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Girls vs. gender stereotypes: The real battle in science competitions?

Theoretical background

German females are underrepresented in national selections for science competitions as well as in the German national science competition teams (Köhler, 2017; Lengfelder & Heller, 2002). This underrepresentation could be explained by a significantly lower female interest in participating in science activities compared to males (OECD, 2016) and a lower female interest in physics and chemistry in general (Krapp & Prenzel, 2011). The difference of interest and achievement in science and mathematics between females and males, on the other hand, cannot simply be explained by a difference in talent or natural ability. Both PISA and TIMSS results show that gender differences in science achievement are not consistently in favour of males throughout all participating countries (Martin et al., 2016; OECD, 2016). Gender-specific differences in interests are influenced by many factors, such as parents' gender specific beliefs (Cho & Lee, 2002), teachers' influence, girls' preference of cooperation over competition (Lengfelder & Heller, 2002; Tirri, 2002), lower short-term goals such as winning the competition, more fear of failure, lower self-concept and less self-efficacy (Urhahne, Ho, Parchmann & Nick, 2012).

Most of the above-mentioned factors are directly or indirectly influenced by gender-science stereotypes according to the expectancy-value model of achievement motivation by Eccles, Adler, and Meece (1984; Wigfield & Eccles, 2000; Fig. 1).

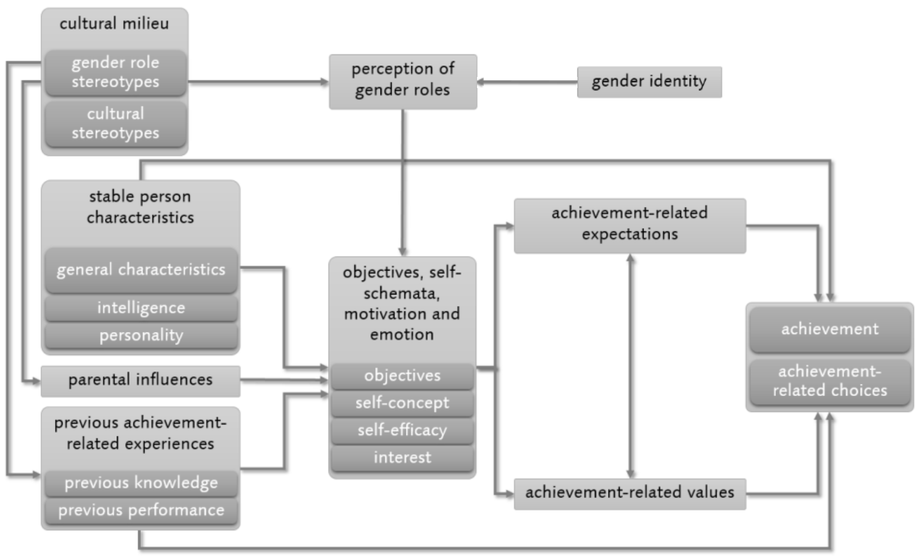

Fig 1. Modified expectancy value model of achievement-related choices (Eccles, 2005). Some concepts are simplified or left out for easier comprehension and the concept 'gender identity' has been added.

The gender-science stereotype is a culturally dependent and extremely common stereotype that portraits males as naturally more talented, interested and therefore better fitting in the fields of science and mathematics. Explicit (self-report questionnaires) and implicit (Implicit Association Test, created by Greenwald, McGhee & Schwartz, 1998) measures have shown that on average, students clearly endorse male-science stereotypes (Nosek, Babaji & Greenwald, 2002; Steffens, Jelenec & Noack, 2010).

