Do various groups involved in physics education appreciate the same aspects of physics demonstrations? – Ongoing research

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Abstract. This contribution presents the research design of an ongoing study of parameters influencing perception of physics demonstrations by different communities of people involved in the upper secondary school (SS) education. Its aim is to determine such parameters in various groups of people (SS teachers, SS students, pre-service physics teachers, pre-service physics teacher trainers) and to compare these parameters between different groups. The research design comprises of a video-study using high-inference rating scales. Item response theory (IRT) will be employed to analyse the data.

Introduction

Physics demonstrations are an inseparable part of physics education, yet proper research into parameters that influence students' perception of such demonstrations is hard to come by. Majority of such research stop at the question whether physics demonstration positively or negatively influence students' perception and learning outcomes (e.g. [1]; [2]), however they do not inquire about aspects of the demonstrations causing such improvements/impediments.

Our ongoing video-study, which implements rating scales for physics demonstration assessment and IRT for data analysis, looks for such aspects in several different communities of people that are on certain level involved in secondary school physics education. Those groups of people are *secondary school students*, *secondary school teachers*, *pre-service physics teachers* and *pre-service physics teacher trainers*.

Focus of our study are *Physics demonstrations for upper secondary school students* (DEMOs), that have been performed by our Department of Physics Education for more than three decades. The department offers seven different physics topics (e.g. *Acoustics*, *Optics*) which are altogether visited by approximately 5,000 students each year. Questionnaire-based research [3] showed significant differences in students' perception of these topics. In our research, we seek to determine what causes these differences.

The aim of this contribution is to present developed methodology for evaluating physics (or more generally science) demonstrations.

Research design

Each topic of DEMOs has been video-recorded. These recordings are assessed both holistically (one performance as a whole unit) and analytically (whole performance is divided into approx. fourteen short – about 6 mins each – monothematic situations). Thus, we are analysing seven whole performances (approx. 75 mins each) and exactly one hundred short situations.

We have developed two sets of rating scales for these assessments – one set for whole performances and one set for short situations, see Table 1. These scales take into account nature of the demonstrations, which are, quite predictably, dominantly performed frontally by the lector. Rating scales consist of five points with a detailed description of the 5th, 3rd and 1st point. Each of these scales is accompanied by a space for a free commentary on whatever interesting happening in the video-recordings.

Table 1. An overview of designed scales for whole shows and for short sections.

Whole show	Short sections
Introduction and establishing contact	Atmosphere in the auditorium
Interaction with the audience	Clarity of experiments
Atmosphere in the auditorium	Visibility
Utilization of motivation	Clarity of speech
Overall logical structure of the show	Overall impression from lecturer's performance
Overall subjective impression of the show	

In addition, the evaluation of the whole show includes a section called *Overall subjective impression of the show*. This section contains ten statements about the show rated on a four-point Likert scale and four open-ended questions about the show. These serve as a "calibration" to the rater's rigorousness/appeal to lecturer's style of presentation.

The research employs 84 raters evenly distributed into the above mentioned categories (21 SS students, 21 SS teachers, 21 university students and 21 teacher trainers). Each rater assesses eleven short sections and one whole performance using above-described scales. Short sections are systematically distributed amongst the raters following a certain set of rules:

- assessing the whole show and sections from that show are mutually excluded,
- distribution of sections for each rater follows the distribution of all sections (about 55% of them are purely experimental, approximately 30% are purely theoretical and the remainder contains a mixture of experiments and theory),
- there is appropriate thematic diversity (sections are from diverse topics),
- there is a sufficient overlap both between raters and between sections.

As a result, twelve distinct raters (three from each rater group) rate each show as a whole unit. Whilst each show is divided into approx. fourteen short sections, each of which is rated by approx. ten different raters.

Conclusion

This research design has been developed to fill a blank spot in general knowledge about physics demonstrations. Results may point to parameters to work on in order to improve the appeal of similar science demonstrations to students, and hence the impact of these activities.

References

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