



# Shine a spotlight on the preparatory service within science teacher education in Germany: A systematic review

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**Citation:** Doil, M., & Pietzner, V. (2023). Shine a spotlight on the preparatory service within science teacher education in Germany: A systematic review. *European Journal of Science and Mathematics Education*, 11(3), 475-487. <https://doi.org/10.30935/scimath/12980>

## ARTICLE INFO

Received: 21 Oct 2022

Accepted: 19 Feb 2023

## ABSTRACT

Due to the lack of success of German students in recent program for international student assessment (PISA) studies since 2001, the question arises whether German teacher training has an impact on this performance. This publication is based on a systematic review which deals with German-language publications of various PISA-relevant areas within the preparatory service in Germany. The results show that there is a clear need for action in the areas of scientific literacy, nature of science as well as media and information literacy. In addition, the structure of the preparatory service as well as the psychological stress of prospective (science) teachers in Germany are explained in more detail. Despite being limited to German publications and individual competencies of PISA surveys, the study identifies a need for action for the German preparatory service. The aim of this publication is to provide a basic description of the German preparatory service in relation to science teacher education to compare German teacher education with better performing teacher training according to PISA.

**Keywords:** Germany, preparatory service, science education, systematic review, teacher education

## INTRODUCTION

The completed program for international student assessment (PISA) studies show that despite extensive educational reforms, Germany has not been able to match the performance of the countries leading PISA rankings. The short-term positive development within the field of science has declined again since 2015 (Reiss et al., 2019). The last PISA rankings in 2018, showed that 19.6% of German students were below proficiency level II in science (Reiss et al., 2019). These developments suggest that the results are not only dependent on the core curriculum and students, but also in particular on teachers. Since teachers are responsible for teaching the competencies which are collected, it seems appropriate here to investigate to what extent PISA-relevant competencies are taught in teacher education. As current educational policy decisions for teacher education are based partially on the past results of the PISA study, this publication highlights various aspects from the previous PISA rankings and their implication for teacher education in Germany. This publication refers to the second phase of German teacher education—the preparatory service.

The preparatory service in Germany is an integral part of teacher education (Kultusministerkonferenz, 2012, 2019a, 2019b). Without passing the preparatory service, prospective teachers are not allowed to teach in state schools (Kultusministerkonferenz, 2012). This publication aims to present the various facets of the preparatory service, especially in relation to the education of prospective science teachers. Within this context, the aim is to clarify problems concerning the teaching of PISA-relevant competencies. The following firstly provides an overview of teacher education as well as the associated difficulties in Germany.

Subsequently, the preparatory service is analyzed based on PISA-relevant competencies like scientific literacy (OECD, 2021), nature of science (Allchin, 2013; McComas, 1998, 2013), or media and information literacy (Grizzle et al., 2021). Here, German-language literature is used to provide a basis for subsequent work. The results show that the German preparatory service needs to be improved, especially in the areas relevant for (prospective) science teachers.

### German Teacher Education

The German teacher education system differs in many respects in comparison with other countries (Klusmann et al., 2012). This applies not only to school education, which can generally be divided into primary school, lower secondary school, and upper secondary school, but also to teacher education. In the first instance, it should be pointed out that in Germany all educational issues are organized federally by the respective federal states. This allows for the establishment of a nationwide standard for all educational goals, the Kultusministerkonferenz (Standing Conference of the Ministers of Education and Cultural Affairs) issues general guidelines that are to be implemented by all federal states (Autorengruppe Bildungsberichterstattung, 2020).

Within teacher education, there are also further differences compared to other countries. Teacher training in Germany is divided into three different phases (Kultusministerkonferenz, 2019a, 2019b). The first phase of teacher education consists of a university study program and practical phases included therein which has been thoroughly elaborated on in a paper by (Doil et al., 2022). This paper focuses on the second phase of teacher education in Germany, the preparatory service, which follows the study program and finishes with the so-called "state examination". During this period, prospective teachers receive both practical training in schools, through job shadowing and their own teaching, as well as in-depth theoretical training in the basics of teaching in teaching seminars. This phase is intended to link the knowledge acquired during the study program with the working world of the school system (Berndt et al., 2017; Fütterer, 2019).

