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Pre-service teachers' beliefs and attitudes about teaching in inclusive mathematics settings

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Research on subject-matter specific programs for inclusive teacher education is still of great importance. Beyond concept development and research on cognitive development, pre-service teachers' beliefs and attitudes are of major interest. The paper reports first on the project ProViel ('Professionalisierung für Vielfalt' – 'professionalisation for diversity') and presents its aims and objectives. Afterwards, we focus on pre-service teachers' affective attitudes about teaching in inclusive mathematics settings before and after a course on learning mathematics with substantial learning environments, and compare the findings concerning inclusive teaching in mathematics and in other subjects. The results show that the pre-service teachers in average feel more optimistic and comfortable than pessimistic and uncomfortable while thinking about teaching mathematics in inclusive settings. This neutral to positive position hardly changed having completed the course.

Keywords: Pre-service teacher education, inclusive education, beliefs, attitudes.

Introduction

Coping with heterogeneity in inclusive settings requires specific competencies of teachers (cf. Scherer, 2019a). Teacher education has to prepare prospective teachers for these challenges, and research is needed especially for subject-matter specific programs. Several studies concentrate on conceptual and developmental work with relevant accompanying research. Apart from content-related objectives teacher education programs have to address pre-service teachers' adequate attitudes and beliefs towards inclusion. In connection with this, investigations of pre-service teachers' competencies and competence development as well as their attitudes and beliefs are of great interest. The following paper will focus on the latter one.

Beliefs and attitudes about inclusive mathematics

Knowledge about pre-service and in-service teachers' attitudes about inclusive (mathematics) teaching is of great interest because a successful implementation of inclusion seems to be dependent on teachers having positive attitudes about inclusion (e. g. Avramidis & Norwich, 2002; Ruberg & Porsch, 2017). There are also first hints concerning effects of positive attitudes about inclusion on important practices and strategies in inclusive teaching (cf. Forlin et al., 2011). Research on beliefs and attitudes about inclusion focuses, for example, on factors that might influence teachers' beliefs and attitudes about inclusion (e. g. Kunz et al., 2021; Ruberg & Porsch, 2017) or how these beliefs and attitudes can be captured via questionnaire (e. g. Ewing et al., 2018).

Traditionally, three components of attitudes can be distinguished: cognitive, affective and behavioral attitudes (Rosenberg & Hovland, 1960; Eagly & Chaiken, 2011), whereby attitudes are defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 2011, p. 11). This tendency or, in terms of Rosenberg and Hovland

(1960), these predispositions, are not directly observable, but the types of response which seem to be indicators of attitudes can be distinguished along the three mentioned categories. While the cognitive and behavioral components of attitudes concentrate on thoughts about and people's actions with the attitude object, "the *affective* [emphasis from original] category consists of feelings or emotions that people have in relation to the attitude object" (Eagly & Chaiken, 2011, p. 10).

The affective component is comparatively less subject of research, although this component seems to be of special interest concerning inclusive teaching (Seifried, 2015). Studies which investigate this component often conceptualize affective attitudes through teacher feelings about the practice of inclusive education or concerns about it (Ewing et al., 2018) as well as teachers' positive expectations of inclusion (Seifried, 2015). First results show that teachers fear being overwhelmed by inclusion or that they might not meet every students' needs (Seifried, 2015). However, teachers also express positive expectations of inclusive education for all students, like their social interaction and learning from each other (Seifried, 2015).

Mostly, this previous research does not consider specific school subjects – a research gap we focused on within our project 'Mathematics Inclusive' (see next section). In different contexts the assumption comes up that it is more difficult to teach mathematics in inclusive settings than other subjects, for example, because of the specific structure of mathematics, but this can exactly be a starting point for individual and joint learning in mathematics for all students (cf. Seitz et al., 2020). Therefore, we are interested in pre-service teachers' affective attitudes about inclusive teaching especially in mathematics but also in comparison to other subjects.

