

Survey on physics knowledge to evaluate the effects of gender gap on orientation towards STEM courses

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Abstract The aim of this research is to monitor the gender gap in a sample of high school and university students, through a survey by multiple choice test in a well-defined sector of physics teaching (Nuclear Physics). The survey results were analyzed and compared with a fixed threshold reference value and used as a measurement of empathy toward hard-science topics. The comparison with gender numerosness in the five pupil populations can be used as a parameter to understand how gender unbalance can influence the attitude toward STEM courses of male/female.

The Italian landscape of gender balance in STEM

It is known that in terms of access to STEM course in Italy the gap between genders is not as accentuated and so unlike what happens in other international educational contexts both the high school and university segments are highly inclusive by gender [1, 2, 3]. This is due to the lower number that characterizes more in general the STEM courses in Italy [4, 5]. Recently a few authors stressed that female students often are more attracted by healthcare programs inside a larger idea of STEM courses [6].

The survey on Nuclear physics

Nuclear physics represents a modern knowledge that has now been historicized for more than a century, characterized by applications in different fields outside the physics (medicine, economy, history, philosophy) and whose experimental and theoretical sections are accessible at every school level, from the simplest that can be tackled in primary school to the most university specializations. This suggests that the preparation of students in this area could be adequate to find out those who intend to continue with STEM and, more generally, to make conscious choices of active global citizenship through a scientific background [7].

The survey consists of two blocks of items. The first block relates to information relating to the subjects making up the sample, the second to questions relating to their knowledge of the foundations of nuclear physics was divided in three levels of complexity: descriptive, formalism and application. As regards the block of nuclear physics questions, there are 28 questions. An acceptability threshold S was set equal to 13 which corresponds to the possession of simple descriptive knowledge of NP [8].

Populations under investigation

The survey has been proposed to five different population of students (age 17-20 y.o.) involved in scientific curricula at different levels, in the last year of high schools in wealthy area of north Milano (HS1-2-3) and to the students of the first year of two Milano universities university degree (U-E, U-S), before carrying out the courses in modern physics. For what concerns HS* we stress that about 95% of pupils followed the same courses for the 5 years.

- *HS1*: a big high school, with two different curricula, Traditional and Applied (mean global score 14,00)

- *HS2*: a little high school, with only applied curriculum coming from a former a technical school (mean global score 9,24)
- *HS3*: a medium size high school, with two different curricula, traditional (Liceo scientifico) and applied (Liceo scienze applicate) (mean global score 11,07)
- *U-E*: an engineering course: (mean global score 12,20)
- *U-S*: a course of Physics (mean global score 13,67)

Outcomes and discussion

For what concerns the HS students 70% declare that they have not followed NP courses in the physics discipline. The remaining 30% also addressed NP in related disciplines (chemistry) or non-scientific (history, civic education). The composition of the different samples and the related survey scores are shown in Table 1.

Curriculum	Cis-female	Cis-male	Trans-gender	No answer	Score		
	F	M	T	O	F	M	T/O
HS1 SA+ST	46%	51%	3%	-	13,60	13,97	21,5
HS2 SA	24%	76%	-	-	8,16	9,58	-
HS3 SA+ST	41%	57%	-	2%	10,28	11,68	10
U-E	56%	43%	-	1%	12,10	11,97	14
U-S	31%	63%	-	6%	12,73	14,30	11,8

Tab. 1: gender distribution and scores of the five populations.

Although reduced, gender polarization is observable in two specific cases, among U-S students (cis-male 63%, cis-female 31%), and those of one secondary school (HS2 II cis-male 76%, cis-female 24%). In these cases, cis-female students obtain scores below the average for significant values (-7% for U-S, -11% for HS2), very far from those obtained by cis-male students of the same subsample (+5% U-S, +4% HS2). In this case a high gender gap disadvantages the cis-female score.

Results are resumable in two short sentences:

- where the gender gap is minimal the scores of both F and M population is on average higher than in situations where the gender gap increases;
- where the gender gap for the number increases, i.e. where the F population represents a minority, the gender gap relating to the score increases.

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