The duration of the preparatory service amongst federal states in Germany varies between 12 and 24 months (Kultusministerkonferenz, 2019a, 2019b). During this phase, the prospective teachers are mainly trained in two locations. The main part of the training period is spent at school, where the prospective teachers observe the lessons of their mentors and colleagues and teach on their own. In addition to classroom activities, prospective teachers also participate in the daily life of the school, including attending conferences, participating in school development, and actively working with parents (Kultusministerkonferenz, 2012). In addition to the training offered within the school, the prospective teachers take part in several teaching seminars over the entire period of the preparatory service outside the school. This allows for the coverage of pedagogical and subject-specific training amongst prospective teachers (Abs & Anderson-Park, 2020; Dzengel, 2016; Kastens et al., 2020).

These teaching seminars are initiated by the Ministry of Education and their own staff, the so-called teacher trainers. These teacher trainers are also teachers at school, but part of their work involves giving teaching seminars according to a fixed curriculum and observing the prospective teachers' lessons. They give advice, rate the quality of teaching, and they also assign the grades for the state exam at the end of the preparatory service (Eghtessad, 2014). The hourly volume of the teaching seminars varies greatly between the federal states, as the examples of Rhineland-Palatinate with 129 hours and Schleswig-Holstein with 360 hours show (Abs & Anderson-Park, 2020). Expanding on these two sub-aspects, the prospective teachers were visited in their lessons by the teacher trainer of the individual subjects. How often these visits take place and whether they are included in the final grade depends on the federal state (Kultusministerkonferenz, 2012).

The goal of all sections of the preparatory service is to continuously develop the teaching skills of the prospective teachers (Berndt et al., 2017; Fütterer, 2019). To pursue this goal even further, the prospective teachers must prepare a portfolio (Fütterer, 2019) over the duration of the preparatory service and write a term paper on science education or educational theory. As the current state of teacher training shows, mentors are only specially prepared for their task in some federal states (Kultusministerkonferenz, 2021).

The scope of the examination and the interplay of the practical and theoretical components vary between the individual federal states. The third phase of teacher training takes place after the teacher work placement

and is characterized primarily by in-service training courses. This particular phase falls outside of the scope of this study and will therefore not be described.

### Current educational policy in Germany

For some years now, German education policy has had to deal with an ever-increasing shortage of teachers. The extent of this shortage varies among the 16 German states, but in all states, it mainly affects the STEM subjects (Lucksnat et al., 2020). STEM subjects are regarded as subjects such as biology, chemistry, and physics. In order to provide the best possible teaching in these subjects, the Standing Ministry of Education and Cultural Affairs issued “special measures to attract teachers to supply teaching” in 2013 (Kultusministerkonferenz, 2013). These special measures are aimed at students who have not completed a teaching study program but a science-related study program. They are offered the opportunity to enter the teaching profession if they have completed a study program with a master’s degree that is close to or identical to a teaching subject. A rough distinction is made between two types, although this distinction does not exist in all federal states.

In the first instance, there is the “short-term” lateral entry (Seiteneinstieg), which is usually not related to completion of the preparatory service. This is used in most federal states to cover the shortage of teachers in the short term (Freiling, 2021). The lateral entry program can be started at the beginning of a school semester. In addition, there is a “long-term” lateral entry (Quereinstieg), which is always accompanied by an additional qualification (Richter & Marx, 2019). In most federal states, lateral entrants must also complete the preparatory service. Therefore, the long term lateral entry starts at the same time as the preparatory service. From 2013 to 2018, the share of lateral entrants increased from 2% to more than 13% (Lucksnat et al., 2020) and this particular trend is continuing. It is, therefore, also necessary to consider this marginal group as they are becoming increasingly relevant. Due to the rather limited data available, this publication mainly looks at the “long-term” lateral entry (Quereinstieg).