The project 'Mathematics Inclusive' within the project ProViel

The project ProViel 'Professionalisierung für Vielfalt' ('Professionalisation for Diversity'; <https://www.uni-due.de/proviel/>) at the University of Duisburg-Essen is funded by the Federal Ministry of Education within the frame of a program for teacher education (1st phase: 2016–2019; 2nd phase: 2019–2023). Numerous university departments are involved to ensure the development of a coherent conceptual program for teacher education. One field of action is 'Diversity & Inclusion', and several sub-projects might cover the wide facets and dimensions in this field (cf. Bishop et al., 2015; Good & Brophy, 2008). One of the sub-projects, 'Mathematics Inclusive', aims at implementing subject-specific concepts and modules for inclusive mathematics education, following a design-based research approach (Scherer, 2019b).

The developmental work firstly concentrated on the course 'Learning Mathematics with Substantial Learning Environments (SLEs)' (3rd year, BA-program for primary mathematics). The didactical concept of working with SLEs, and by this realizing a natural differentiation is in line with a constructivist understanding of teaching and learning, and has been proved to be suitable for heterogeneous learning groups in primary mathematics (cf. Krauthausen & Scherer, 2013; Scherer & Krauthausen, 2010). The course lays theoretical foundations with respect to SLEs and natural differentiation and gives examples for planning SLEs as well as analyses of concrete lessons. Moreover, the pre-service teachers have to plan clinical interviews for a chosen SLE, carry out these interviews in school and analyze the interviews according to selected focal points.

The design process for this course started in 2016, and the first course has been running during the winter semester 2016/17, followed by the three repetitions during the winter semesters 2017/18, 2018/19, and 2019/20. All courses were evaluated, and data collection comprised questionnaires (pre-post-design), selected interviews, as well as field notes. The following section will report some former results with respect to pre-service teachers' pre-experiences and competence development with respect to inclusive mathematics. After that the research question focused in this paper as well as the used methods for investigating pre-service teachers' affective attitudes will be reported.

Previous results

For data collection with respect to pre-service teachers' individual pre-experiences with inclusive mathematics an open item "*Which experiences have you made so far with inclusion in mathematics instruction?*" was used within an extensive questionnaire (see also section research question and methods). Written comments showed that only about 50 % of the pre-service teachers have made school-related-experiences whereas the others had no experiences, made experiences out of school or in other fields (see Scherer, 2019a). In many cases, specific experiences for mathematics were related to *differentiated learning offers* and forms of *inner* or *outer differentiation*. Experiences that are of great importance for the course concept 'Learning Mathematics with SLEs', as the pre-service teachers' experiences and classroom observations represent a quite different teaching concept than the university course (Scherer, 2019a).

Moreover, for measuring pre-service teachers' competence development the post-test included six items for a retrospective self-assessment (cf. Nimon et al., 2011). At the end of the course, participants had to rate their competencies 'before the course' and 'today'. These items were designed according to the curriculum objectives focusing on substantial learning environments, clinical interviews and analyses of students' thinking and learning processes. The pre-service teachers had to rate their competencies for these three aspects on the one hand in general, on the other hand concerning the relevance for inclusive mathematics. The differences of the retrospective self-assessment before/after the course showed high significances with all items (for all items $p < .001$; Cohens $d > 0.8$; for detailed analysis see Scherer, 2021). Looking at all items, the results show important developments of pre-service teachers' competencies and beliefs. With regard to the pre-experiences of the majority that differ from the course conception (Scherer, 2019a), these findings are of great importance.

Research question and methods

Beyond central research questions with respect to course design and pre-service teachers' competence development (cf. Scherer, 2019b; 2021), this paper will focus on the following research question:

Which changes of pre-service teachers' attitudes and beliefs can be identified after they had completed a course that addresses inclusive mathematics?

To answer the research question, a standardized questionnaire was used in a pre-post-design, filled in by about 240 participants. The questionnaire contains items concerning attitudes and beliefs with respect to inclusion and inclusive mathematics (cf. Meyer, 2011), and one of the questions was, if and how pre-service teachers' attitudes and beliefs changed after completing the course. A bipolar scale with five pairs of adjectives (by Meyer, 2011) was used that allows the pre-service teachers to

rate how they feel about teaching in inclusive mathematics settings (Figure 1). The participants did answer this question before and after the course with respect to inclusive mathematics teaching, as well as on how they feel about teaching in inclusive settings in other subjects than mathematics.

