Physics as an exact science requires at times a high degree of abstract thinking, but also provides very clear and pure premises as the basis for deductions. Its logically and well organized contents and precepts when adapted to school-age level are source of great intellectual stimulation and contribute to cognitive development in a broad sense. This should be kept in mind when teaching about physical phenomena to very young children, especially at the time when the selection of experiments and methods of presentation is made.

The results obtained after several years of research on children’s understanding of physical phenomena, and the experience gained from experimenting with the selection of content adjusted to the preschoolers and young elementary school pupils have shown that the natural interest of children in the activities, which lead to the understanding of physical phenomena, is an unquestionable fact. It stands to reason because physics is, after all, a science that gives answers to WHAT, HOW and WHY questions.

If our primary goal in introducing children to physical phenomena is intellectual activity, it is necessary to consider in detail the following questions:

• The choice of experiments and method of presentation
• Children’s ability to comprehend physical phenomena
• Variations of the experiment and the problem situation as a stimulus for intellectual activity
• The role of the teacher during the experiment

The selection of experiments and method of presentation

1. The choice of experiments should not be limited only to the most interesting phenomena in respective fields. Many phenomena are interesting and provocative in themselves and to the inexperienced, it may seem sufficient. However, it should be borne in mind that if a phenomenon is not supplemented by variations that help the child to understand, it only prompts the child’s egocentricity, particularly at preschool level. Then it is almost unavoidable to get answers in which everything that has been seen is attributed to “magic”, “trickery” or “conjuring tricks”, explanations that are too often used by parents in their conversations with children.

For example, if a charged balloon is placed near a thin stream of water, the stream will bend. The phenomenon is truly fascinating. One child will be satisfied with the “interesting” aspect of the phenomenon, while another will wish to know the reason why it happens. Respecting the principle that the aim of these activities is not giving ready answers, we introduce new variants of the experiment, which offer more perceptive elements. They will serve as the basis for reflection and solution of the problem.

For instance, if the experiment with the stream of water is carried out after a series of activities in which the children have the opportunity of charging different objects and examining their proprieties, the bending of the stream of water would then be an expected phenomenon.

2. The requirements that must be met:
- simple equipment and material for the experiment
- dynamic changes that can attract children’s attention
- possibility for children to carry out experiments by themselves
- safety of the children

For example, thermal conduction of different materials can be examined by using bars of approximately the same dimensions (about 15 centimeters long), made of glass, wood, plastic and different metals. A wax ball or a small nail is fixed to outside ends of the bars. A round tin may serve as a stand. Several holes are made at the same height of the tin, so that the bars can be put through. Then the opposite sides of the bars are heated while the children anticipate the sequence of events and watch the wax ball or the nail fall.

The same bars (or rods) may serve for examining electrical conduction. All that is needed besides the bars are two electrosopes which can be made out of jars and copper bars with pieces of aluminum foil on their ends. One electroscope is charged, the other is not. Children observe the foil on both electrosopes and notice any changes while the wire rings are connected with wooden, glass, plastic and metal bars. Children try to answer the question: Which bar should be used, wooden or metal, to connect electroscope’s rings and to make the foil on the uncharged electroscope spread?

3. Experiments should be structured in such a way that they represent individual physical phenomena, which we often encounter in everyday life. There are many “physical experiments” we all take part in when we do everyday chores, walk, run or go in for sports.

This can be illustrated by the experiment with the rocking doll (which cannot turn over) and a pram. Children observe the behavior of the doll when the pram suddenly starts moving or stops short.

According to our experience, the child should first become acquainted with a certain physical phenomenon through immediate experience in everyday life. Later through research as an individual activity, the child satisfies his or her curiosity, thinks about his experience, and introduces small changes and checks up on their effects. In the end, during a conversation about similar phenomena in life, the child returns to everyday life enriched with new insights. For this reason after the experiment with the rocking doll and the pram, it is recommended to have conversation with children about the effects that appear when the bus suddenly starts or stops short. After the experiment on movement on rough and smooth surfaces, the subject of the conversation should be: Is it possible without friction?
It is similar situation when children observe the movement of an object on the inclined plane. Almost all children enjoy sliding down a slope covered with snow, skiing or rolling down a hillock. Many people know how difficult it is to cycle uphill. So, by examining the movement of an object on the inclined plane, children complete their everyday experience. It makes it easier for them to notice and comprehend the use of the inclined plane. This approach enables children of different age and interests to become acquainted with physical phenomena.

**Children’s ability to comprehend physical phenomena**

The choice of the method of presentation of an experiment depends on the complexity of a phenomenon on one hand, and the children’s ability to understand it on the other. Some experiments should be arranged in separate phases, starting with the simplest and gradually progressing towards the more complex ones. The experience gained at one stage is important for the next stage since it enables the child to participate in the more complex activities that follow. Efforts should be made to standardize the problem assignments in every phase of the experiment and stick to the sequences of their performance.

