



## KoKoHs Working Papers

### No. 12

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**Student Learning Outcomes Assessment in Higher Education**  
—  
**Perspectives, Concepts and Approaches for Research, Transfer and Implementation**

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***KoKoHs Working Papers* from the BMBF-funded research initiative  
„Modeling and Measuring Competencies in Higher Education“**

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The research initiative is funded by the German Federal Ministry of Education and Research under grant no. 01PK11100A and 01PK11100B.

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# **Student Learning Outcomes Assessment in Higher Education - Ideas, Approaches and Concepts for Research, Transfer and Implementation**

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## **Bibliographical references:**

*Lautenbach, C., Fischer, J., Zlatkin-Troitschanskaia, O., Toepper, M. & Pant, H. A (2019). Student Learning Outcomes Assessment in Higher Education - Ideas, Approaches and Concepts for Research, Transfer and Implementation (KoKoHs Working Papers, 12). Berlin & Mainz: Humboldt University & Johannes Gutenberg University.*

## **Student Learning Outcomes Assessment in Higher Education - Ideas, Approaches and Concepts for Research, Transfer and Implementation**

### **Abstract:**

One main aim of the research program “Modeling and Measuring Competencies in Higher Education (KoKoHs)”, funded by the Federal Ministry of Education and Research (BMBF), is the systematic and sustainable advancement of young researchers. To meet this task as well as to achieve higher international visibility and to maintain and enhance existing international cooperations, the Scientific Transfer Project KoKoHs organized the “International Junior Faculty Research Conference” from December 5-8, 2018 in Berlin. The present working paper documents the concepts and project approaches developed by young researchers in the context of the conference.

### **Keywords:**

Competence assessment, higher education, advancement of young researchers, international collaboration

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## 1. Introduction

### 1.1 The KoKoHs Program

To foster professional competences of university students according to the requirements of the 21<sup>st</sup> century, characterized by fast changes and rapid developments of the labor market, objective and valid measurements are required, which can provide valuable information for employers and promote equal and fair training opportunities based on students' individual skills and preconditions. The Germany-wide research program "Modeling and Measuring Competencies in Higher Education" (KoKoHs), funded by the German Federal Ministry of Education and Research (2011-2020), provides valid and objective assessments of students' preconditions and learning outcomes in higher education, which, in terms of prognostic validity, indicate professional performance, focusing on validly assessing generic and domain-specific competencies in five major study areas (economics, social science, teacher education, medicine and psychology) at all study stages and during later employment.

The first research phase ran from 2011 to 2015, and, after positive external evaluations, the program was funded for another five years (from 2016 to 2020). The KoKoHs program in its next funding phase includes 16 cross-university collaborative projects encompassing 40 single projects with over 100 researchers at more than 30 institutions in Germany and Austria. The program aims to increase the explanatory power and broaden the scope of the use of existing assessment instruments through in-depth validation, and to drive methodological innovations in the assessment of student learning outcomes. More than 120 assessment instruments have been developed in the KoKoHs program, covering a broad range of innovative assessment methods, which have been validated by numerous approaches. Assessment instruments include innovative formats such as computer-based tests, video-based assessments, and simulation-based instruments. Areas of use include the beginning, middle, and end of studies, the practical phase or traineeship as well as the occupational phase. Potential areas of use comprise initial diagnosis at the beginning of a course of studies, formative and summative diagnosis, as well as prognosis of professional performance. So far, developed test instruments have been used to assess over 75,000 participants at more than 325 higher education institutions. The validity of the assessment instruments is assessed extensively by a broad spectrum of methods, which cover the validity criteria of the Standards for Educational Testing (AERA et al., 2014). The assessment models and test instruments developed and validated in KoKoHs provide more detailed information on the diversity of students and their preconditions and performance than had previously been available based on official statistics or self-evaluations. By means of these new instruments, for instance, students' prior knowledge and professional performance potentials can be assessed in a

valid way. Based on the assessment results, more suitable and effective learning opportunities can be developed, especially for the introductory study phase, which promote students' individual potentials, help systematically reduce knowledge and skill gaps, address misconceptions and thus significantly contribute to a successful integration of students in higher education and greater study success (Zlatkin-Troitschanskaia et al., 2017).

