

Exploring the Relationships between Physics Identity and Endorsement of Stereotyped views of Physics of STEM Undergraduate Students

Silvia GALANO, Antonella LICCARDO, Italo Testa

Department of Physics “E. Pancini”, Via Cintia, 80126, Naples, Italy

Abstract. This study aims at investigating the relationship between physics identity and stereotyped views of physics in a sample of $N = 386$ students enrolled in three undergraduate courses – physics, biology/biotechnology, computer science. Through hierarchical cluster analysis and a 2-way analysis of variance we found that students with higher physics identity had significantly more stereotyped views of physics. We also found that female students with higher physics identity had significantly more stereotyped views of physics than female students with lower physics identity. Our study suggests that identification with physics may be biased by endorsement of stereotyped views about physics.

Introduction

One of the priorities of the EU for an inclusive growth is to overcome educational and employment gender inequalities by bringing young minds closer to research and innovation [1]. Specifically, there is increasing attention to encourage female students towards STEM (Science, Technology, Engineering and Mathematics) disciplines [2]. Despite such efforts, the gender gap in STEM persists and is fuelled by a complex set of gender stereotypes that affect girls' interest, self-efficacy and, in turn, educational and professional choices [3]. Moreover, young female students may not be interested in STEM careers because of their perception of these subjects as predominantly masculine thus implicitly guided them towards female-dominated careers [4-5]. Recent studies show that one way to deconstruct gender stereotypes in STEM is to foster the development of a disciplinary identity related to the specific field of interest [6]. The identity construct indicates a person's understanding of her/himself and of the others in a context in which she or he is placed [7]. Therefore, in the STEM field, to study the disciplinary identity can be a way to identify possible causes for which girls do not choose STEM careers and to prevent the problem of girls' drop-out in STEM disciplines. However, most of the research so far has investigated stereotyped views about STEM and disciplinary identity in STEM separately. Moreover, no study has yet explored whether the relationship between the two constructs is affected by gender. In this study, we aim at addressing this issue taking physics as example.

Research Questions

The specific research questions were: RQ1) What is the relationship between physics identity and stereotyped views about physics? RQ2) Does the relationship between physics identity and stereotyped views about physics depend on gender?

Methods

We involved $N = 386$ students enrolled in three different STEM undergraduate courses: biology and biotechnologies ($N = 210$); computer science ($N = 81$); physics ($N = 95$). The reason for involving this sample is that the gender distribution is significantly different across these undergraduate courses ($\chi^2 = 88.176$, d.o.f. = 2; $p < .001$). Female students were $N = 205$ (53.1%).

We used two instruments: a 7-item survey to measure physics identity adapted from the literature and a 3-item scale to measure stereotyped views about physics. The reliability of the physics identity scale is excellent (McDonald's omega = 0.92), while the reliability of the stereotyped views about physics scale is good (McDonald's omega = 0.82).

Data were analyzed as follows: we first performed a hierarchical cluster analysis to determine students' physics identity profiles on the basis of the responses to the 7-item survey. Three profiles were extracted: *low identity* (32.6%); *interested in physics but with low perceived recognition* (37.0%); *high identity* (29.0%). The solution was validated by investigating the association with the item: "I see my self as a physics person", $F = 168.099$, d.o.f. = 2; $p < .001$. The associations of the three profiles with gender and type of STEM course attended are both significant: $\chi^2 = 10.227$, d.o.f. = 2; $p < .001$; $\chi^2 = 99.165$, d.o.f. = 4; $p < .001$, respectively.

To answer our first research question, we performed a one-way analysis of variance (ANOVA) with the average score in the stereotyped views about physics scale as dependent variable and profiles of physics identity as independent variable. To answer our second research question, we performed a 2-way between-subjects ANOVA with the average score in the stereotyped views about physics scale as dependent variable and gender and profiles of physics identity as independent variables.

Results

Overall, the average score in the stereotyped views about physics scale was 1.68 ± 0.96 out of 6 for the whole sample. Students in the three physics identity profiles scored significantly different, $F = 4.871$, d.o.f. = 2; $p < .01$. Specifically, the students in the *high identity* cluster had a significantly higher score (1.90), with respect to the students in the *low identity* (1.50) and *interested in physics but with low perceived recognition* clusters (1.66). The 2-way ANOVA shows a significant effect of gender on the stereotyped views about physics average score, $F = 12.159$, d.o.f. = 1, $p < .001$, and of the physics identity profiles, $F = 3.188$, d.o.f. = 2, $p < .05$. The interaction term is not significant.

Conclusions

In this study, we investigated the relationships between physics identity and stereotyped views about physics. We found that students with higher physics identity scored significantly higher than students with lower physics identity. Moreover, we also found that this relationship depends on gender, in particular that female students with higher physics identity scored higher than female students with lower physics identity. Overall, our study suggests that identification with physics may be biased by endorsement of stereotyped views about physics.

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