For example, a systematic and gradual introduction to electrical phenomena and their better comprehension require answers to series of questions: *Can all objects be charged? What does the attraction and repulsion depend on (when will it be stronger and when weaker)? Are both substances (object and wool cloth, for example) charged by rubbing together? Can the part of the object, which has not been rubbed, attract? Is this a lasting phenomenon? Do the charged objects interact with each other?*

Adults already know the effects of rubbing different substances together, or static charge, and that phenomenon isn’t lasting. Children will learn about it by experimenting and finding answers to the following questions: *Which end of the comb attracts small pieces of paper, ... etc.? Can we attract a styrofoam ball by using the end of a comb which has not been rubbed? How many times can the pieces of styrofoam be picked up without further rubbing the comb? How long have the small pieces of paper been attached to the comb?*

The experiment is carried out in three phases. During the first phase, children use charged objects to attract small, light things and a styrofoam ball on the pendulum. In the second phase children try to attract small things as long as the force of attraction lasts. The object is charged only once at the beginning of the activity. In the third phase, after a break, children use the same object once again and try to pick up small pieces of paper. During the conversation, children are asked why the charged object stopped attracting small pieces of paper and what should be done to make the object regain the same propriety. Each phase or variation of the experiment should prompt the child to further research, not to discourage. That is why the level of children’s capability of comprehension should always be borne in mind.

Children (students) investigate scientific concepts and phenomena firsthand, record and reflect on their observations, share their findings with others, and apply the skills and knowledge they have gained to new situations. This is hands-on but also minds-on, inquiry-based approach to physical phenomena (science). These activities help children (students) understand the “why” and “how” of their work.

**Variation of the experiment and problem situation as a stimulus for intellectual activities**

In order to observe objectively children’s ability to comprehend physical phenomena separate stages of the experiment, whenever possible, should be structured in terms of problem situations, offering sufficient perceptive elements as basis for deductions.
Here is one example. Children are asked to form the shadow of a stick at a given place and then to determine the position of the shadow in relation to the source of light (a torch) and the obstacle (the stick). When children conclude that the shadow is formed on the side opposite to the stick in relation to the source of light, they are asked to form a shadow by moving the torch, but this time on the side of the torch. As this is impossible, the problem cannot be solved. However, the aim of the experiment is to examine conditions in which the phenomenon appears. This experiment was carried out with children who were 10 years old.

A variation of this experiment is adjusted to children who are 5 years old. Children anticipate the number of shadows that will be formed when a stick is lit by several torches. Children are then asked to switch on and off the torches. Each time they anticipate the effects (the number of shadows).

Here is a variation for the youngest children and following interesting question: **Is the shadow of a red circle (geometrical form made of cardboard) red?**

At some stages of an experiment, the problem may be set in such a way that requires close observation in order to find corresponding relations. For instance, during an experiment children try to find the answer to the question: **When do cubes of equal size cover different distances? What must be done if we want the bigger cube to cover the same distance?**

New variations of an experiment and problem situation should indicate the cause of the phenomenon in a more direct way to stimulate the child to reflect and overcome cognitive conflict. This particularly refers to contents with a higher degree of abstraction.

Activities with children can be realized in play. Play is organized so that children actually do certain assignments. “Play with balloons” is both a pleasure for children and an intellectual stimulus. Using Magic Makers draw happy faces on a number of balloons. Then rub the “face” of one balloon with fur or wool. Children can see the balloons “kissing”.

In the following variation of the experiment balloons are charged on all sides and then placed close to one another. While the balloons repel it is interesting to ask this question: **What face would you draw on these balloons now?**

If a pair of balloons is charged on one side only, their behavior depends on the sides which are turned to each other. That is why the following question is put to children: **Is it important which sides of the balloons are facing one another?**

Children should be allowed to play with the balloons freely and take their time to observe what is going on.
The role of the teacher in research activities

We must not deprive children of the joy of discovery. We must create conditions for them to learn about the world around them and the laws of nature through research. The role of adults in this process is of great importance because it is through their unobtrusive help and stimulation that children gain new experience and knowledge.

In recent times, the role of the teacher in the cognitive development of children, especially in natural sciences, is in the focus of attention. A teacher of natural sciences is not expected to teach in the sense of giving lectures. Teaching is a mutual process that helps a child to construct knowledge from within. Discussions about teacher titular and / or mediator have contributed to the idea that the relationship between a teacher and a pupil should be one of partnership, with all its implications, including social. Human relations play important parts in all domains of life, education being no exception.

During compulsory education, children become acquainted with the contents of physics through different subjects as well. Their knowledge increases and at the same time they acquire a certain number of skills. Between the ages of 8 and 11 pupils are faced with more complex tasks. They are to learn how to formulate questions, suggest reasonable solutions based on observation, measuring, connecting data, cause and effect, etc. Pupils are expected to interpret the obtained results in their own words. For this reason, it is often stated that a child (student) should be treated as a researcher.” Facts are important, but the younger the students are, the more important it is to learn the process of science”, stated Dr Leon Lederman Nobel Prize Laureate. In such an approach to the study of physics (natural sciences), the role of the teacher is the following:
- To contribute to students’ conceptual understanding of physics at a level that is appropriate to their stage of cognitive development.
- To help children develop scientific attitudes, such as curiosity, respect for evidence, the capacity for critical reflection, flexibility.
- To develop scientific reasoning and critical – thinking skills.

Literature