Science centre as a part of the education system in the Czech Republic

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Abstract. The aim of this poster presentation is to present the results of a survey regarding the impact of extracurricular education at Palacký University science centre on pupils’ school performance in comparison with curricular education survey. This survey is realised by a pre-test and a post-test. Furthermore, readers will be introduced to teaching materials used during the science centre lectures - pupils’ worksheets, methodology for teachers and optical lenses preparation manual. These components are used by the pupils during the experiments. After their evaluation, the pupils describe the observed physical phenomena.

Keywords Didactics of physics, science centre, extracurricular education, school performance, optics.

1. Introduction
One of the primary motivations for choosing this topic was the fact that very little research concerning the impact of extra-curricular education on students exists.

Furthermore, such studies are largely concerned with describing the motivations and interests of individuals visiting extra-curricular institutions, failing to compare the effect of formal and informal environment on learning [1, 2]. According to [1] “though most education research to date has focused on learning that takes place in school, there is an increasing awareness in the field that science, technology, engineering, and mathematics (STEM) learning occurs across a broad range of contexts, including museums, afterschool programs, the internet, and other media, as well family learning at home [3].”

Studies concerned with analysing the impact of learning in formal settings are far more prevalent compared to research on the effects of learning in informal settings [4]. Despite being published more than ten years ago, there has been little development in terms of utilizing quantitative methods to assess the effects of science-centre-based extra-curricular education.

Although extra-curricular education in science centres is gradually being integrated into the Czech education system, visiting science centres is still based on the initiatives by schools, or rather, teachers. This could be caused by the yet-to-be-understood impact of extra-curricular education in science centres on pupils’ school performance.

The aim of this research is to determine whether extra-curricular education yield different quantitative results of the students’ success throughout the learning process, as opposed to curricular education settings.

The reason why I choose this topic is the current science-centre-based physics-themed exhibition focused on optical phenomena. Another reason is that, there is a prevalent issue with the lack of lab
equipment in primary schools. Therefore, this research is to serve as a source of new ideas for the teachers to improve their lesson content. Also, my main focus is aimed at preparation optical lenses, as they can be utilized during the lessons. In this way, the teachers are able to use their self-produced equipment to demonstrate physical phenomena, allowing a more hands-on approach, as well as increasing the students’ engagement with the subject matter.

2. Methods

2.1. The science centre lesson
Before starting the lesson it is necessary to prepare 8% pure gelatine solution. This solution will be dissolved at 60 °C by the lecturer just before the start of the lesson. Temperature of the mixture must be maintained at 32 °C, ideally using a magnetic stirrer. The temperature should not drop below 30 °C, because at this point the gelatine solution starts turning into jelly.

The pupils will choose a mould they want to use for casting a lens. They can choose a mould either for converging or diverging lens, each with different thickness. The lecturer’s main task is to ensure that all types of lenses are included in the experiment, so that the pupils are able to compare the results of their observation.

The pupils cast the lenses and while the gelatine is curing in the refrigerator, the lecturer introduces the topic. They explain the basic terminology e.g. spherical boundary, optical axis, light ray. Observing the physical phenomena is subject to the pupils’ own research. These observed physical phenomena will be described by the pupils and recorded into a worksheet provided by the lecturer. During their science-centre-based lessons, the pupils complete the worksheet given to them for their own needs. The worksheet is not to be evaluated.

2.2. Survey
The lecturer/teacher distributes the questionnaires before starting the lesson, and immediately after finishing the lesson. Pupils complete their personal information anonymously and respond to seven basic questions pertaining to the topic.

Survey questions

Type of school:
Year of study:
Age:
Gender:
I studied this topic at school: YES/NO
I am currently: at school/at science centre
I am completing this questionnaire: before the lesson/immediately after the lesson/more than three months after the lesson

1) Lenses with a centre wider than their edge are called:
   a) emerging lens
   b) diverging lens
   c) converging lens

2) Lenses with an edge wider than their centre are called:
   a) emerging lens
   b) diverging lens
   c) converging lens

3) After transiting through the converging lens, light ray parallel with optical axis refracts in such a way that beyond the lens:
a) its direction appears to emerge from one single axial point.
b) it leads to a single non-axial point.
c) it leads to a single axial point.