Gender identity, parental influences and cultural stereotypes shape a student's gender-science stereotypical beliefs (Eccles, 2005), but students can also use gender-science stereotypes in the process of developing their gender identity. For instance, a young girl can strengthen and demonstrate her feminine gender identity by showing a disinterest in science, a masculine domain (Kessels, 2005; Kessels, Heyder, Latsch & Hannover, 2014). On the other hand, Kessels (2005) found that peers regarded females who are interested in physics as less feminine. These interactions between stereotype and gender identity can be explained by the balanced identity theory (Greenwald et al., 2002; Fig. 2). The principle behind this theory is that two concepts with a shared first order link also have a shared association. The balanced identity theory for gender-science is represented by the interactions between the three concepts 'self', 'gender group' and 'science'. It theorizes that a female endorsing the gender-science stereotype could have difficulty with endorsing her female gender identity or with establishing a positive science science-related self-concept.

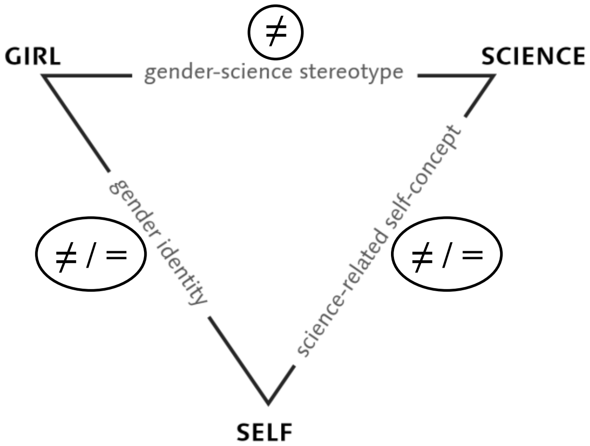

Fig 2. Representation of balanced identity theory for gender-science. The association between the concepts 'gender group' and 'science' is represented by gender-science stereotypical beliefs. Self-science association is an aspect of science-related self-concept. A gender identity is formed through the association between 'self' and 'gender group'. A female with science=male stereotypical beliefs could have difficulty endorsing her female gender identity or have a low science-related self-concept.

Aims

This project aims to investigate the relation between stereotypes and female achievement in German science Olympiads by conducting a longitudinal study amongst participants.

Research aims:

- Characterisation of the relationship between science achievement and science-related self-concept, self-efficacy and interest among participants.
- Characterisation of gender differences in the relationship between gender-science stereotypical beliefs and science-related self-concept, self-efficacy and interest among participants.
- Characterisation of gender differences in the relationship between gender-science stereotypical beliefs, gender identity as well as science-related self-concept, self-efficacy and interest among participants.

The above aims will be investigated for successful versus unsuccessful male and/or female participants and high achieving participants versus high achieving non-participants.

Methods

Participants of the national selections of the International Junior Science Olympiad (IJSO), the International Biology Olympiad (IBO), the International Chemistry Olympiad (IChO) and the International Physics Olympiad (IPhO), and participants of the federal environment competition (BUW) take part in an online survey consisting of five measurement points (MP). MP1 will take place during Olympiad selection round 1, MP2 after the feedback from round 1 but before the start of round 2, MP3 after the feedback from round 2 but before the start of round 3, MP4 after the feedback from round 3 but before the start of round 4, and MP5 takes place after all teams have been to the international competitions and will serve as a follow up.

The expected number of competition participants will be approximately 7000. Even with a 30% response rate, chances are high that a sufficient sample size of 400 students will be reached. The control group will consist of students attending general education schools in science profile classes.

Stable characteristics of the participants such as demographics (i.e. age, gender, etc.) as well as personality traits and intelligence will be collected. A selection of measured concepts important to this particular research is shown in Table 1.

Tab. 1. Concept, measurement time point, scale and source

Concept	*MP*	*# items*	*Source*
subject-specific self-concept	1-5	6	PISA, 2006
explicit gender-science association	1	5	Fennema & Sherman, 1976
implicit gender-science association	1	-	Greenwald et al., 1998
self-gender association	1	4	Schmader, 2002
interest in science activities	1-5	28	Dierks et al., 2014
interest in science activities+context	2	42	Modified from Dierks et al., 2016
subject-specific self-efficacy	1-5	4	Urhahne et al., 2012
support from parents, teachers, peers	1-5	6 x parents; 3 x teachers; 4 x peers	Urhahne et al., 2012

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