

Understanding of optical phenomena in simple experiments

Justyna NOWAK

Academy of Young Explorers Foundation, Rzemieślnicza 1/417, 30-363 Krakow, Poland

Dagmara SOKOŁOWSKA

Institute of Physics, Jagiellonian University, Łojasiewicza 11, 30-348 Krakow, Poland

Abstract. Despite research results showing a huge drop in pupils' positive attitude towards science at school taking place between ages 8 and 11, our experience with primary school children reveals their enormous interest in science out of school and in particular – in doing science experiments. That encouraged us to organize a national competition in science for primary school pupils in which children perform experiments and take part in a test on science. Our research focused on the answers given by participants over a period of 11 years to the questions related to experiments in optics and showed different patterns for different ages.

1 Introduction

The research results show that positive attitude towards mathematics, science and technology school subjects decreases with age and recently it has been indicated that the biggest drop takes place between ages 8 and 11 [1]. At the same time the evidences have been collected to conclude that more efforts are needed at early stages of schooling for implementation of group work, more practical activities and tasks enhancing the analytical thinking [2]. On the other hand our experience from a bunch of open events, organized by our Institute of Physics at the Jagiellonian University, shows an enormous increase of children's interest in all kinds of popular science over the last decade or so.

This strong children's motivation towards experimentation and interest in scientific knowledge gathered from different resources encouraged us eleven years ago to start a new national competition in science for primary school, *Firefly* [3]. The idea was to engage the group most motivated to do experiments and soak up the scientific knowledge out of school curriculum, meaning children aged 7-14 (grade 1 to 7), together with their parents and/or teachers in guided science hands-on and minds-on activities at school or at home. The key role in the competition is played by simple experiments, based on everyday materials. The experimental part is then followed by a multiple-choice test, organized for all participants on a certain day in March and examining their engagement in experiments, analytical thinking and scientific knowledge. A separate test is prepared for each school grade. Questions are equally composed of three categories: (1) biology, chemistry and medicine, (2) ecology, geography and climate, (3) engineering, physics and astronomy. Two months before the test pupils are encouraged to perform a set of simple hands-on experiments selected for the competition each year. Children do them at school during classes or individually at home at any convenient time before the test [3,4]. On average 10 - 30% questions in a final test are linked to experiments.

In the first run a number of 4664 pupils from 245 schools took part in the contest and over 11 years the numbers increased to 52200 pupils and 1350 schools.

Recently the idea of science competition for primary school pupils was followed in a modified form by one of the organizations in Slovenia [5].

2 Research and result

This contribution is devoted to the elaboration of the results related to questions linked to experiments on the basis of the statistics of answers given by pupils from each grade. The main aim of our research was to examine engagement of students in performance of experiments and understanding of optical phenomena derived from simple learning units. We focused on experiments on optics phenomena. Fifteen of them have been proposed in Firefly since 2009, including: (1) *Arrows* and (2) *Dark* for the first grade; (3) *Magnifier without glass* for the second grade; (4) *Illusion*, (5) *Why do you need two eyes?*, (6) *Shadow and flame* for the third grade; (7) *Image in a glass*, (8) *Angles and images*, (9) *Afterimage* for the fourth grade; (10) *Ray of light* for fifth grade; (11) *Rainbow*, (12) *Spectroscope*, (13) *Jelly lens*, (14) *Human eye* for sixth grade and (15) *Mirror for a cloakroom* for seventh grade.

All descriptions of experiments have the same structure. At the beginning, the steps and tasks necessary to carry out experiment are presented. Next a few simple questions about observations and conclusions are asked. The last part is a comment in which we explain what happened and what phenomena occurred during the experiment. The test questions linked to experiments are related to their different parts - performance, observations, results or the comment.

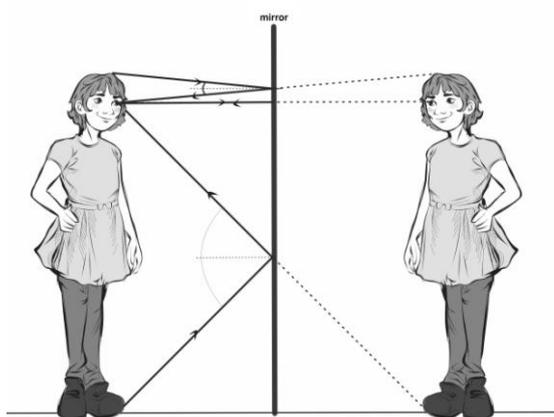


Fig 1. Exemplary picture from a comment to the experiment "Mirror for cloakroom", grade 7, 2018 [2].

3 Conclusion

Our research focused on the answers given by participants over a period of 11 years to the questions related to experiments in optics and showed different patterns for different ages. We will present them in details during in our contribution.

References

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