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## PROFESSIONAL COMPETENCE OF TEACHERS

What aspects of teacher knowledge are crucial for students' learning? How does teacher knowledge develop? Are teachers a selective group in terms of personality and cognitive abilities, and are other psychosocial characteristics relevant for students' learning? In this chapter of the IPN Research Report we present a selection of studies that examine these questions focusing on the professional competence of (prospective) teachers. In keeping with the IPN's profile, our research concentrates mainly on (prospective) teachers of biology, chemistry, physics, and mathematics. Our work aims to generate both fundamental theoretical knowledge and practical knowledge for the development of teacher education. For this purpose a combination of cross-sectional, longitudinal, as well as intervention studies are conducted.

In current educational research the term professional competence is used to describe the personal prerequisites that are necessary for teachers to successfully master the requirements of the profession. It is assumed that professional competence can be learned and taught. In line with the COACTIV model, professional competence embraces professional knowledge as well as motivational and affective aspects. The professional knowledge is differentiated into several domains inter alia content knowledge (CK), pedagogical content knowledge (PCK), and pedagogical-psychological knowledge (PK). As outlined in the IPN's 2013–2014 Research Report, all of the departments of the IPN closely collaborated on the project 'Measuring the Professional Knowledge of Preservice Mathematics and Science Teachers' (Messung professioneller Kompetenzen in mathematischen und naturwissenschaftlichen Lehramtsstudiengängen, KiL) which started 2011 and in which these three knowledge domains were the focus. Its central outcome was tests that now allow us to validly assess the development of students' professional knowledge throughout their university studies in these three knowledge domains. The tests are currently applied in the longitudinal study 'Development of Professional Competence in Preservice Mathematics and Science Teacher Education' (Kompetenzentwicklung in mathematischen und naturwissenschaftlichen Lehramtsstudiengängen, KeiLa) conducted at 25 universities all over Germany. Thus we aim to get substantial insight into the development of CK and PCK in the science disciplines and mathematics as well as in the PK of student teachers during their university studies.

The project KeiLa currently forms the nucleus of the IPN's research on (prospective) teachers' professional competence. It is extended by further studies that expand the perspective beyond pure professional knowledge on questions addressing for example their impact on students' performance, the interplay of the three knowledge domains, and notably other

Neumann, K., Härtig, H., Harms, U., & Parchmann, I. (in press). Model science teacher preparation programs: An international comparison of what works best. In J. Pederson, T. Isozaki, & T. Hirano (Eds.), *Science teacher education: A multi country comparison.* Charlotte, NC: Information Age Publishing.

Großschedl, J., & Harms, U. (2016). *A new instrument for measuring pre-service biology teachers' pedagogical content knowledge.* Manuscript submitted for publication.

Großschedl, J., Mahler, D., & Harms, U. (2016). *Construction and evaluation of an instrument to measure content knowledge in biology.* Manuscript submitted for publication.

features of teachers like motivational and affective aspects. In this report we present some examples of these studies carried out in 2015 and 2016. The first, taken from biology, begins by investigating the interrelationship of teachers' knowledge and student performance. The second study focuses on mathematics education and concentrates on the PCK domain of professional knowledge, elaborating on the question which role CK and PK play in its formation. In the third part of this chapter a trio of studies is outlined that goes beyond teachers' knowledge, that is, analyzing psychosocial characteristics and cognitive abilities of teachers and their relevance for students' outcome.

## 1 The Impact of Biology Teachers' Content-Related Professional Knowledge on Students' Performance

### Introduction

The biology teacher is an essential factor for students' learning in the biology classroom. Hence, it is important to identify characteristics of biology teachers (i.e., knowledge, attitudes, and beliefs) that are crucial for effective teaching and student outcome. As teaching a particular subject matter is one of the core tasks of a biology teacher, content-related professional knowledge is of great importance when thinking about effective teaching. Likewise the relevance of content-related professional knowledge is stressed in standards for science teacher education in many countries. In accordance with current models on the structure of teachers' content-related professional knowledge and our own empirical findings, we assume three domains of content-related professional knowledge: (a) content knowledge (CK), (b) pedagogical content knowledge (PCK), and (c) curricular knowledge (CuK). CK covers factual knowledge, that is, the knowledge of the relevant concepts, the principles, and the structure of the subject, in this case biology. PCK is the knowledge needed to make subject matter comprehensible to students. Finally, CuK is conceptualized here as the knowledge related to the German national educational standards for the intermediate school leaving certificate in biology. Research to date – mostly from mathematics education – supports the relevance of PCK for students' performance; findings concerning CK or CuK are mixed or even lacking.

Großschedl, J., Harms, U., Kleickmann, T., & Glowinski, I. (2015). Preservice biology teachers' professional knowledge: Structure and learning opportunities. *Journal of Science Teacher Education, 26*(3), 291–318.

## Objectives

There is no clear-cut evidence yet, how detailed and if the separate domains of biology teachers' content-related professional knowledge are related to students' biology performance. However, to improve biology teacher education at universities this matter is of central interest. Respective findings should provide sound indications of how to tailor teacher education programs to prepare the future teacher generation adequately for their profession. Hence, our study – conducted in the context of biology education – aimed to elucidate how teachers' (a) CK, (b) PCK, and (c) CuK are related to students' biology performance.