4) Diverging lens transform parallel light rays into:
   a) a converging type
   b) a diverging type
   c) an emerging type

5) The distance between the lens’ centre and its focus is called:
   a) oblique radius
   b) lens’ height
   c) focal distance

6) The thicker the lens, the __________ its focal distance $f$.
   a) shorter
   b) longer

7) The larger the lens’ focal distance $f$, the __________ optical power (vergency) $\Phi$.
   a) smaller
   b) larger

3. Results
The results presented in the survey do not account for the pupils’ gender and age diversity, nor do they take into account the type of school they attend. The questions aiming at the differences serve as a basis for future research. The science-centre-based survey included the testing of four primary school classes, consisting of 106 test pupils. The number of students attending the science centre always equalled to less than fifteen pupils, as the whole class was divided into two groups. The school-based survey also included the testing of four primary school classes, consisting of 97 test pupils. The number of students attending the classes equalled to 20 to 30 pupils, a number comprising a single class.

Fig. 1. Survey results in the science centre ($N=106$).

Fig. 1 shows: In the case of the science-centre based survey there is a noticeable increase in the frequency of correct answers in the post-test compared to the pre-test. The third question proved to be difficult to answer. This result can be attributed to the more complex nature of the text, as it requires more imagination from the pupils.
Fig. 2. Survey results in school ($N=97$).

Fig. 2 shows: In the school-based survey, there is an evident increase in the frequency of correct answers in the pre-test compared to the post-test. However, the difference in frequency is less noticeable than in the science-centre-based testing. The frequency of correct answers in the third question decreased.

Fig. 3. Pre-test results ($N=203$).

Fig. 3 shows: The frequency of correct answers in the science-centre-based pre-test testing is comparable to the school-based pre-test testing, except items 1, 2 and 7. In items 1 and 2 the frequency of correct answers in the school-based pre-testing testing is higher. In item 7 the frequency of correct answers in the school-based pre-testing testing is lower.
Fig. 4. Post-test results (N=203).

Fig. 4 shows: The frequency of correct answers in the science-centre-based post-test testing exceeds the frequency of correct answers in the school-based post-test testing. There is no occurrence of correct answers with a higher frequency in the school-based post-test testing.

Fig. 5. Overall results of the survey (N=203).

Fig. 5 shows: Comparing the overall results of correct answer frequency attracts attention. The pupils tested in schools and the pupils tested in science centre were comparatively successful in the pre-test, whereas the pupils tested in the science centre were successful in the post-test.
Fig. 6. Comparison of increase in correct answers (N=203).

Fig. 6 shows: The school-based testing can be characterized by a low increase in the frequency of correct answers. Contrastively, the science-centre-based testing shows a more significant rise in the frequency of correct answers.

4. Discussion and conclusion
As no static analysis was made, these conclusions should be seen as input hypotheses for further research. To conclude, the results of science-centre-based testing are better compared to the school-based results. This conclusion is based on the results of the survey, indicating that science-centre-based testing displays a significant increase in the frequency of correct answers in the post-test as opposed to the pre-test. The correct answer frequency ratio between science-centre-based and school-based overall post-lesson testing changed to favour the science-centre-based conditions. The question remains whether the change of environment, the lecturer’s personality, or a smaller number of pupils in the group contributed to the final results in any way.

The following research will attempt to account for the test group diversity, particularly evaluating the impact of the pupils’ age and gender on the survey results. An important factor in the follow-up research will be the pupils’ prior school-attained knowledge of the subject matter. Re-testing after a three-month period will follow. An alternative approach is to study the pupils’ pre-concepts.

5. References
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