### Research Questions

The aim of this study is to work the difficulties within the German preparatory service. In order to respond to this particular aim, the following two research questions were considered.

1. How is the teacher preparation service structured in Germany?

Since the system within Germany is already so multifaceted, the first question aims to provide an overview of the structure of the preparatory service. In doing so, commonalities as well as the most significant differences between the federal states will be outlined.

2. How are the teacher competencies required by PISA implemented in the teacher preparation service in Germany?

Based on the structural facets of the preparatory service within Germany, it will then be examined to what extent the competencies demanded in the PISA survey are included in this phase of German teacher education. The relevance of this can be seen in the results shown in past PISA studies (Reiss et al., 2019). Since teachers can only teach the competencies that they have learned themselves, the teaching of PISA-relevant competencies is also of great importance for future teachers. The goal of this review is to identify potential for improvement in the organization as well as in the content taught, so that the preparatory service appears more effective and, if possible, affordable for more prospective teachers. It must be pointed out here, however, that in contrast to the teacher study program at university, hardly any research publications for the preparatory service can be found (Abs & Anderson-Park, 2020).

## MATERIALS AND METHOD

### Process

To address the questions we have just raised, a systematic review was conducted in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement (Butler et al., 2016; Liberati et al., 2009; Petticrew & Roberts, 2006; Zawacki-Richter et al., 2020). Here, an intermediate step not presented in the literature was implemented in advance. In this step, all official decrees of the Standing

**Table 1.** Categories and subcategories

Category	Subcategory
Scientific literacy	Use of scientific knowledge to identify questions
	Acquire new knowledge
	Explain scientific phenomena
	Draw evidence-based conclusions about science-related issues
	Research-based learning
Nature of science	Communication about science
	Creativity
	Variety of scientific methods
	Social/-cultural impact
	Theory and scientific law
	Observation and conclusion
	Changeability of scientific knowledge
Media & information literacy	Equipment at school
	Use of digital devices
Career motivation	Self-efficacy expectation
	Professional motivation
	Stress experience
Structural analysis	Federal states
	Duration
	Workload

Conference of the Ministers of Education and Cultural Affairs and of the individual federal states concerning the preparatory service were analyzed. The analysis showed differences both in the temporal scope and in the organization of the examination of the preparatory service. This gave further impetus to continue to investigate its content-related structures.

A total of seven experts from the field of science education were asked to participate in the review process. All reviewers hold at least a PhD in their field or a professorship. All reviewers remained anonymous for the duration of the review to avoid collusion. The reviewers were sent an Excel sheet with the title, author, publisher, and abstract of the publications. In addition, all reviewers received a list of criteria, which will also be presented during this chapter. Since one reviewer did not report back in the long term, the publication sent to her was validated orally within the working group.

For the review, a total of 42 publications were collected with the help of extensive online research. The following search terms were used for this research: Vorbereitungsdienst [preparatory service], Referendariat [trainee teacher], Lehrerbildung [teacher education], Lehrerausbildung [teacher training], naturwissenschaftliche Lehrerausbildung [science teacher training], PISA Kompetenzen [PISA competencies].

All publications that contained the above-mentioned search terms in the title or abstract were collected. The search was limited to German-language publications to systematize the terms that are not clearly defined in Germany and to show where there are gaps in German-language educational research that could potentially have an influence on German educational policy. The research was conducted in September 2021 and the review process continued until April 2022. In total, 24 publications were finally selected for this review. The final 24 publications were analyzed using the category system presented below. The analysis was performed using MaxQDA 2022. As already mentioned, hardly any publications can be found on the preparatory service (Abs & Anderson-Park, 2020).