As biology performance is a very vague construct, we focused on a particular area of biology learning, which is of crucial importance for the subject. As open and complex systems are ubiquitous in the life sciences, dealing with systems is a core challenge in biology education. According to this relevance we conceptualized students' performance as *system thinking*. System thinking in general covers the ability to understand a system's organizational framework and the dynamic and cyclic relationships within it.

## Method

In our study, 48 biology teachers from secondary schools (age: $M$ = 40.91 years, $SD$ = 11.02; teaching experience: $M$ = 11.58 years, $SD$ = 10.46) participated with their classes ($N$ = 1 036 students, age: $M$ = 13.50, $SD$ = 0.73).

We measured biology teachers' CK (19 items), PCK (9 items), and CuK (4 items) using a paper-and-pencil test. In addition to the completion of the paper-and-pencil test, the teachers were subsequently asked to plan and conduct a short teaching unit lasting four hours. We asked the teachers to provide information about the planning and conduction of these lessons. The aim was to use this information as an additional step to gather insight into how teachers' content-related professional knowledge is reflected in teaching. Students' system thinking performance was measured before and after the unit using a paper-and-pencil test (26 items) as well as concept maps. The paper-and-pencil tests, the unit, as well as the concept maps addressed the biological topic ecosystem Wadden Sea.

As control variables we considered students' cognitive abilities (verbal and non-verbal) as well as the performance in the pretest. Moreover, we considered the type of school (non-academic track vs. academic track) teachers and students attended as we assume that the assignment to different tracks has impact on both teacher and student performance.

In order to examine the relationship between the three domains of content-related professional knowledge and students' performance we specified different multilevel structural equation models. A multilevel structural equation model considers the hierarchical structure in the data (students clustered in classes) and simultaneously controls for measurement and sampling errors. The dependent variable (here: students' performance) is considered as latent trait both on the within as well as on the between level. Students' performance was modeled as latent trait considering the results of the paper-and-pencil test as well as students' concept map performance as indicators. CK, PCK, and CuK were regarded as independent variables whereas students' performance in the pretest as well as their cognitive abilities (both grand mean-centered) and the type of school were considered as control variables.

*Table 1.* Relationship Between the Considered Control Variables, as Well as the Independent Variables CK, PCK, CuK, and Students' Performance (Standard Errors in Parentheses)

| Parameter | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| | | | Within | | |
| **Pretest** | .83*** (.05) | .83*** (.05) | .83*** (.05) | .83*** (.05) | .83*** (.05) |
| **CAT verbal** | .14*** (.03) | .14*** (.03) | .14*** (.03) | .14*** (.03) | .14*** (.03) |
| **CAT non-verbal** | .19*** (.04) | .19*** (.04) | .19*** (.04) | .19*** (.04) | .19*** (.04) |
| $R^2$ | .77 | .77 | .77 | .77 | .77 |
| | | | Between | | |
| **CK** | | .19 (.16) | | | .11 (.15) |
| **PCK** | | | .29* (.13) | | .36* (.14) |
| **CuK** | | | | -.10 (.16) | -.26 (.15) |
| **Track** | .53*** (.15) | .54*** (.15) | .52*** (.15) | .52*** (.15) | .50*** (.15) |
| $R^2$ | .28 | .31 | .36 | .29 | .42 |

*Note*. CAT = cognitive abilities test; CK = content knowledge; PCK = pedagogical content knowledge; CuK = curricular knowledge; track: 0 = non-academic track school, 1 = academic track school. $^*p < .05$. $^{***}p < .001$.

## Results

Five models were specified in order to examine the relationship between teachers' content-related professional knowledge and students' performance. Model 1 considered the control variables on both levels. The results reveal a positive relationship between the considered control variables (pretest performance verbal cognitive abilities, non-verbal cognitive abilities, type of school) and students' performance. Models 2 to 4 considered the respective domains of teachers' content-related professional knowledge. We found no relationship between biology teachers' CK or CuK and students' performance, but a significant positive relationship between biology teachers' PCK and students' performance. Accordingly, adding PCK to the model noticeably contributes to the explanation of variance in the dependent variable when compared to Model 1. These results remain stable, also when all three domains of content-related professional knowledge are considered together in one model (see Model 5). Table 1 provides an overview of the different models and the results.

## Discussion

The results indicate that biology teachers' PCK does have a clear impact on students' performance. This is an important result in terms of teacher education as the need to offer explicit opportunities to develop PCK becomes obvious. There is empirical evidence that both pre- and inservice teacher education offers beneficial opportunities for the development of teachers' PCK. Beyond courses during preservice teacher education at university, also integrated practical phases positively impact on the development of PCK. Inservice teachers' PCK benefits from the attendance in professional development courses and from opportunities for self-studies (e.g., reading journals in the field of biology education).

Even though we could not detect a relationship between teachers' CK and students' performance in our study, we do not assume that CK is meaningless for students' performance. We rather hypothesize, that CK is a premise for the formation of PCK. Accordingly, we assume an indirect effect of CK on students' performance, which is mediated by PCK. This assumption is supported for mathematic student teachers by the T-KnoX study (see 2). As mentioned above, we conceptualized CuK as knowledge related to the German national educational standards for the intermediate school leaving certificate in biology. According to the relevance of educational standards in Germany and many other countries, we do not assume CuK as irrelevant. Nevertheless, as our instrument particularly focuses on factual knowledge related to the standards, we assume that a more teaching-related conceptualization of CuK (i.e., the implementation of the standards in lesson planning and teaching) would have given a deeper insight into the meaning of CuK for students' performance.

