

Science Identity Development in Early Physics and Chemistry Classes: A Longitudinal Study

Frederik BUB (1), Thorid RABE (1), Lisa-Marie CHRIST (2), Olaf KREY (2)

(1) *Martin Luther University Halle-Wittenberg, Institute of Physics, Hoher Weg 8, 06120 Halle (Saale), Germany*

(2) *University of Augsburg, Institute of Physics, Universitätsstraße 1, 86159 Augsburg, Germany*

Abstract. The study takes a comprehensive look at students' educational choices from the perspective of identity. German students are surveyed at three points in time during the initial physics and chemistry lessons. We present the study design and then focus on the quantitative findings. Constructs associated with identity are analysed and corresponding scales are validated. Gender proves to have strong influence on physics- and chemistry-specific constructs surveyed. A decline in constructs such as interest and self-efficacy expectations can be observed during early science classes which will be discussed with regard to students' educational choices.

Theoretical Framework and Research Questions

Young people who are faced with educational choices often see science as relevant, but as "not for me" [1]. As a result, educational choices are often made against science [2]. There are findings on numerous individual aspects of these decisions. Identity as an overarching construct that understands educational choices as the product of intrapersonal negotiations (identity work) influenced by the person's social environment allows to take a variety of influences and underlying conditions into consideration [3]. In the BMBF-funded IdentMINT project, the identity construct [4, 5] serves as the analytical perspective for researching students' educational pathways. Methodologically, the identity construct allows both qualitative-narrative approaches (in the sense of identity work) and quantitative approaches (relying on operationalizable constructs like self-efficacy expectations and interest) [3]. A learner's first science lessons in particular can be seen as a critical phase for science identity formation. The project therefore focuses on clarifying how students construct their science identity(ies) when they first encounter subject specific science instruction in physics and chemistry lessons and how these identities develop during this phase (especially in relation to chemistry and physics).

Methods

In accordance with the structure of the identity construct, a mixed-methods approach was chosen, in which questionnaire and interview data were collected from students at three survey points in time (T1-T3). These cover a two-year period with the first formal instructions in physics (T1) and chemistry (T2 and T3) for students aged 11 to 14 in two federal states of Germany. In the following, we focus on the quantitative sub-study of the project and results from the first two survey points in time (T1 and T2 with $n > 850$).

We used established scales to collect data on self-efficacy expectations in relation to physics, chemistry and biology, interest in physics and chemistry, perception of physics and chemistry lessons, extracurricular science activities, aspects of gender identity and the presumed attitudes of significant others (e.g. peers and parents). The used scales are validated using confirmatory factor analysis [6] and tested for measurement invariance [7], a necessary pre-condition for our cross-sectional and longitudinal analyses.

Results on Self-Efficacy Expectations and Interest as Part of a Science Identity

Gender proves to be a significant factor with regard to the expression of self-efficacy expectations [8] in the subjects of physics (Cohen's $d=.48$) and chemistry ($d=.32$), whilst no significant gender differences were found for biology-self-efficacy. A correlation between gender and interest [9] in chemistry ($d=.27$) and physics (T1 $d=.40$, T2 $d=.48$) was found. Beside the increased gender specific differences in interest in physics we were able to identify further significant developments between the survey dates: The interest in physics ($d=.60$) and self-efficacy expectations in physics ($d=1.22$) declined strongly. In contrast, self-efficacy expectations in biology did not change significantly.

Conclusion

Identity as an analytical perspective can provide a comprehensive view of students' educational choices. We were able to clarify quantitative aspects of a science identity with strong subject specific aspects, to determine key influencing factors (such as gender) and to analyse their critical development in initial science lessons. In our presentation, we will also look at other constructs such as the image of science and extracurricular activities and show connections with science capital. However, analysing singular quantitative constructs only allows a limited view of identity work. We therefore provide an outlook on the synthesis with qualitative data from the project.

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