

Physics education: Who comes, and why?

A. Isnes, Dept. of Teacher Education and School Development, University of Oslo

C. Angell, Dept. of Physics, University of Oslo

E.K. Henriksen, Dept. of Physics, University of Oslo

Abstract

In order to address the current recruitment crisis in physics, we have undertaken a questionnaire study to explore how students and teachers in secondary education, and university students, view physics and physics instruction. Our results show that students on all levels indicate personal interest and talents as important factors for their choice to study physics. Secondary school students see physics as interesting, but demanding and labor-intensive. "Understanding the world" is students' and teachers' most frequent description of what physics is about. Regarding the quality of physics instruction, secondary school students are generally satisfied; however, they would like "qualitative instruction approaches" to be applied more frequently. University students express an even stronger wish for such changes. In view of these and other findings, we discuss possible changes to physics education.

1. Background, Aims and Framework

Many western countries experience a decline in the number of students choosing to study science and technology in general and physics in particular [1,2]. To improve the recruitment situation, it is essential to understand young people's reasons for their educational choices as well as the image they have of physics and physics teaching. The present research project was undertaken with the following aims:

- to explore the factors that influence young people's choice to study (or not to study) physics in upper secondary school and university
- to explore how students and teachers perceive physics as a subject
- to explore how students and teachers experience physics instruction

2. Methods and samples

Questionnaires were administered to a random sample of physics students in upper secondary school, to all physics teachers from every Norwegian upper secondary school, and to all Norwegian students currently enrolled in a first-year university physics course (Table 1). Approximately 13 % of the age cohort of Norwegian youth take grade 12 physics and 8 % take grade 13 physics.

Respondent group	No. of responses	Approx. response rate	Proportion of females
Grade 12 students	1141	70 %	33 %
Grade 13 stud. (final year sec. sch.)	1051	70 %	29 %
Teachers of grade 12/13 physics	342	50 %	11 %
1 st year university physics students	196	65 %	36 %

Table 1: Number of respondents, approximate response rate and gender distribution for the different respondent categories in the present study

The questionnaires contained both open and closed questions. The closed questions had a common format with a 1-5 Likert scale. Some questions were the same across all respondent groups; others were specific to each group.

3. Results

When asked what was important to them in a future occupation, most secondary school students rated high wages and autonomy very high. Factors such as helping others and working with people received lower ratings, especially from the boys.

On the question of which factors might, explicitly or implicitly, have influenced their choice to study physics, students rated factors of personal interest and abilities very high, whereas a range of other factors such as parents and siblings, friends, teachers and the mass media were all rated low (fig.1).

Among the 12th-graders in our sample, 40 % of the girls and 27 % of the boys had decided to leave physics after grade 12. The reason most frequently stated for dropping out was "I don't need it for my future education". Other frequently stated reasons were that the subject was difficult and labor-intensive.

Secondary school students were, on the whole, satisfied with both the content and quality of the physics courses, although they perceived physics as a demanding subject. Close to 60 % of all students rated school physics as "interesting" or "very interesting", the teaching quality as "high" or "very high" and the subject as "difficult" or "very difficult".

When asked to rate factors they might see as important in school physics, all respondents gave the highest ratings to aspects that concerned using physics to understand the world and everyday phenomena (fig. 2). Teachers attached a higher importance to experimental work than did the students.

All respondent groups were asked an open question about what they saw as most characteristic of physics as a subject. The characteristics mentioned by the most students were formulas, theory and mathematical calculations, followed by physics as describing phenomena in the world. Teachers put relatively more emphasis on physics as describing the world and on experiments.

Regarding their experience of physics instruction, all respondent groups were asked to state how frequently a range of different instruction methods were applied in the physics course they worked with. Students were also asked to indicate how frequently they would prefer these methods to be applied if they could choose. The methods presented included lectures, small-group discussions, demonstrations, individual problem solving etc.

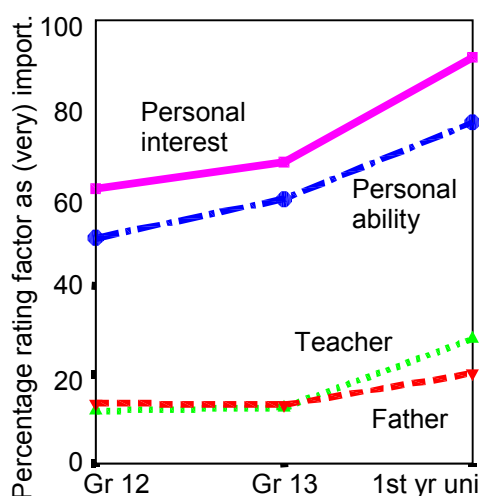


Figure 1: Students' ratings of the importance of various influence factors for their choice to study physics. Graphs show percentage of respondents rating each factor as "important" or "very important".