Mahler, D., Großschedl, J., & Harms, U. (2016). *Using doubly-latent multilevel analysis to elucidate relationships between science teachers' professional knowledge and students' performance.* Manuscript submitted for publication.

IPN RESEARCH GROUP // Jörg Großschedl, Ute Harms, Daniela Mahler

COOPERATION // University of Cologne

HOMEPAGE // www.ipn.uni-kiel.de/de/das-ipn/abteilungen/didaktik-der-biologie/forschung-und-projekte/aktuelle-projekte/biotec-biology-teachers2019-professional-competence

# 2 The Role of Content Knowledge and Pedagogical Knowledge for the Formation of Pedagogical Content Knowledge

## Introduction

Empirical evidence suggests that PCK as teacher-specific knowledge about making subject matter accessible to students is one of the most influential teacher factors for classroom quality and students' learning progress. From the perspective of teacher education the relevance of PCK for educational practice directly leads to the question of the formation of teachers' PCK. In this context, the role of content knowledge (CK) and generic pedagogical knowledge (PK) are of special interest. On the one hand, CK and PK are also relevant components of teachers' professional knowledge. CK is necessary to analyze the learning content presented for example in textbooks, and PK is the basis for aspects like classroom management. On the other hand, there are conjectures about the impact of CK and PK on the PCK formation.

Research at the IPN on teachers' professional knowledge addresses this topic in different studies following different research designs (see e.g., Section 1). The ongoing longitudinal study KeiLa examines the formation of CK, PCK, and PK under ecologically highly valid conditions over the course of teacher education programs at different universities in Germany. First results are expected for the next IPN research report. In contrast, the experimental study T-KnoX (Teacher Knowledge Experiment) was specifically conducted under strictly controlled conditions to get insights into the role of CK and PK for PCK formation.

T-KnoX
Teacher Knowledge Experiment

Kleickmann, T., Tröbst, S., Heinze, A., Bernholt, A., Rink, R., & Kunter, M. (in press). Teacher knowledge experiment: Conditions of the development of pedagogical content knowledge. In D. Leutner, J. Fleischer, J. Grünkorn, & E. Klieme (Eds.), *Competence assessment in education: Research, models and instruments.* New York, NY: Springer.

## Objectives

Based on the current scholarly discussion in mathematics education research the following three assumptions were tested in the T-KnoX study: (a) PCK is based on an amalgamation of CK and PK, (b) PCK acquisition is facilitated by CK, and (c) PCK formation is mainly based on CK as a sufficient prerequisite. In addition to this question of PCK formation, the study was to reveal implications of how to design effective teacher education programs. In particular the question how to combine learning opportunities for CK, PCK, and PK was addressed.

## Method

The T-KnoX study was realized as a randomized controlled trial with 100 German preservice elementary school teachers. Almost all participants were in the second semester of their studies so that they only passed the introductory courses of the teacher education program. The participants were randomly assigned to one of five different two-day courses (three experimental and two control conditions) representing the three hypotheses about PCK formation. To address the amalgamation hypothesis (a), the experimental group CK-PK was exposed to lessons on CK on the first day and lessons on PK on the second day. The hypothesis that CK facilitates the formation of PCK (b) corresponded to the experimental group CK-PCK with lessons on CK on the first day and lessons on PCK on the second day. The experimental group CK-CK representing the hypothesis that CK is sufficient for PCK formation (c) received lessons on CK on both days. Two control conditions were implemented. The participants of a weak PK-PK control group only received instruction on PK, whereas in the strong control group PCK-PCK two days of instruction on PCK was realized.

As measures paper-and-pencil tests on PCK, CK, and PK were administered as pre-, intermediate and posttest. Participants' PCK was again assessed after six weeks using a follow-up test. The randomization of participants' assignment to conditions was confirmed by using data of various control variables (e.g., general cognitive abilities).

In the T-KnoX project, the mathematical topic fractions was chosen for the courses on CK and PCK. The topic fractions represents one of the most important topics in the mathematics curriculum, it is well structured, and PCK about fraction education is clearly defined. In the CK treatment, fractions were presented as equivalence classes of linear equations followed, for example, by techniques of expanding and reducing as well as the arithmetic operations. The PCK course addressed for example conceptual aspects of fractions like the operator and the part–whole concept, strategies to compare fractions, operations involving fractions, as well as common student errors with fractions. In the PK course, participants got acquainted with teaching as the provision of learning opportunities and learning as conceptual change involving the revision and enrichment of student conceptions. Generic principles of teaching like a constructive feedback culture, the exploitation of student conceptions for learning processes, the necessity of scaffolding, and the utilization of representations for enhancing understanding were presented. Overall, the correspondence between the CK and the PCK course was based on the content fractions whereas the correspondence between the PCK and the PK course was given by the consideration of the same teaching and learning principles in a general or a subject-specific context. The treatments were implemented by an experienced lecturer for elementary mathematics education who closely followed instructional storylines provided by presentation slides.

## Results

Videotapes of the treatments and participants' self-reports confirmed that the quality of treatment implementation was comparable across groups. A confirmation of the effectiveness of the course implementation was provided by participants' substantial treatment-specific knowledge gains in the conditions CK-CK, PCK-PCK, and PK-PK (Figures 1–3).