## Concepts

For the review process, a guideline was drafted for the reviewers to justify their decisions. First, all publications should have been published after 2004. In addition, the publications derive from the field of science teacher education. Other publications centered around mathematics teacher education. To provide a more comprehensive overview of the preparatory service, publications from the educational sciences were also permitted. From these publications multiple research designs and forms of data were accepted and acknowledged. Given this background, a total of five main categories with several subcategories were defined, which are briefly introduced below and presented in [Table 1](#).

**Table 2.** Quantity of categories

Category	Scientific literacy	Nature of science	Media & information literacy	Career motivation	Structural analysis
Quantity	4	3	0	14	17

A closer look at the table suggests that only the first three categories target PISA-relevant competencies. In the first instance, it will be examined whether and how the concept of scientific literacy is dealt with in the preparatory service. Here, we refer to the definition of the OECD: “Scientific performance, for PISA, measures the scientific literacy of a 15-year-old in the use of scientific knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related issues. The mean score is the measure” (OECD, 2021).

Extending the concept of scientific literacy, the concept of nature of science will also be reviewed. Here, the work of Allchin (2013) and McComas (1998, 2013) is used as a basis and appropriate subcategories are formed according to their definitions. The last PISA-related competence to be examined is Media and Information Literacy, as defined by UNESCO (Grizzle et al., 2021). This involves both the equipment of the individual institutions in which the preparatory service takes place and the thematization of digital media in the classroom and the active use of these.

In addition to these three concepts, the self-concept of the prospective teachers will be examined under the umbrella term “career motivation”. This includes any experiences of stress as well as the professional development of the teacher persona. Finally, in order to embed all the previous concepts in the preparatory service, the structure of the preparatory service itself will be analyzed. The 24 final publications which can be categorized more than one time can be assigned to the categories as found in [Appendix A. Table 2](#) outlines the distribution of the publications briefly.

## RESULTS

In the following two sections, the results of the review are presented in detail and categorized based on the concepts. A distinction is made here between regular preparatory service and “long-term” lateral entry.

### Preparatory Service

The abrupt transition from the study program to the preparatory service and the structure of the preparatory service is associated with increased demands that are seemingly difficult to cope with. Empirical findings point to an emotional exhaustion of the trainee teachers (Drüge et al., 2014; Dzengel, 2016; Klusmann et al., 2012; Košinár, 2014). This emotional exhaustion increases statistically significantly, especially within the first year of the preparatory service, resulting in a high dropout. In this context, various factors should be emphasized and are evaluated in the literature as a negative influence.

First, the study seminar, which, unlike the university or the training school, does not have a clearly defined content framework. Since the teacher trainer takes on both an advisory and an assessment role, it is difficult for most prospective teachers to entrust them with all questions and problems that arise during teaching. Furthermore, the prospective teachers themselves take on an ambiguous role; while in most schools they are treated as members of the staff, they take on the role of trainees within the study seminar. In addition, there is a lack of coordination between the schools and the teaching seminars, unrealistic goals are set and, above all, the prospective teachers are overwhelmed by, for example, the scope and diversity of the requirements (Abs, 2013; Abs & Anderson-Park, 2020; Drüge et al., 2014; Dzengel, 2016; Kastens et al., 2020; Schulte, 2008). Particularly noteworthy here is the classroom observation, where prospective teachers in the preparatory service spend almost ten times as long on preparation as for a normal school lesson, adapted to the individual assessment standards of the teacher trainer (Kastens et al., 2020). Schulte (2008) describes the condition of success for the preparatory service as the success in establishing a functioning and trusting relationship with the persons involved in training.

