7. Connect the light bulbs to the batteries in a parallel circuit.**

The evaluation of the **lability** understanding the concepts of electrical features was carried out offering a similar test to the same respondents in 3 months time. A relative coefficient of task forgetfulness was calculated following the formula

$$U = (P_I - P_{II})/P_I,$$

where $P_I$ is a complexity coefficient of the first fulfilment of the test and $P_{II}$ is a complexity coefficient of the second fulfilment of the test. Thus, the forgotten part of knowledge of physics as well as the lost abilities and skills were established. The test results of the first and second fulfilment in the experimental and control groups were compared following the method of a factorial assessment that indicated the average evaluations of the task groups. Table 1 represents the task complexity coefficients $P_I$ and $P_{II}$ of the first and second fulfilment of the 3 factors, the deviations of the complexity coefficients between groups [E] and [C] $\Delta P$ and the comparative task forgetfulness coefficients of the given factor U showing the forgotten part of the acquired material.

**Table 1. Comparative forgetfulness of the material of the test on *Electricity.***

| | Factor 1 *knowledge reproduction tasks* | | | Factor 2 *graphical quantity-based tasks* | | | Factor 3 *quality-based tasks* | | |
|---|---|---|---|---|---|---|---|---|---|
| | $P_I$ | $P_{II}$ | U | $P_I$ | $P_{II}$ | U | $P_I$ | $P_{II}$ | U |
| **[E]** | 0.89 | 0.71 | 0.20 | 0.71 | 0.59 | 0.17 | 0.75 | 0.57 | 0.24 |
| **[C]** | 0.77 | 0.60 | 0.22 | 0.47 | 0.37 | 0.21 | 0.47 | 0.33 | 0.30 |
| **$\Delta$P** | 0.12 | 0.11 | | 0.24 | 0.22 | | 0.28 | 0.24 | |
| **In total** | 0.83 | 0.66 | 0.21 | 0.59 | 0.48 | 0.19 | 0.61 | 0.45 | 0.27 |

The table shows that recently acquired material can be missed to a certain degree in every group or in any indicated part of a subtest taken by a learner. An average of 20% of the respondents of group [E] and 24% of the representatives of group [C] tend to forget the obtained material. Most frequently quality - based tasks, less frequently - knowledge reproduction tasks and the least frequently – graphical quantity-based tasks are forgotten, although the deviations of the comparative forgetfulness coefficients are not very high. Evidently, the formally acquired part of information will be eventually forgotten. For instance, the first fulfilment of the test of task 3 indicates that 78% of the schoolchildren of group [E] and 33% of the learners of group [C] explained how the mass of a positively electrified body changed in case of earth connection, though a correct interpretation was given only by 62 % and 12 % of the students respectively. Therefore, the second fulfilment of the task was successful for 52% of the respondents of group [E] and 20% of those of group [C] as they managed to accurately establish the alterations of the body mass.

The comparison of the retesting results in terms of the experimental and control groups reveals that the comparative coefficient of material forgetfulness in every part of the test is lower in group [E] rather than that in group [C]. A hypothesis about the equality of the comparative coefficient of test material forgetfulness achieved by the learners of both groups was rejected ($p < 0.05$). During the second fulfilment, statistically significant deviations of the results in behalf of the experimental group have been obtained, though in comparison with deviations gained within the first fulfilment, they slightly decreased. It is acclaimed to be an essential point that a learner having a broader knowledge usually forgets more than that having nothing to be forgotten. Thus, the impact of the oriented tasks on the results of the experimental group is not short-termed and remains unaltered for a longer time.

**Conclusions and Discussion**

In conclusion, we can maintain that the oriented tasks helped with understanding the concepts of electrical phenomena, highlighted the typical learners' mistakes and imposed conditions for their correction and improvement. Research disclosed that the schoolchildren most frequently misinterpreted the content of some concepts (current source, resistance); did not distinguish between two concepts (*electric current* is identified with *electric energy*); referred to the wrong views when identifying the features and making conclusions (interpretation of the current flow in the electric circuit); felt confused about the functional links and relations between these concepts (notion of Ohm's Law for a part of the circuit).

A statistical assessment of the test *Electricity* revealed that the examined findings of the respondents of the experimental and control groups showed statistically significant deviations in behalf of group [E]. Thus, in order to understand the concepts, the experimental group used the oriented tasks, and therefore the achievements of the latter group were more remarkable rather than those of the control group that did not employ such tasks. The research results indicate that the oriented tasks make a weak impact on the acquisition of a declarative knowledge. Most successfully the schoolchildren of both groups coped with the tasks of knowledge reproduction (factor 1) and a deviation between the groups' results in this part of the test is the most noticeable. More substantial deviations can be observed between the achievements in the experimental and control groups as they were achieved completing the tasks on applying knowledge in concrete situations (factors 2 and 3) when the learners analyze the situation, interpret and conclude the results and make conclusions.