To test the three hypotheses on PCK formation, a comparison of the average PCK gain in the five conditions was considered (Figure 1). For the amalgamation hypothesis and the hypothesis that CK is sufficient for PCK formation the

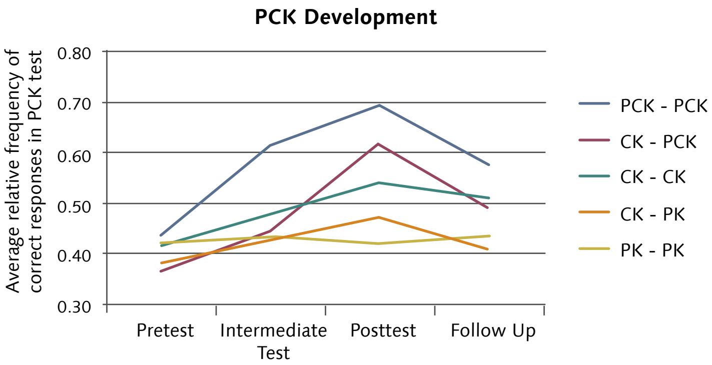


*Figure 1.* The development of estimated average relative frequencies of correct responses for the test on pedagogical content knowledge (PCK) by group across measurement occasions. Average relative frequencies were derived from estimates of fixed effects from the corresponding explanatory item response model.

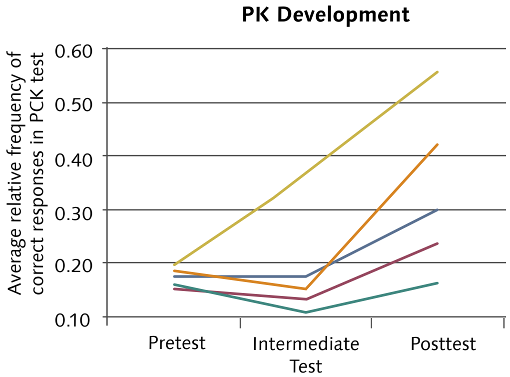


*Figure 2.* The development of estimated average relative frequencies of correct responses for the test on pedagogical knowledge (PK) by group across measurement occasions. Average relative frequencies were derived from estimates of fixed effects from the corresponding explanatory item response model.

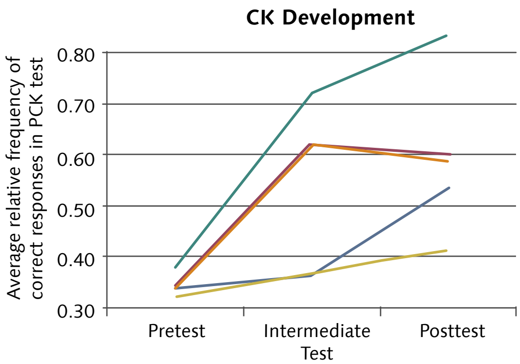


*Figure 3.* The development of estimated average relative frequencies of correct responses for the test on content knowledge (CK) by group across measurement occasions. Average relative frequencies were derived from estimates of fixed effects from the corresponding explanatory item response model.

experimental groups CK-PK and CK-CK were compared with the weak control group PK-PK. In contrast to the weak control group, both experimental groups show a significant PCK growth from pre- to posttest. In the follow-up test, however, the effect for the CK-PK group disappeared. Accordingly, the results provide only evidence for the hypothesis that CK is sufficient for (a moderate) PCK acquisition. The hypothesis that CK facilitates PCK formation was examined by a comparison of the experimental CK-PCK group with the strong PCK-PCK control group. The results do not support the facilitation hypothesis because the participants of both groups did not show a significantly different development in their PCK (Figure 1).

Because there were no sustainable effects of the PK-PK and the CK-PK condition on PCK performance, it can be questioned whether PK is relevant for PCK formation. Taking into account the results of PK development in the different conditions (Figure 2) one can hypothesize an effect in the reverse direction, that is, participants' PCK increase fosters a moderate PK growth (e.g., in the conditions PCK-PCK and CK-PCK). Because PK was not part of the follow-up test, there is no information whether the effect is sustainable.

Finally, there is an interesting result when combining the findings of PCK and CK development. As reported above the CK-PCK group does not differ from the PCK-PCK group regarding the PCK growth. In addition, the CK-PCK group shows a substantial gain in CK from pre- to posttest (Figure 3). Hence, one can hypothesize that the combination CK-PCK is the most efficient way to teach both CK and PCK. Again, follow-up data is only available for PCK and not for CK so that this effect has to be examined in a future study.

## Discussion

Regarding the PCK formation the T-KnoX results neither support the amalgamation hypothesis (a) nor the facilitation hypothesis (b). The findings indicate that to a certain extent student teachers acquire PCK through learning opportunities for CK. In sum, the results indicate a substantial relation between CK and PCK and there are some indicators for reciprocal effects between CK and PCK development. Regarding the relation between PCK and PK the results only provide evidence for an influence of PCK on PK, but not vice versa. One conclusion of these findings could be that there is potential for the use of synergy effects in teacher education programs. In particular, a clever combination of learning opportunities for CK and PCK as well as for PCK and PK might increase the efficiency in teacher education.