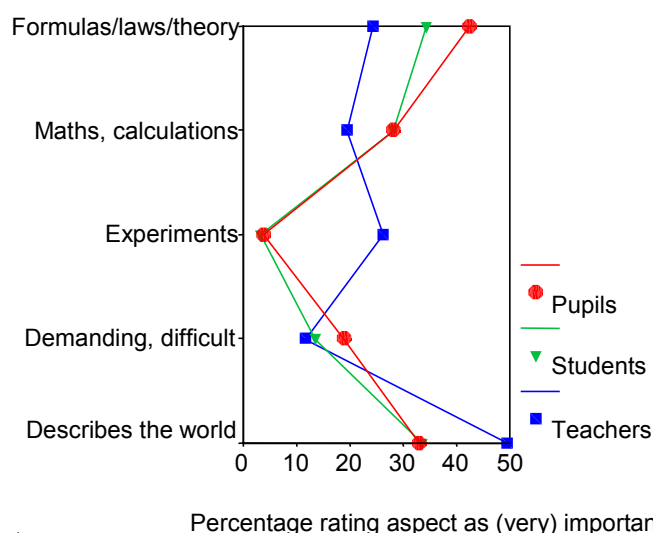


Figure 2: Proportion of respondents rating aspects of school physics as "important" or "very important"

Secondary school students were relatively satisfied with the instruction they experienced; however, they wanted more of what we might call "qualitative instruction styles" such as discussions of qualitative aspects of concepts and practical demonstrations of concepts (fig. 3). University students experienced an even larger discrepancy in this respect.

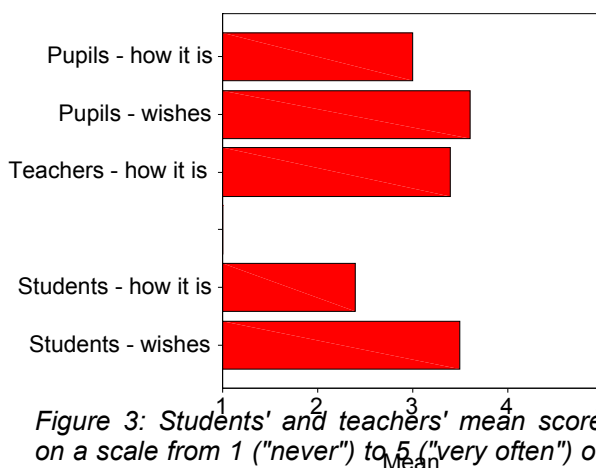


Figure 3: Students' and teachers' mean score, on a scale from 1 ("never") to 5 ("very often") on a combination of three items indicative of a qualitative instruction style

4. Conclusions and Implications

The situation for secondary school physics in Norway appears as something of a paradox: Recruitment is too low to fill the future need for scientists and engineers. At the same time, the few students who do choose the subject, and also their teachers, are relatively satisfied with the subject and have few wishes for change. They constitute a "closed system" where both students and teachers get the subject they like. Moreover, the TIMSS study [3] showed that Norwegian physics students in secondary school were among the highest performers internationally.

Given this situation, a question arises: if the subject is to be changed to enhance recruitment, what kind of changes should this be, and how will these changes be received by the groups who are currently engaged in the subject? Regarding the nature of possible changes, some recommendations are implied in our data.

First, lowering the perceived level of difficulty and the workload appears as a prerequisite for attracting more pupils to physics. Second, since girls are under-represented among physics students on all levels, they represent the largest potential for recruitment. Since there are considerable differences in the values and priorities of girls and boys, girls being more "person-oriented" [4,5], physics may need to incorporate more of these values in order to appear palatable to more girls. Third, changing the instruction methods in the direction of more qualitative discussions and demonstrations of concepts is suggested (especially in university).

Will a few changes in physics curricula and instruction methods be sufficient to change the current trend for young people to turn away from the subject? It may not be quite so easy; there are indications that the decline in interest, knowledge and pursuit of science is related to fundamental changes of the conditions of life in modern society [1]. However, given the demand for scientifically skilled personnel in modern society, we can hardly afford not to try the means available to us.

5. Bibliography

1. B.C. Jorgensen, Mathematics and Physics Education in Society – The Justification and Enrolment Problems from a General Perspective, in J.H. Jensen, M. Niss and T. Wedege (eds.), *Justification and Enrolment Problems in Education Involving Mathematics or Physics*, Roskilde University Press, 1998.
2. EPS, Securing the Future of Physics. European Physical Society, Malvern seminar report, September 1999.
3. Mullis, I.V.S. et al, Mathematics and Science Achievement in the Final Year of Secondary School, TIMSS, Boston College, Chestnut Hill, MA, 1998.
4. M. Stewart, Gender issues in physics education, *Educational research* 40, pp. 283-293, 1998.
5. L.J. Sax, Retaining tomorrow's scientists: Exploring factors that keep male and female college students interested in science careers, *Journal of Women and Minorities in Science and Engineering* 1, pp. 45-61, 1994.