The categories scientific literacy and nature of science will be considered together in the following section since data on these categories is very limited as shown in [Table 2](#). First, it can be stated that both concepts are defined in educational policy as useful and necessary for science education (Billion-Kramer et al., 2020). In this regard, Billion-Kramer et al. (2020) find that prospective science teachers have only slightly higher

professional knowledge about Nature of Science than prospective teachers from other subject areas. This raises the question of whether Nature of Science is sufficient to distinguish an adequate understanding of science from other disciplines. In addition, it was found that the existing content knowledge among prospective teachers depends to a great extent on the type of school they are aiming for. In addition, there is barely any measurable increase in the pedagogical content knowledge during the time of the preparatory service (Mutke, 2017; Oettinghaus, 2016). Based on the data set of literature selected for the review, no conclusions can be drawn regarding media and information literacy.

In the category of career motivation, the main publications that can be found are on the self-efficacy expectations of prospective teachers as well as on the professionalization process during the preparatory service. Three different orientations can be identified for the professionalization understanding of the individual prospective teachers: restrictive professionalization understanding, developmental professionalization understanding, and the external expectation-centered professionalization understanding (Košinár, 2014). Here, a clear connection between the individual's understanding of professionalization and their fit in the professional field of school could be identified. A higher level of emotional exhaustion, which has already been described, occurs above all in prospective teachers who can be assigned to the group of professionalization understanding centered on external expectations (Abs & Anderson-Park, 2020; Kastens et al., 2020; Košinár, 2014). In the worst case, this emotional exhaustion can lead to mental illnesses such as burnout (Zimmermann & Klusmann, 2016). Here, no correlation between knowledge aspects and the satisfaction of the prospective teachers can be found. In addition, there is no statistically significant correlation between previous pedagogical knowledge and emotional exhaustion. In summary, it can be stated in this area that the prospective teachers in their preparatory service exhibit emotional exhaustion like teachers who have already been in the profession for 20 years (Kastens et al., 2020).

Both the cooperation with the mentors and the exchange with other teachers in the preparatory service are cited as beneficial effects for professionalization. Three different forms of support provided by the two groups mentioned can be identified: informal, instrumental, and emotional support. The latter seems to alleviate emotional exhaustion among preparatory service teachers. The prerequisites for the positive effects mentioned are first and foremost a positive working atmosphere, a good relationship of trust and, in the area of professional development, professionally competent colleagues (Abs & Anderson-Park, 2020; Berndt et al., 2017; Kastens et al., 2020; Richter et al., 2011).

In addition to the personal prerequisites for professionalization, the literature repeatedly points out that both feedback and reflection are emphasized as learning opportunities for prospective teachers (Bellenberg et al., 2020; Kastens et al., 2020). Reflection on one's own actions in the classroom is seen as an essential factor in building and sustaining professional action. Therefore, reflection on one's own actions is placed in the focus of classroom discussions, both with mentors, the school administration, and with the teacher trainer. The goal is to analyze the lessons discursively based on one's own observations and to reflect on one's own actions (Abs & Anderson-Park, 2020; Bellenberg et al., 2020). The feedback provided by the teacher trainer and the mentors can be used by the prospective teacher to build on their reflection. Here, it becomes apparent that the self-efficacy expectations of the prospective teachers have an influence on the perception of the feedback from the teacher trainer.

Prospective teachers in the preparatory service who already have a pronounced self-efficacy expectation view the feedback given to them the teacher trainer more positively (Kastens et al., 2020; Košinár, 2014). The mentors have a great influence on both aspects mentioned. As already shown, the mentors' actions can have a positive influence on the experiences of stress as well as on the self-efficacy expectations of the prospective teachers. In this context, the quality of the training within the school is very much dependent on the mentor's commitment. In this respect, the individual experience of stress as well as the personal self-efficacy expectation play a major role in addition to the professional training or further training as a mentor. The latter two factors have been shown to have a significant influence on the training of the prospective teachers. Based on this, the prospective teachers consider the amount of time spent on mentoring to be too short and the depth of content to be insufficiently differentiated (Berndt et al., 2017; Kastens et al., 2020; Richter et al., 2011).