How do you feel about the thought of teaching MATHEMATICS in an inclusive class? Please mark the box (1 = very anxious to 7 = very relaxed) that describes your feelings best.								
	1	2	3	4	5	6	7	
anxious	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	relaxed
helpless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	self-confident
burdened	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	unburdened
pessimistic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	optimistic
uncomfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	comfortable

Figure 1: Question for capturing pre-service teachers' affective attitudes

Results

Pre-service teachers' affective attitudes can be described as follows: They feel neither anxious or relaxed, helpless or self-confident and burdened or unburdened, as they answered in average with a neutral position between the opposite pairs (Table 1).

Table 1: Pre-service teachers' affective attitudes about teaching mathematics in inclusive settings (1 = very anxious and 7 = very relaxed; N = 241)

	1	2	3	4	5	6	7	mean
anxious/relaxed	2 %	5 %	16 %	32 %	27 %	17 %	2 %	4.37
helpless/self-confident	2 %	10 %	19 %	30 %	24 %	13 %	2 %	4.12
burdened/unburdened	3 %	12 %	31 %	27 %	14 %	11 %	2 %	3.79
pessimistic/optimistic	2 %	3 %	8 %	17 %	27 %	29 %	14 %	5.10
uncomfortable/comfortable	1 %	1 %	5 %	29 %	29 %	22 %	11 %	4.96

However, in average they feel more optimistic and comfortable than pessimistic and uncomfortable while thinking about teaching mathematics in inclusive settings. Although it seems as if pre-service teachers feel quite neutral to positive about inclusive mathematics teaching, there are also more than just a few pre-service teachers who seem to be burdened (46 %). This facet of affective attitudes is also the most negatively one in Meyer's (2011) study. The in-service teachers, asked in that study, answered quite similar, with feeling burdened (67 %). Maybe teachers in their everyday practice face the challenges of inclusive mathematics teaching even more than pre-service teachers, as the percentage of teachers being burdened is even higher than the percentage of pre-service teachers feeling burdened. Additionally, pre-service teachers seem to feel more positive than the in-service teachers in Meyer's study did concerning the other facets of affective attitudes.

With respect to our research question (see section research question and methods), we figured out that pre-service teachers' affective attitudes hardly changed over the semester, having completed the SLE-course. In average, at the end of the semester they still feel neutral to positive about teaching mathematics in inclusive settings (Table 2). However, our analysis showed one significant result for the pre-post-comparison in the opposite pair pessimistic/optimistic. Participants still feel optimistic about teaching mathematics in inclusive settings but significantly less optimistic than before the course. Possibly, the pre-service teachers experienced challenges within the course while working with the pupils they did not experience before, which made them feel less optimistic than before.

Table 2: Pre-service teachers' affective attitudes about teaching mathematics in inclusive settings after the course (1 = very anxious and 7 = very relaxed; N = 240 to 241¹; *p < 0.05)

	1	2	3	4	5	6	7	mean
anxious/relaxed	1 %	6 %	20 %	34 %	26 %	11 %	3 %	4.23
helpless/self-confident	2 %	6 %	17 %	34 %	27 %	12 %	3 %	4.26
burdened/unburdened	3 %	12 %	30 %	29 %	17 %	7 %	2 %	3.72
pessimistic/optimistic	1 %	2 %	10 %	24 %	27 %	25 %	11 %	4.93*
uncomfortable/comfortable	1 %	1 %	10 %	28 %	34 %	20 %	7 %	4.80

