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Pre-service primary school teachers' beliefs about learning and teaching science

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Abstract

Beliefs about learning and teaching are critical components of teachers' professional competence. They have been shown to affect children's learning at school. In particular, constructivism-based beliefs of learning and teaching, in contrast to transmission-based views, are related to a deeper learning. Identifying, evaluating, and challenging teachers' beliefs should thus be an integral part of teachers' professional training and development. This is particularly true for training in science teaching, where teachers are usually faced with students' deep-rooted misconceptions about natural phenomena. The aim of this cross-sectional study was to examine whether and to what extent pre-service primary school teachers change their beliefs about science learning and teaching in the course of their education program, which contains courses specifically designed to challenge such beliefs. Furthermore, we examined to what extent this change depends on their science-specific self-efficacy, content knowledge and general educational level. Our findings revealed significant differences across second-, and third-year students. These differences were related to an increase in beliefs associated with learning as conceptual change on the one hand, and to a decrease in transmission-based views on the other. Interestingly, cohort-specific differences of conceptual-change-based views were significantly moderated by self-efficacy. Furthermore, significant relationships could be found between the students' beliefs and content knowledge. Implications of these findings for teacher education and professional development will be discussed.

Extended Summary

Teachers' beliefs about learning and teaching influence instructional quality. Staub and Stern (2002), for example, found that teachers holding cognitive constructivist beliefs were associated to larger student achievement gains in elementary mathematics. Furthermore, Kleickmann and colleagues (2010) identified relations between primary school teachers' cognitions and their use of scaffolding techniques in science teaching at primary school.

Teachers' beliefs about learning and teaching are considered critical components of the pedagogical content knowledge. This holds especially for science teaching, where teachers are usually faced with students' deep-rooted misconceptions about natural phenomena. Here, an understanding of learning as 'conceptual change' and as an active, self-directed, constructive and social process contrasts with transmission-based views according to which students pick up content presented in the classroom, given that teachers provide sufficient explanations, practice, and reinforcement.

These findings suggest that identifying, challenging, and developing teachers' beliefs about teaching and learning should be an integral part of professional education and development. However, the alteration of teachers' beliefs cannot be seen as a straightforward task. This is particularly true for kindergarten and primary school science teachers as they have only marginal prior science education and low confidence in their science competence (Appleton, 2008).

The aim of this cross-sectional study was to examine whether and to what extent pre-service primary school teacher change their beliefs about science learning and teaching in the course of a teacher education program and to what extent this change depends on their science-specific self-efficacy, content knowledge, and general educational level. We studied pre-service primary school teachers at the University of Teacher Education Central Switzerland. There, courses specifically designed to challenge and develop students' beliefs about science learning and teaching are integrated in the second year of the program.

Research questions

- (1) Do second- and third-year students differ with respect to conceptual-change- and transmission-based views?
- (2) Are cross-cohort differences in conceptual-change- and transmission-based views moderated by science-specific self-efficacy?
- (3) Are students' science-specific self-efficacy, content knowledge, and general educational level related to their conceptual-change- and transmission-based views?

Methods

The sample consisted of 242 prospective primary school teachers (females 89.7%; males 10.3%), whereas 62.0% (N = 150) are second-year students and 38.0% (N = 92) third-year students.

The instrument to measure students' beliefs towards science learning and teaching, which has been developed by Kleickmann (2008), comprises 9 scales, consisting of a total of 47 items. In the present study, only two scales were used: 'conceptual change' (Cronbach's Alpha=0.71) and 'transmission' (Cronbach's Alpha=0.71). Participants were asked to rate the items on a five-point Likert scale. We further assessed science-specific self-efficacy, content knowledge, and general educational level by items, which have been specifically developed for this study.

Results

There were significant differences between the two cohorts with respect to their conceptual-change- and transmission-based views. Third-year students ($M=3.83$, $SD=0.60$) rated conceptual-change-based views higher than second-year students ($M=3.14$, $SD=0.55$): $t(240)=9.086$, $p<.001$, $d=1.22$. Furthermore, third-year students ($M=2.65$, $SD=0.68$) rated transmission-based views lower than second-year students ($M=3.10$, $SD=0.64$): $t(240)=-5.185$, $p<.001$, $d=-0.69$.

Science-specific self-efficacy proved to be a relevant moderator in explaining cross-cohort difference in conceptual-change-based views, $F(1,239)=4.185$, $p<.05$, $r=.26$, but not the difference in transmission-based views, $F(1,239)=0.816$, $p>.05$, $r=.05$. The cross-cohort difference in conceptual-change-based views was larger among students with higher science-specific self-efficacy than among students with low science-specific self-efficacy. Even after controlling for the effect of self-efficacy, there was a significant effect of cohort on agreement to conceptual-change-based views, $F(1, 239) = 85.73$, $p<.001$, *partial eta squared* = .26.

We found a significant relation between students' self-efficacy and conceptual-change-based view: students with above-average self-efficacy gave higher ratings than below-average students ($t(240)=2.019$, $p<.05$, $d=0.26$). No relation was found between students' self-efficacy and transmission-based views. A significant relationship was found between science-specific content knowledge and transmission-based views ($r=-.26$, $p<.001$) as well as between science-specific content knowledge and conceptual-change-based views ($r=.24$, $p<.001$): The better students' content knowledge about science the more they agreed to conceptual-change-oriented items and the less they agreed to transmission-oriented items. Likewise, students having a higher educational level prior to entering university agreed more to conceptual-change-oriented items and less to transmission-oriented items than students with lower educational level ($t(240)=2.315$, $p<.05$, $r=.15$, and, $t(240)=-2.995$, $p<.01$, $r=.19$, respectively).

Discussion

In this study, we found significant differences across cohorts of students of a teacher education program with respect to their beliefs about science learning and teaching. As expected, third-year students showed higher acceptance of conceptual-change-views and lower acceptance of transmission-based views than second-year students. This finding suggests that the prospective primary school teachers shift their beliefs about science learning and teaching toward a more constructivists' orientations in the course of their training. To confirm this finding, we will follow the students longitudinally in a subsequent study.

Interestingly, the alteration of students' beliefs is moderated by their science-specific self-efficacy. This suggests that programs intending to effectively alter beliefs about science learning and teaching need to provide opportunities to strengthen students' confidence in their own science learning and teaching capabilities.

Finally, the obtained relation between beliefs about science learning and teaching and science-specific content knowledge as well as general educational level confirms previous research findings indicating that pedagogical content knowledge is inseparably connected to content knowledge (Baumert et al., 2010).

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