## Lateral Entrance

In general, the Standing Conference of Ministers of Education and Cultural Affairs emphasizes the need to recruit new teachers (Kultusministerkonferenz, 2013). Due to a steadily increasing shortage of teachers and the need to cover classes, various groups of people have been recruited to work in schools in recent years. In addition to hiring already retired teachers or (student) teachers, academics from other fields are also being hired (Bellenberg et al., 2020). These are referred to as lateral hires or lateral entrants. As described in the introduction, a clear distinction between the two terms is difficult to make due to differences in implementation within the federal states. Roughly speaking, lateral hires (Seiteneinsteiger) do not complete a teaching traineeship in most federal states and tend to be hired to cover teaching in the short term. Lateral entrants (Quereinsteiger), on the other hand, are supposed to cover teaching in the long term and therefore undergo a preparatory service or similar training provided by the school. The structure of the preparatory service for these individuals differs between the federal states. In general, most lateral entrants come from the natural sciences and are expected to cover STEM subjects (Bellenberg et al., 2020; Lucksnat et al., 2020; Oettinghaus et al., 2011; Richter & Marx, 2019). When the lateral entrants have successfully completed the preparatory service, the federal states are obligated to offer them a job. The type of school at which the lateral entrants are employed depends on the needs of the respective federal state (Lucksnat et al., 2020).

## DISCUSSION

Before considering the results in the discussion, it should be pointed out here again that this publication only considers German-language studies. The results presented for the preparatory service as well as for lateral entry primarily show a very incomplete representation of the requirements as well as the implementations. In addition, only an ambiguous picture can be drawn of the training situation in the preparatory service due to the federal education system in Germany (Dzengel, 2016). Based on the small basis of publications on the preparatory service, the statement of Abs and Anderson-Park (2020) can be confirmed that, compared to the teacher study program, research in the preparatory service is very low. What should be noted in this context is that lateral entrants in most cases complete the same preparatory service as “traditionally” trained prospective teachers. Therefore, the results of the preparatory service also apply to the lateral entrants.

To answer the first research question, the specifications of the individual federal states can be primarily referenced. In addition, there are isolated publications. As shown in the results, differences in the preparatory service become apparent by comparing the individual federal states. The only structure that can be found so far in all federal states is the division of training between the school and the teaching seminars (Abs & Anderson-Park, 2020; Berndt et al., 2017; Dzengel, 2016; Fütterer, 2019; Kastens et al., 2020). The scope of independent teaching and time spend attending teaching seminars vary greatly from federal state to federal state (Abs & Anderson-Park, 2020). A similar picture emerges in terms of the number of classroom visits and how much they count towards the final exam.

Furthermore, the training provided by the mentors is also difficult to compare, as the mentors set individual priorities (Berndt et al., 2017; Richter et al., 2011). Particularly in terms of content, the federal education system means that there is a wide variation in the topics covered. The Standing Conference of the Ministers of Education and Cultural Affairs sets general guidelines for the required content, but they are so broad that the individual federal states have a great deal of leeway. The final exam, which is a requirement to work at state schools in Germany, is also different in each state. There are differences in the length of the exam, the number of interviews, and whether classroom observation counts towards the final exam grade. The only thing that is the same in all federal states is that an exam lesson must be given and assessed in all subjects to be taught by the prospective teacher (Kultusministerkonferenz, 2012, 2019a, 2019b).

Based on these structural prerequisites, similar sobering results emerge for the second question. Looking at the previously defined categories, the topic dealing with scientific literacy and the nature of science is hardly represented in the literature. Although these concepts are repeatedly emphasized as important in the science education (Billion-Kramer et al., 2020), they do not seem to be taught in a sustainable way to prospective teachers. Likewise, educational policy repeatedly emphasizes that media and information literacy are of great

importance for the German education system (van Ackeren et al., 2019). Based on the non-existent German language publications in this subject area, a tension between the contents required and the contents implemented in German teacher education becomes apparent. In addition, official figures from the Federal Statistical Office indicate that the teaching of media and information literacy is already failing due to the digital equipment in many schools (Maaz et al., 2020).