## **1.2 Activities for Young Researchers in the KoKoHs Program: the International Junior Faculty Research Conference**

One main objective of the KoKoHs program has been the systematic and sustainable advancement of young researchers to help build capacities for research in higher education. To meet this challenge, several activities to promote young researchers and their PhD projects have been organized throughout the recent years. In the KoKoHs research program, these activities included different workshops, several PhD student colloquia as well as the possibility to attend coaching and method counselling events with national and international experts. In one-on-one discussions, the young researchers received stimulating impulses while introducing their individual research and dissertation projects to experts. In addition, several possibilities for national and international networking were provided throughout the years in order to create networks of young researchers in the field of competency assessment in higher education.

As one of the main purposes of the KoKoHs program has been to bring together young researchers from Germany and international researchers from the field of competency assessment, young researchers were invited to attend the International Junior Faculty Research Conference (IJFRC), which took place in December 2018 in Berlin. The researchers presented their own current research, and generated and worked together on joint research projects, experiencing the challenges and advantages of international cooperation. The working groups were supported by experienced researchers who advised them on their work.

The KoKoHs IJFRC took place from December 5<sup>th</sup> to 8<sup>th</sup>, 2018, at the Humboldt University of Berlin. More than 40 national and international researchers participated in the conference during the three days. On the first day, after a round of introductions, brief inputs from the field of educational and assessment research were given by the international IJFRC participants. In the next step, interdisciplinary working groups were formed and started to work on joint projects. In the evening, a first keynote and succeeding workshop by Dr. Heidi Hyytinen (University of Helsinki) focusing on "Computer-based Performance Assessment in Higher Education" took place. The second day started with a presentation by Dr. Harrison J. Kell and Dr. Lin Gu from the Educational Testing Service, Princeton, USA, on "Innovative Assessment of Student Learning Outcomes in Higher Education and Predicting



Real-World Outcomes". In the afternoon, four keynotes gave valuable input and advice on highly important topics such as "The Integration of Teaching, Learning and Assessment: A Design-Based Approach" by Prof. James Pellegrino, University of Illinois, "Measuring Tertiary Students' Higher-order Reasoning Capabilities: Implications for Higher Education Policies and Practices" by Prof. Patricia Alexander, University of Maryland, "Large Scale and Cross-national Assessment of Students' Skills in Higher Education" by Dr. Lydia Liu, Educational Testing Service, and "Intelligent Learning Technologies for Fostering Student Learning in Higher Education" by Dr. Vinay Chaudhri, Stanford University. The day was concluded with the groups of young researchers working on the projects under the supervision of these experienced researchers. The conference ended on the third day with the working groups presenting their project results.

### **1.3 The Working Paper**

This working paper encompasses an overview of ideas for projects and collaborations of researchers on assessing learning outcomes in higher education. The contributions connect to, or directly follow up on, the research conducted in the KoKoHs research program, for instance by describing further applications, in research or practice, of the test instruments developed in the KoKoHs projects. The outcomes of the International Junior Faculty Research Conference in December 2018 in Berlin, including innovative project ideas, are presented in this working paper. Moreover, a wide range of topics from the field of assessing academic competencies and adjacent contexts is covered. The working paper not only documents the IJFRC but also outlines new research and transfer perspectives of the KoKoHs projects.

## 2. Research Projects on Assessing Student Learning Outcomes in Higher Education

### 2.1 Generic Competencies

#### **Implementation of Self-Regulated Learning Training Approaches into Higher Education |**

Nicole Eckerlein, Gabriele Steuer, Nora Maria Foerst, Bettina Schumacher, Christiane Spiel, Barbara Schober, Bernhard Schmitz and Markus Dresel

##### *Project idea*

Competences of self-regulated learning are both a requirement for the acquisition of subject specific knowledge and competences, as well as a result of higher education and the foundation for lifelong learning (Artelt, Baumert, Julius-McElvany, & Peschar, 2003). University students have to acquire new knowledge autonomously, monitor and evaluate their learning progress, use learning strategies and regulate emerging motivational problems (Zimmerman & Schunk, 2011). As these competences can be acquired, it is assumed that they can also be trained (e.g., Bloemke, Zlatkin-Troitschanskaia, Kuhn, & Fege, 2013).