IPN RESEARCH GROUP // Andrea Bernholt, Aiso Heinze, Thilo Kleickmann, Steffen Tröbst

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COOPERATION // Goethe University Frankfurt am Main; Humboldt-Universität zu Berlin

HOMEPAGE // www.ipn.uni-kiel.de/de/forschung/projekte/t-knox

# 3 Psychosocial Characteristics and Cognitive Abilities of Teachers

The investigation of teachers' psychosocial and cognitive characteristics is a relatively new research focus at the IPN. According to a developmental model of teachers' professional competence, psychosocial teacher characteristics are assumed to play an important role to acquire learning opportunities. Additionally, it has been suggested that beyond subject-specific knowledge further aspects such as teacher beliefs and motivational and affective characteristics are crucial prerequisites to fostering students' learning and motivation. For this research report we present results regarding two major questions. First, is there empirical evidence for an often assumed negative selection of prospective teachers regarding cognitive abilities and personality traits? Second, are affective teacher characteristics and expectancy beliefs related to students' learning and motivation?

## 3.1 Who Becomes a Teacher? Psychosocial and Cognitive Characteristics of Prospective Teachers

### Introduction

It has been argued that the disappointing student outcomes of some countries in international educational assessments can be traced back to the inability of these countries' school systems to attract people with favorable cognitive and personality characteristics to the teaching profession. Current concerns about the supply of high-quality teachers particularly referred to study majors in the field of science, technology, engineering, and mathematics (STEM). Although the belief in a negative selection into the teaching profession seems to find widespread acceptance in politics, public opinion, and several studies, there is little conclusive empirical data supporting this.

### Objectives

In the present investigation we separately measured teacher candidates' cognitive abilities and personality traits in comparison to the characteristics of students in other subject areas for STEM and non-STEM study majors.

## Method

We drew on data from the longitudinal study Transformation of the Secondary School System and Academic Careers which follows the educational and personality development of two cohorts of students from secondary school to tertiary education and occupational career. At the first measurement occasion, which was in students' last year of upper secondary school (in 2002 for Cohort 1 and in 2006 for Cohort 2), participants took part in various achievement tests and personality questionnaires. The second measurement took place 2 years after the first measurement occasion for both cohorts. Participants completed a postal questionnaire including questions on their actual vocational situation. Based on their study choice, students were assigned to four groups: (a) 85 teacher candidates with at least one study major STEM, (b) 174 teacher candidates with non-STEM study majors, (c) 758 other students with at least one study major STEM, (d) 447 other students with non-STEM study majors. For the present analysis to measure students' general cognitive ability we used two subtests of the KFT, a German version of the Cognitive Abilities Test of reasoning skills. The NEO-FFI, which was developed to assess the domains of the five factor model of personality, was used to measure personality: neuroticism, extraversion, openness, conscientiousness, and agreeableness.

## Results

Both in the area of STEM majors and non-STEM majors there were no differences between teacher candidates and students in other subject areas in terms of their cognitive abilities (see Figure 4). Moreover, with regards to personality traits the findings showed no negative selection into teacher education (see Figure 5). Independently from their study choice, students reported a comparable amount of neuroticism and conscientiousness. In the area of STEM majors, teacher candidates were statistically significantly more extraverted and had higher social interest than students in other subject areas. Both traits are seen to be favorable for the teaching profession. Additional analyses on the relative predictive value of students' personality characteristics for the decision to enroll in a teacher education program showed that especially the social interest is a crucial factor influencing the choice of teacher education.

## Discussion

In sum, we found differences between the individual characteristics of teacher candidates and students in other subject areas. Additionally, there was no proof of a negative selection into the teaching profession when the students' study majors were controlled for. With its longitudinal data, its adequate comparison group with students in other subject areas, and its focus on differences between STEM and non-STEM study majors, this study makes an important contribution to existing research on teacher candidates' characteristics. In conclusion, less favorable personal prerequisites of teacher candidates and a negative selection into the teaching profession cannot be observed. However, it seems important to take a look at the quality of teacher education to explain differences in teacher candidates' quality and success.

Roloff Henoch, J., Klusmann, U., Lüdtke, O., & Trautwein, U. (2015). Who becomes a teacher? Challenging the "negative selection" hypothesis. *Learning and Instruction, 36*, 46–56.

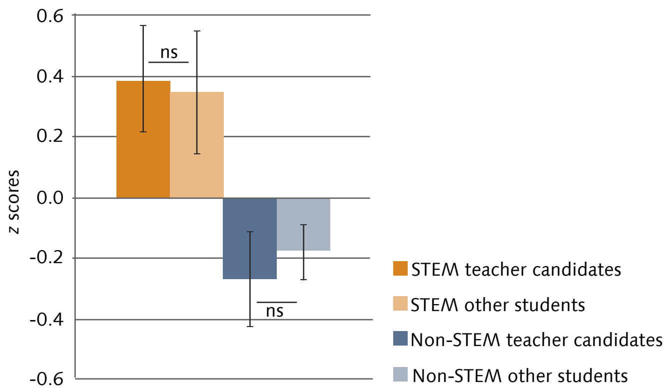


*Figure 4. Z* transformed means (and 95 % confidence intervals) of cognitive abilities separately for STEM and non-STEM majors. ns = not statistically significant.

