Transfer of fundamental physics research results to education and identification of the underprivileged gifted

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Abstract. In this contribution we consider possibility to apply an introduction of novel fundamental results in physics to the classroom for a tool in identification of the gifted with an underprivileged background. The idea of the approach is discussed, the criteria for topics applicable for the purpose of gifted identification are presented, and results of testing of one module are shown.

1 Introduction

Novel research results are seldom introduced to the lecture below the university level. Even introductory courses often do not include any novel results to the students. On the other hand, several everyday issues were a motivation for serious studies that were published in high impact physics journals, for example Shell buckling [1], Hard cubes ordering [2], and many others. Although titles of the paper do not reveal simplicity and elegance of experiments behind. Virot et al studied a buckling of the coca cola can under longitudinal stress [1], Asencio et al studied ordering of cubes in a glass that was shaken to and fro rotationally [2]. All the articles were chosen as editor's suggestion, as they revealed new physics in spite of simple, almost hands-on experimental procedures. In addition, several relatively recently discovered phenomena, are already a part of every day life as they are used in various devices. Examples are liquid crystals [3], hydrogels [4], several optical phenomena associated to polarization [5], and many others. Last but not least, several phenomena often met in everyday life are not considered thoroughly in the classroom, but they are often purely understood also by experts, for example osmosis [6], syphons [7] and many others. All these topics or phenomena allow introduction to regular school programs, but systematic studies with these respects are extremely rare [8].

Besides usual education research questions, like, how much students learn, which concepts are more difficult than others and why, how to teach such topics better; such topics offer also a laboratory for other education research studies. For example, all those topics have something similar, students do not have much preliminary knowledge and experience. So, development of conceptual understanding can be studied in parallel for students of various age. Several topics are practically unknown to high school students, so one can study how experienced learners cope with unique new problems, where no preliminary experience is present. Finally, the idea, which is developed in this paper, is the following. If students' preliminary knowledge on the topic is negligible, by developing simple inquiry type experiments, all students are provided with an equal initial experience related to the studied topic or phenomenon. During this process, one could identify students that are able to discover patterns quickly, grasp relations among variables, and most importantly, quickly use new information in new circumstances. All these are typical characteristics of students, physicists consider as gifted. However, in such circumstances also students that lack academic skills, like good reading and writing, mathematical skills, and fine arts, which is often the case of students with underprivileged circumstances, may excel. Therefore, they can be noticed by a teacher that usually does not expect their good results, especially if a teacher is trained to focus on few specific issues related to the activity.

In this paper we present criteria for the topics that we consider appropriate for development into teaching modules allowing identification of the gifted, present few examples of such topics and one module into more details. We also discuss some results of a pilot study of this module.

2 The modules

The topic, which could be considered for identification of underprivileged gifted, has to fulfill a few requirements. It should be either interesting or relevant for everyday life, if both, even better. The topic has to allow for development of quick, easy to perform, hands-on, if possible, experiments, which provide a new experience to students. The experiments have to lead to a few very demanding questions, which could be answered correctly by comprehension and application of new experience. The topic should not be introduced by reading, talking or other means that do not force student to investigate by themselves.

Let us describe a few examples, and indicate questions that can be used for identification of the gifted.

a) Siphon, prediction of flow for a few settings;

b) Screen colours, recognition of enlarged parts of the screen, and how to change dark red to pink by using colour components?

c) Osmosis in jelly bears, how to reverse the osmotic process?

d) Spreading shadow, effects of additive penumbrae;

e) Microwaves and the birefringence of wood, is the splinter board birefringent?

f) Polarization of light, how is the circular polariser constructed?

g) Polarization of light, how to make a double picture, the picture that is different if observed trough the polarizer?

h) Hydrogels, and what could one guess from an observation of growth?

3 Pilot case studies and conclusions

The module for screen colors was tested with few individuals age 13-15. The chosen students came from the group of identified gifted and from the others. The protocol for a structures experimentation will be presented as well as the results of the testing.

Introduction of new topics that come from contemporary research has several benefits for students. Besides these topics being and evidence that physics is not old and irrelevant, but is a vivid research field with problems everybody can grasp its idea, they offer also a new research framework for various other aspects in physics education research, identification of the underprivileged gifted s only one of them.

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