The retesting assessment disclosed that a new material can be forgotten at a different level in both groups of the respondents. The statistically significant deviations obtained during the second fulfilment indicate the results of both groups [E] and [C] that are in behalf of the experimental group. The comparative forgetfulness coefficient in all parts of sub-testing is lower in group [E] rather than that in group [C]. Thus, the impact of the oriented tasks is not short-termed.

In order the schoolchildren should purposefully master the scientific concepts and be able to apply them in a concrete situation, the processes of formulating and operating them has to be properly organized. The teachers should take into consideration that learning a definition of a concept is not the end of forming the concept as the quality of understanding it greatly depends on how the essential features are revised and embedded, how the links and relations with other concepts are discovered and how the concept is used for accomplishing the tasks of a different format i.e. how the process of the concept development is built.

To increase the efficiency of mastering the concepts of physics and other science subjects, the educational tasks structurally and contentedly oriented towards promoting the learners' practical and mental activities has to be approached. Hence, they could encourage the students to self-sufficiently act in a rational way.

Considering that the tasks having need for knowledge reproduction are supposed to be less complex for the schoolchildren rather than those requiring a situational assessment, clear conclusions and interpretation of the results, closer attention during the practical classes should be paid to the tasks of the latter format.

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## Appendix

### A Parallel Circuit

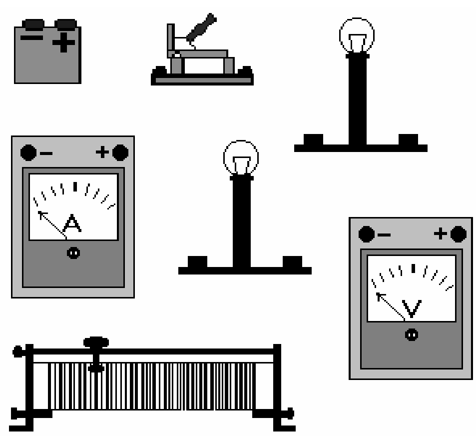
**What is given:** A picture showing the elements of an electric circuit.

**What to do:**

- To indicate a parallel circuit for the lights; to supply the circuit with a rheostat to measure voltage in the light-bulbs; to equip the circuit with devices for measuring voltage of a parallel circuit and total current; to use a plug-switch for connecting the whole circuit to a source terminal.
- To draw up a scheme of a completed electric circuit (the scheme is designed on a reverse side of the list).
- To use "+ "and "– "for marking the terminal poles of measuring devices and to point out to the arrows indicating the flow of current.

**Having moved the slide-block of a rheostat to the right:**

1) resistance of the rheostat:
   A increases,
   B decreases,
   C invariant;
2) the current strength in the rheostat:
   A increases,
   B decreases,
   C invariant;
3) voltage in the light-bulbs:
   A increases,
   B decreases,
   C invariant.



## Резюме

# ВЛИЯНИЕ ФИЗИЧЕСКИХ ОРИЕНТИРОВОЧНЫХ ЗАДАНИЙ НА УСВОЕНИЕ ПОНЯТИЙ ОБ ЭЛЕКТРИЧЕСКИХ ЯВЛЕНИЯХ

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Исследование формирования научных понятий является важной научной и практической проблемой современной эдукологии. Для сознательного усвоения научных понятий необходимо правильно организовать процесс их формирования и уметь им управлять. В процессе формирования физических понятий авторы статьи применяли ориентировочные физические задания с существенными дидактическими ссылками учебной деятельности. В исследовании делается предположение, что ориентировочные задания, в учебном процессе применены как ориентировочная основа, обуславливают направленное движение к положительному результату. Педагогическим экспериментом проверяется влияние физических ориентировочных заданий на усвоение учениками понятий об электрических явлениях. В педагогическом эксперименте участвовало 230 девятиклассников из разных средних школ Литвы. Исследование показало, что ученики часто неправильно понимают содержание некоторых понятий, неотличают одного понятия от другого, путают функциональные связи и соотношения между понятиями. Результатами эксперимента и их статистическим анализом показано, что физические ориентировочные задания способствуют усвоению научных понятий, выявляют типичные ошибки учеников, создают условия для их корректировки и исправления.

**Ключевые слова:** обучение физики, электрические явления, формирование понятий, ориентировочные задания, педагогический эксперимент.

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