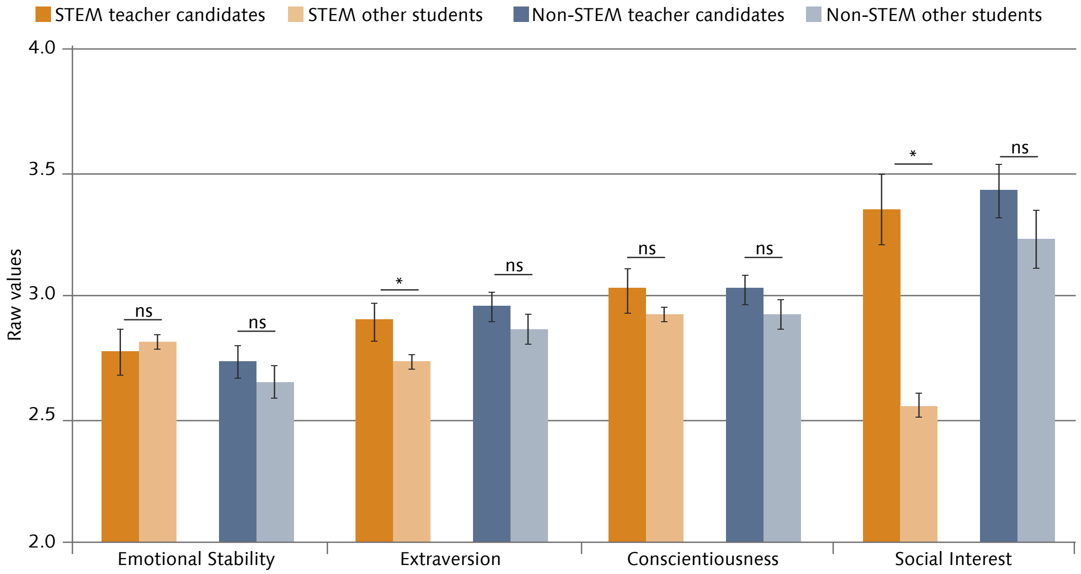


*Figure 5.* Means (and 95 % confidence intervals) of personality traits separately for STEM and non-STEM majors. ns = not statistically significant. $^{*}p < .001$.

IPN RESEARCH GROUP // Uta Klusmann, Oliver Lüdtke, Janina Roloff-Bruchmann

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DURATION // 2012–2015

COOPERATION // Hector Research Institute of Education Sciences and Psychology; University of Tübingen

HOMEPAGE // www.ipn.uni-kiel.de/en/research/projects/seko?set_language=en
www.kompetenzen-im-hochschulsektor.de/212_ENG_HTML.php

## 3.2 Do Teachers' Psychosocial and Cognitive Characteristics Affect Student Outcomes?

### 3.2.1 Teachers, Gender Stereotypes and Student Motivation

#### Introduction and Objectives

According to expectancy–value theory, the gender stereotypes of significant others such as parents, peers, or teachers affect students' competence beliefs, values, and achievement-related behavior. We aimed to investigate the relation of teachers' gender stereotypes about reading ability to students' reading self-concept. It is important to note that in academic contexts the particular domain determines which gender is negatively stereotyped. Because gender-related beliefs about reading stereotypically favor girls, we expected that the negative gender stereotypes of boys' reading abilities would negatively affect their reading self-concept. For girls no significant effect of teachers' gender stereotype on reading self-concept was expected.

#### Method

Our sample stemmed from the larger longitudinal project LISA (in German: Lesen in der Sekundarstufe [Reading in secondary school]) and comprised $N$ = 1 358 students (49 % girls; age at T1: $M$ = 10.89, $SD$ = 0.56; 36 % at academic track schools) and their $N$ = 54 German language teach-

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ers for this investigation. We drew on a longitudinal study comprising two occasions of data collection: toward the beginning of Grade 5 (T1) and in the second half of Grade 6 (T2). Teachers' gender stereotypes and students' reading self-concept were measured by self-report questionnaires; students' reading achievement was assessed by standardized tests. We analyzed the association between teachers' gender stereotypes and students' self-concept by means of multiple group multilevel modeling. Reading self-concept at T1, reading achievement, and teachers' gender stereotype were standardized ($M = 0$, $SD = 1$). Reading self-concept at T2 was standardized at the T1 mean and standard deviation of reading self-concept. To test our assumption that teachers' gender stereotypes affect boys' but not girls' self-concept, we specified a multiple group model with gender as a grouping variable.

## Results

The results of our multiple group multilevel analyses are presented in Table 2. We tested a model in which reading self-concept and reading achievement at T1 were included as within-level predictors and teachers' gender stereotype as a between-level predictor of reading self-concept at T2. For boys and girls, reading self-concept and reading achievement proved to be significant predictors. Moreover, as expected, a significant negative effect of teachers' gender stereotypes on students' reading self-concept was recorded for boys but not for girls (effect sizes: $\Delta$boys = -0.25, $\Delta$girls = -0.03). The difference between boys and girls was tested by applying a Wald chi-square test, which indicated that the association between teachers' gender stereotype and reading self-concept was significantly stronger for boys than for girls ($\chi^2(1) = 11.05$, $p < .001$). We also tested additional models including aggregated scores of reading self-concept and reading achievement at T1, school track, teachers' gender, and the interaction of teachers' gender by teachers' gender stereotype as between-level predictors. None of these predictors yielded significance and the differential effects of teachers' gender stereotypes for boys and girls were consistently recorded.

To illustrate the differential associations between teachers' gender stereotypes and students' reading self-concept, simple slopes for boys and for girls were plotted for the results of the model presented in Table 2 (Figure 6). Stronger gender stereotypes—for example that teachers believe that girls outperform boys in reading—are associated with boys' lower reading self-concept, whereas girls' reading self-concept was unaffected by teachers' stereotype.