If the main goal of the preparatory service in addition to the two questions is now considered, it becomes apparent that the structure and course of the preparatory service means that the desired professionalization of the prospective teachers can only be achieved to a limited extent. As the results have already made clear, the preparatory service carries the risk of emotional exhaustion and, in addition, other psychological illnesses (Drüge et al., 2014; Klusmann et al., 2012; Richter et al., 2011; Schulte, 2008; Zimmermann & Klusmann, 2016). Since these phenomena have been known for a long time and prospective science teachers in particular are affected by them, possible relief or assistance or a general revision of the preparatory service should be sought.

Building on this publication, the next step is to compare Germany's teacher education with the teacher education in the top-ranking PISA countries. The long-term goal is to identify possible improvements for the preparatory service by making an international comparison in order to improve German teacher education in the long term.

**Author contributions:** MD: planning the systematic review, data analysis, conceptualization, & writing the manuscript & VP: planning the systematic review, discussing the evaluation results, & revision of the manuscript. All authors approved the final version of the article.

**Funding:** The authors received no financial support for the research and/or authorship of this article.

**Acknowledgements:** The authors would like to thank all colleagues that took part in the systematic review.

**Ethics declaration:** Authors declared that only previously published scientific papers were used to conduct this systematic review. No additional personal data was collected; therefore, this work was not reviewed by an ethics committee.