The research project PRO-SRL-EVA (Product- and Process-oriented Modeling and Assessment of Self-regulation Competencies in Higher Education – Further Validation) focused on developing and validating innovative measuring instruments to capture competencies of self-regulated learning: A Situational Judgement Test to measure conditional strategy knowledge on motivational regulation strategies, a Competence-Performance-Assessment on self-regulation strategies, and a Standardized Learning Diary to capture self-regulated learning behavior in process have been extensively validated.

The Situational Judgement Test (Steuer, Engelschalk, Eckerlein, & Dresel, in press) can be used to assess competence and competence development of motivational regulation in a population of university students. It consists of 8 (short version: 5) situational vignettes, describing motivational problem situations. For each situation, the participants rate the usefulness of given motivational regulation strategies to face the problem described. The ratings are then compared against expert ratings of strategy suitability to determine conditional strategy knowledge of the participants. The Competence-Performance-Assessment (SRL-QuAK) can be used to assess discrepancies between self-regulated strategy knowledge and use and also reasons for non-application of strategies. It consists of 366 items (short version: 85) assessing self-regulation strategy use in four subscales: metacognition, cognition, frustration and boredom. The instrument is also suitable for measuring competence development. The Standardized Learning Diary assesses different competences of self-regulated

learning during an exam preparation phase and is administered via a mobile phone app. The app assesses motivation, self-efficacy, planning, goal setting, reflection and mood with 20 items and can be used in assessment as well as a training tool.

Furthermore, first training approaches to foster self-regulated learning and motivational regulation have been developed. An approach to foster motivational regulation has been developed and evaluated in two consecutive quasi-experimental studies (N1 = 135; N2 = 131) at the University of Augsburg. The training approach was able to foster motivational regulation in three key aspects (quantity of strategy use, situation-specific fit of strategy and motivational problem, and strategy application quality) and also had positive and sustainable effects on the use of cognitive and metacognitive strategies, invested effort and subjective well-being, while reducing procrastination. First approaches to intervention studies to foster self-regulated learning strategies in undergraduate and postgraduate students were conducted at the University of Vienna and the Technical University of Darmstadt – in part using innovative approaches such as smartphone apps (e.g., Foerst, Pfaffel, Klug, Spiel, & Schober, in press).

Based on the extensive prior work on the assessment of self-regulated learning competencies and first evidence regarding their trainability (which function as a proof-of-concept), the logical next step should be addressed to the systematic development, implementation and evaluation of training approaches to foster self-regulated learning competencies in higher education. Based on the multidimensional model of these competencies (Dresel et al., 2015), a bundle of complementary training modules should be conceptualized that enhances specific competence facets (e.g., metacognitive control, motivational regulation, resource management). This type of modular training conception allows for an individualized training strategy targeting specific requirements in the practice of higher education, which can be identified with a thorough assessment of self-regulated learning competencies (on the level of the individual student, the level of study programs or the level of organizations), utilizing the assessments developed in the project PRO-SRL-EVA. Use-inspired research, that aims to develop, implement and evaluate the aforementioned systematic bundle of complementary training modules to foster self-regulated learning competencies, may function as a good example for the high transfer potential of the extensive evidence generated by the research program “Modeling and Measuring Competencies in Higher Education” (KoKoHs). In the present case, tools will result that could be integrated into the curriculum of different courses of studies, contributing to a better preparation of students to face the various challenges higher education poses for them on a self-regulatory as well as a subject-specific level. Thus, implementing training approaches to foster competences of self-regulated learning could also decrease the risk of student dropout and increase the performance of the higher education system.

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**Promoting Reading Goals and Strategy Knowledge to Improve University Students' Comprehension of Multiple Documents** | Carolin Hahnel, Nina Mahlow, Cornelia Schoor and Raquel Cerdán

*Project idea*

The proposed project focuses on the comprehension of multiple documents in university students. Although strategies and skills are required to achieve a comprehensive understanding of multiple documents for studying successfully, many students struggle with important parts of this process. The proposed project seeks to investigate how interindividual differences in the representation of a task will affect students' comprehension, and examines the effectiveness of a short-term intervention on the students' performance and behavior when dealing with multiple documents.