Comparing pre-service teachers' attitudes between teaching mathematics and other subjects in inclusive settings showed the following results: Their affective attitudes about teaching other subjects in inclusive settings are slightly more positive than about teaching mathematics when focusing on the average of pre-service teachers' answers (Table 3). This means, that pre-service teachers in average feel more relaxed, more self-confident, more unburdened, more optimistic and more comfortable about teaching other subjects compared to mathematics in inclusive settings. Although this is just a descriptive result (if all numbers were rounded to integers, there would be no visible difference), it seems to be a result consistent with the assumption that it might be more difficult to teach mathematics in inclusive settings than other subjects (see section beliefs and attitudes; cf. Seitz et al., 2020). However, concentrating on the average does not seem to be very informative with regard to differences and similarities in pre-service teachers' attitudes about teaching mathematics and other subjects in inclusive settings. Therefore, we analyzed how often they do feel exactly the same, i. e. how many participants crossed out exactly the same for teaching mathematics and other subjects in inclusive settings. It turned out that between about 73 % (helpless/self-confident) and about 79 % (uncomfortable/comfortable) feel the same about teaching in inclusive settings no matter if they think about mathematics or other subjects. Nevertheless, some pre-service teachers see even big differences between teaching mathematics or other subjects in inclusive settings. Single participants even feel

¹ N = 240 for helpless/self-confident, N = 241 for all other opposite pairs

(very) burdened with respect to teaching mathematics but (very) unburdened with respect to teaching other subjects in inclusive settings. However, also the other way round could be identified, i. e. single participants who feel burdened with respect to teaching other subjects but unburdened with respect to teaching mathematics in inclusive settings.

Table 3: Pre-service teachers' affective attitudes in comparison of teaching mathematics or other subjects in inclusive settings (1 = very anxious and 7 = very relaxed)

	means before the course		means after the course	
	mathematics	other subjects	mathematics	other subjects
anxious/relaxed	4.37	4.46	4.23	4.39
helpless/self-confident	4.12	4.3	4.26	4.40
burdened/unburdened	3.79	3.93	3.72	3.93
pessimistic/optimistic	5.10	5.13	4.93	4.98
uncomfortable/comfortable	4.96	5.01	4.80	4.88

A pre-post-comparison did not show significant changes in pre-service teachers' affective attitudes about teaching other subjects in inclusive settings after they had completed the SLE-course. This might not be surprising because the course on SLEs especially focused on teaching mathematics in inclusive settings.

Discussion and conclusions

In total, results of the project 'Mathematics Inclusive' show that the underlying didactical concept of using SLEs and realizing a natural differentiation is suitable for inclusive classrooms. Moreover, the course concept with the combination of theoretical elements, concrete video examples and pupils' documents (lecture) and practical experiences (interviews at school) with a common reflection (seminar) could reach the mentioned project objectives (see Scherer, 2019b; 2021). However, only a few changes of pre-service teachers' attitudes and beliefs could be identified after they had completed the course (whereby participants still feel optimistic about teaching mathematics in inclusive settings but significantly less optimistic than before the course; see section results). On the one hand, it might be interesting to further develop the concept of the course in a way that pre-service teachers' emotions and feelings are going to be more in focus – especially the ones of pre-service teachers' who associate quite negative feelings about teaching mathematics in inclusive settings. On the other hand, beliefs and attitudes might not change within a course which lasts for one semester. Therefore, it would be interesting to analyze their beliefs and attitudes after a longer period of time.

Future research within the project will focus on a connection between pre-service teachers' pre-experiences with inclusive mathematics (see section previous results) and their beliefs and attitudes. For example, it could be interesting to compare their affective attitudes depending on their

experiences (especially, because experiences seem to be an important factor that might influence pre-service teachers' beliefs and attitudes about inclusion (cf. Ruberg & Porsch, 2017)).

At the moment, the used items of the questionnaire for investigating pre-service teachers' affective attitudes take into account teaching mathematics in a class as a whole. It could be interesting to ask for pre-service teachers' affective attitudes in a narrower way, like we did for analyzing their competence development. For example, it could be focused on their feelings concerning interviews with pupils or planning and using SLEs in classroom. As pre-service teachers' feel a bit less optimistic after the course, interviews are planned to gain deeper insights in their affective attitudes. Possibly, the practical experiences within the course did lead to a less optimistic view because they experienced and might assess the specific requirements of inclusive mathematics teaching now more realistic. The differences and similarities concerning teaching mathematics or other subjects in inclusive mathematics could also be analyzed in more detail, if interviews were conducted.

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