**Declaration of interest:** Authors declare no competing interest.

**Data availability:** Data generated or analyzed during this study are available from the authors on request.

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## APPENDIX A

**Table A1.** Overview of the literature used for the systematic review

Author	Title	Categories
Abs	Zur Bildung diagnostischer Kompetenz in der zweiten Phase der Lehrerbildung [On the formation of diagnostic competence in the second phase of teacher education]	CM, SA
Abs and Anderson-Park	Der Vorbereitungsdienst für Lehrerinnen und Lehrer in Deutschland. Stand und Herausforderungen [The preparatory service for teachers in Germany. Status and challenges]	CM, SA
Bellenberg et al.	Der Seiteneinstieg in den Lehrerberuf in Nordrhein-Westfalen. Perspektiven von Schulleitungen und Ausbildungsbeauftragten [The lateral entry into the teaching profession in North Rhine-Westphalia. Perspectives of school headmasters and training officers]	SA
Berndt et al.	Reflexive Lehrerbildung revisited: Traditionen–Zugänge–Perspektiven [Reflective teacher education revisited: Traditions–approaches–perspectives]	CM, SA
Billion-Kramer et al.	Professionswissen angehender Lehrkräfte zum Konstrukt nature of science (NOS): Entwicklung und Validierung eines Vignettestests (EKoL-NOS) [Professional knowledge of prospective teachers on the nature of science (NOS) construct: Development and validation of a vignette test (EKoL-NOS)]	SL, NoS
Böhmman	Das Quereinsteiger-Buch: So gelingt der Start in den Lehrerberuf [The career changer book: How to get started in the teaching profession]	SA
Drüge et al.	Psychosoziale Belastungen im Referendariat–Merkmale, Ausprägungen, Folgen [Psychosocial stress in trainee teachers–Characteristics, manifestations, consequences]	CM, SA
Dzengel	Schule spielen [Play school]	CM, SA
Eghtessad	Merkmale und Strukturen von Professionalisierungsprozessen in der ersten und zweiten Phase der Chemielehrerbildung: Eine empirisch-qualitative Studie mit niedersächsischen Fachleiter_innen der Sekundarstufenlehrämter [Characteristics and structures of professionalization processes in the first and second phase of chemistry teacher training: An empirical-qualitative study with Lower Saxon subject leaders of secondary school teaching professions]	SL, SA
Freiling	Kostengünstige Vertretungsverträge statt berufsqualifizierender Seiteneinstiege. Eine Problemskizze am Beispiel des Landes Hessen [Cost-effective substitute contracts instead of career-qualifying lateral entrants. A problem sketch using the example of the state of Hesse]	SA
Fütterer	Professional development portfolios im Vorbereitungsdienst: Die Wirksamkeit von Lernumgebungen auf die Qualität der Portfolioarbeit [Professional development portfolios in the preparatory service: The effectiveness of learning environments on the quality of portfolio work]	CM, SA
Kastens et al.	Selbstwirksamkeit erlangen, Belastung reduzieren?–Effekte des Feedbackverhaltens der Ausbilder/innen in Unterrichtsnachbesprechungen [Acquiring self-efficacy and reducing emotional exhaustion?–Effects of teacher educators' feedback]	CM
Klusmann et al.	Berufliche Beanspruchung angehender Lehrkräfte: Die Effekte von Persönlichkeit, pädagogischer Vorerfahrung und professioneller Kompetenz [Professional stress of prospective teachers: The effects of personality, prior pedagogical experience and professional competence]	CM
Košinár	Die Bedeutung von Passungserfahrungen für Professionalisierungsverläufe im Referendariat [The importance of experiences of fit for professionalization processes in the traineeship]	CM
Lucksnat et al.	Unterschiedliche Wege ins Lehramt–unterschiedliche Kompetenzen?: Ein Vergleich von Quereinsteigern und traditionell ausgebildeten Lehramtsanwärtern im Vorbereitungsdienst [Different routes into the teaching profession–Different competences?: A comparison of lateral entrants and traditionally trained trainee teachers in the preparatory service]	CM, SA
Mutke	Das Professionswissen von Chemiereferendarinnen und -referendaren in Nordrhein-Westfalen: Eine Längsschnittstudie [The professional knowledge of chemistry trainees in North Rhine-Westphalia: A longitudinal study]	SL, NoS
Oettinghaus	Lehrerüberzeugungen und physikbezogenes Professionswissen: Vergleich von Absolventinnen und Absolventen verschiedener Ausbildungswege im Physikreferendariat [Teacher beliefs and physics-related professional knowledge: Comparison of graduates of different physics teacher training programs]	SL, NoS
Oettinghaus et al.	Quereinsteiger in das Lehramt Physik der Sekundarstufe I [Career changers in the secondary school physics teaching profession]	SA

**Table A1 (Continued).** Overview of the literature used for the systematic review

Author	Title	Categories
Richter and Marx	Quereinsteigende und grundständig ausgebildete Lehrkräfte im Vorbereitungsdienst in Berlin: Eine vergleichende Analyse ihres Einsatzortes [Lateral entrants and undergraduate teachers in the preparatory service in Berlin: A comparative analysis of their place of employment]	SA
Richter et al.	Soziale Unterstützung beim Berufseinstieg ins Lehramt: Eine empirische Untersuchung zur Bedeutung von Mentoren und Mitreferendaren [Social support when entering the teaching profession: An empirical study of the importance of mentors and fellow teachers]	CM, SA
Rippler and Woischwill	Erfolgreich als Quereinsteiger [Successful as a career changer]	SA
Schulte	Die Ausbildung im Studienseminar (Gymnasium und Gesamtschule) aus der Perspektive der Referendare [The Studienseminar: Training in the Studienseminar (Gymnasium and comprehensive school) from the perspective of trainee teachers]	CM, SA
Storr	"In der Lehrprobe da machst du 'ne Show": Das Referendariat als Gegenstand rekonstruktiver Sozialforschung ["You put on a show during the teaching rehearsal": The traineeship as the subject of reconstructive social research]	CM, SA
Zimmermann and Klusmann	Burnout und stress beim Übergang in den Lehrerberuf [Burnout and stress in the transition to the teaching profession]	CM