## Discussion

Our study complements previous research by investigating the effects of teachers' stereotypes on students' reading self-concept, drawing on a relatively large sample tested in a naturalistic setting. Our results suggest that gender stereotypes contribute to the long-term development of reading self-concept as a relatively stable personal characteristic in those students that are negatively stereotyped. In our study boys were the disadvantaged group so that we would like to note that these results have to be considered in light of general male advantage in society, such as the gender pay gap that still persists. However, it should not be the aim to pit males' advantages in one area against their disadvantages in another area.

*Table 2.* Results of the Multiple Group Multilevel Analysis Predicting Reading Self-Concept at T2

| | Girls | | Boys | |
|---|---|---|---|---|
| | *B* | *SE* | *B* | *SE* |
| | **Within level** | | | |
| **Reading self-concept T1** | .387*** | .032 | .389*** | .033 |
| **Reading achievement T1** | .243*** | .030 | .273*** | .037 |
| | **Between level** | | | |
| **Teachers' gender stereotype T1** | -.012 | .024 | -.090** | .033 |

*Note.* All variables but the dummies have been standardized (Reading self-concept T2 was standardized at the mean at standard deviation of Reading self-concept T1. *** $p < .001$ ** $p < .01$).


*Figure 6.* Relation between teachers' gender stereotype on boys' and girls' reading self-concept at the second measurement occasion (all variables have been standardized).

Retelsdorf, J., Schwartz, K., & Asbrock, F. (2015). "Michael can't read!" – Teachers' gender stereotypes and boys' reading self-concept. *Journal of Educational Psychology, 107*, 186–194.

IPN RESEARCH GROUP // Olaf Köller, Michael Leucht, Jan Retelsdorf

COOPERATION // Kiel University

HOMEPAGE // survey.psychpaed.uni-kiel.de/LISA-Lesen-in-der-Sekundarstufe.html

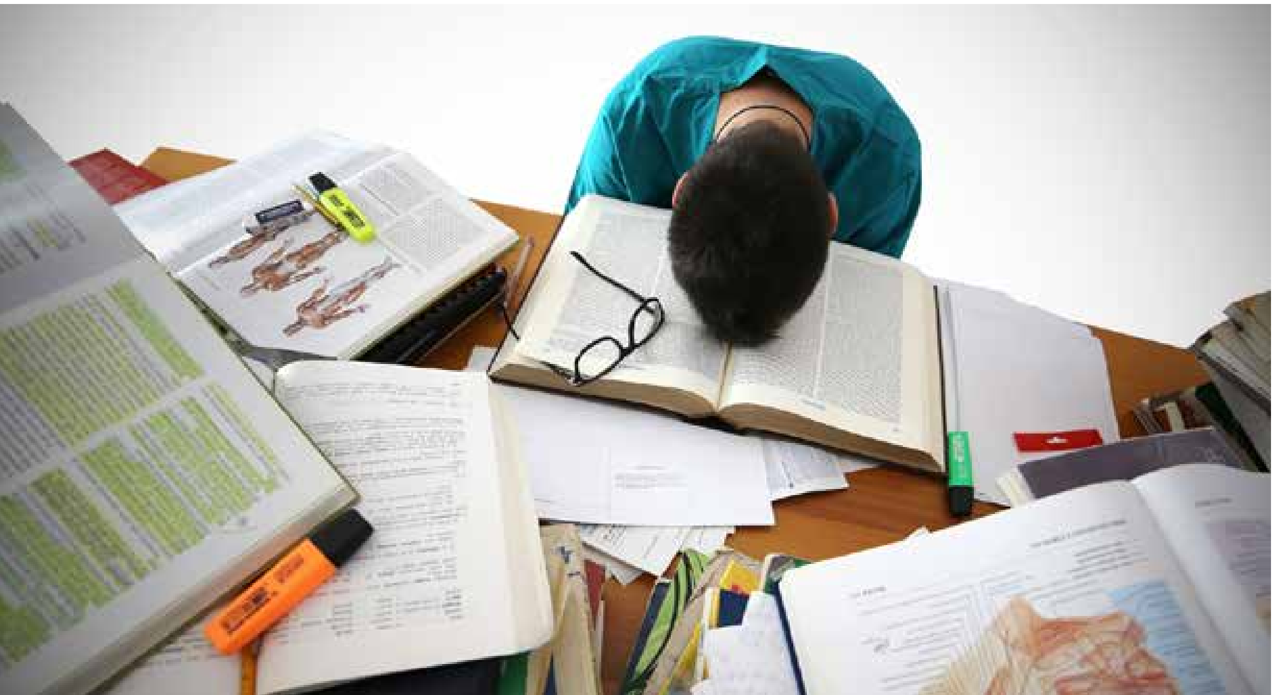
### 3.2.2 Teachers' Emotional Exhaustion and Students' Achievement

#### Introduction

Teachers' professional knowledge is strongly related to students' learning. Moreover, there is evidence that also teachers' motivational and emotional characteristics, such as enthusiasm and self-regulation are related to teachers' instructional behavior and student outcomes. Surprisingly, less is known about the role of negative affective experiences. This is remarkable because teachers have often been described as being at risk of experiencing chronic stress and burnout. Therefore, understanding the performance-related consequences is highly relevant. Moreover, in burnout research it has been postulated that the experience of emotional exhaustion and depersonalization has serious negative consequences for teachers' work performance.

#### Objectives

First, we hypothesized that teachers' emotional exhaustion would be negatively related to students' achievement. In our study, we controlled for students' gender, language minority, socioeconomic status, and cognitive ability both on the student- and the class-level. We also controlled for teachers' gender, years of experience, and teaching certificate in mathematics. Second, we hypothesized that the association between teachers'



emotional exhaustion and students' achievement would be stronger in classes with a high level of composition-related risk factors (such as low socioeconomic status, higher proportions of language minority students, or lower average cognitive ability level).

### Method

Participants included fourth-grade mathematics teachers and students from the German National Assessment Study in 2011 conducted by the Institute for Educational Quality Improvement (IQB) in Berlin. The sample for the present study included 1 102 teachers, 22 002 students, and 16 737 parents. Teachers' emotional exhaustion was assessed with an established German version of the Maslach Burnout Inventory (example item: "I often feel exhausted at school."). We also obtained information on the teachers' gender, years of teaching experience, and teaching certificate in mathematics. Students' achievement in mathematics was assessed with a standardized competencies test measuring the national educational standards in mathematics at the end of elementary school (Grade 4). We also used data on students' home language, socioeconomic status, and cognitive abilities.

### Results

Based on multilevel models we found that teachers' emotional exhaustion was significantly negatively associated with students' mathematics achievement ($B = -4.56$, $p < .01$). This means that classes with more exhausted teachers obtained lower scores on the achievement test, even after controlling for teachers' years of experience ($B = 3.34$, $p < .05$), teaching certificate in mathematics ($B = 7.46$, $p < .01$), and individual student characteristics. In the next step, we added classroom composition variables including the proportion of language minority students, the average socioeconomic status, and the average cognitive ability. The results revealed that the regression coefficient of teachers' emotional exhaustion decreased but still remained statistically significant. Additionally, we included three class-level interaction terms in the analysis. We found a statistically significant interaction between teachers' emotional exhaustion and the proportion of language minority students in class ($B = -1.66$, $p < .05$). Figure 7 illustrates the relationship between the expected class achievement and teachers' emotional exhaustion for classes with no language minority students and classes with 30 percent language minority students.

Klusmann, U., Richter, D., & Lüdtke, O. (2016 ). Teachers' emotional exhaustion is negatively related to students' achievement: Evidence from a large-scale assessment study. *Journal of Educational Psychology, 108*(8), 1193–1203.

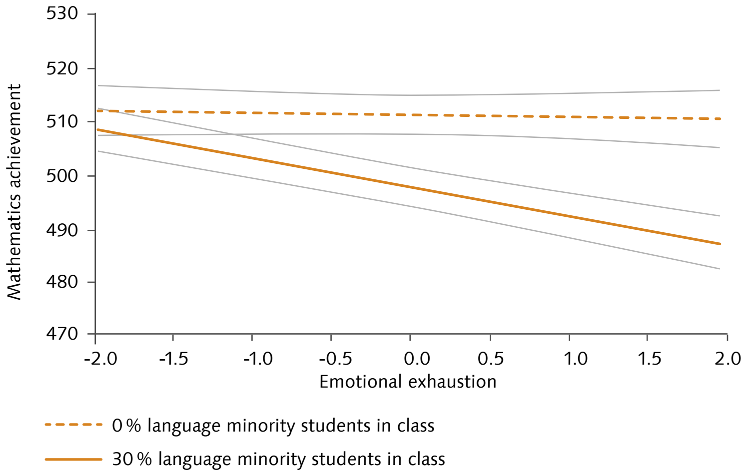



*Figure 7*. Interaction between emotional exhaustion and proportion of language minority students in class. Confidence bands represent the standard errors of the predicted curves.

## Discussion

The current study demonstrates that an affective teacher variable – emotional exhaustion – is also associated with students' achievement. Moreover, the association between teachers' emotional exhaustion and students' achievement was stronger in classes with a high number of language minority students. Despite the small effect sizes we consider the finding to be of practical importance. At least 10 percent of teachers reported very high levels of emotional exhaustion although the level of emotional exhaustion for most teachers was not very high. Not only is these teachers' life quality negatively affected, but given the fact that an exhausted teacher might remain in the profession for several years, they will teach a large number of classes and students. However, the cross-sectional design of the study did not allow for causal inferences. Understanding the underlying psychological processes between teachers' affective experience and students' achievement is an important objective for further research.

IPN RESEARCH GROUP // Uta Klusmann, Oliver Lüdtke

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## 4 Further Research

In 2016 the studies reported above merged into the IPN's new Research Line 3 Professional Competence where they are combined with teacher education program development and evaluation. Furthermore, questions addressing the structure and measurement of teachers' professional competence will be one focal point of our research for the science subjects and mathematics. Hereby, we aim to expand knowledge about the structure and level of (prospective) teachers' professional competence. This knowledge forms the basis for the further development of teacher education. Therefore, competency structure models and corresponding measurement instruments will be refined and used to further examine (a) the competence of teacher students and (b) the role that teachers' professional competence plays in instructional practice. Professional competence is developed both during teacher training and on the job. In order to examine this development we will further investigate knowledge, opinions, emotional and motivational aspects of competence, and learning opportunities that influence this development. From now on one focus will be laid on this context and also on the transition from preservice teacher education to the internship between university studies and the teacher profession. In combination with the results from the KeiLa study, we hope to elaborate substantial, empirically supported findings to contribute to the further development of teacher training. The aim of the (further) development of teachers' professional competence is ultimately to promote students' competency development in mathematics and science subjects. Which individual competency aspects are effective and how these aspects interact with each other will also be focal questions in this Research Line at the IPN.