*Theoretical considerations*

Working with multiple documents with the purpose of solving comprehension tasks poses important challenges on the learner, beyond those at single text level (Britt & Gabrys, 2001; Rouet, 2006). Readers need to corroborate and integrate information across documents, take into account the characteristics and the quality of sources, and place the events described into an appropriate context (Wineburg, 1991). Whether and to what extent they engage in such activities depends on the goals that readers have set themselves for reading. In their definition of the reading goal, readers will evaluate the characteristics of the context and the task and strategically select what to read and how to read it (Britt et al., 2018; Cerdán et al., 2009).

Britt et al. (2018) recently presented a framework that addresses most purposeful and contextualized reading situations for single and multiple text reading (REading as problem SOLVing). RESOLV suggests that readers construct two types of representations prior to their text engagement: a context model and a task model. The context model is a representation of a reading situation based on the selection and prioritization of cues from the context (e.g., reading for a school assignment vs. a low stake assessment). Readers can translate these cues into a task model, or an initial set of goals and actions (Rouet & Britt, 2011). The task model specifies concrete goals and plans to process a particular reading task, is updated throughout the entire task, and guides strategic reading behaviors.

Supporting students in constructing a task model can improve their comprehension in purposeful reading situations. In a recently published study, Cerdán, Pérez, Vidal-Abarca and Rouet (2019) found that secondary school children with low comprehension skills benefit from an intervention that involves reformulating the wording of a question. In the same vein, Cerdán, Rouet and Pérez (in prepa-

ration) found in another study that the accuracy of students in identifying task requirements predicted their precision in answering comprehension questions and learning from the texts.

### *Research objectives*

The implementation of specific reading instructions is a simple, but still effective intervention method compared to more comprehensive reading trainings. This project aims at analyzing two specific types of instruction that could help university students to construct their task model. These instructions will be evaluated with regard to their effectiveness in promoting students' comprehension of multiple documents. The first instruction focuses on the metacognitive level by asking participants to think about their task model. The second instruction is more cognitive in nature and will explain to participants which strategies are appropriate for building a deep comprehension of multiple documents. We expect both experimental groups to outperform a control group that has not received such instructions.

### *Methodological approach*

We will use the Test of Multiple Document Comprehension, which we developed in the KoKoHs project "MultiTex: Process-based assessment of multiple documents comprehension" (Schoor et al., in press). The test includes a short video-based tutorial on how to use the test environment. The control group will work with this version. In addition to this tutorial, the first experimental group will receive a metacognitive intervention related to the task model. They will be asked to think about how best to approach a task that requires multiple document comprehension. In contrast, the second experimental group will receive a cognitive intervention related to the task model. In this condition, the tutorial will provide the participants with further information on strategies of corroboration and sourcing. As dependent variables, the results of the test and indicators from computer-based process files will be analyzed. Control variables will include variables such as prior knowledge, interest, epistemic beliefs and cognitive abilities.

### *Current status and next steps*

The project is currently in a stage of planning and refinement. The preparation of a grant proposal is being sought. Within the context of a pilot project, parts of the MDC instrument will be translated into Spanish and tested on a sample of Spanish university students. Performance and behavior indicators will then be compared with indicators from a German sample (Schoor et al., in press). Psychometric characteristics of the instrument will be examined and compared to ensure comparability of measures.

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## **Influence of Media Consumption over the Course of Bachelor Studies on University Dropouts** | Judith Jitomirski, Carla M. Kühling-Thees, Olga Zlatkin-Troitschanskaia and Jasmin Schlax

### *Background and theoretical considerations*

The information age of the 21st century has exposed higher education (HE) students to an exponentially increasing amount of information from various media sources. What Lewis (1996) first called the exponential growth of information has increased demands on education to prepare young people for the digitized world of work (BMBF, 2018). The advantages of information accessibility are countless but so are the challenges posed. Although students struggle with the amount of information available (Wineburg, Breakstone, McGrew, & Ortega, 2018), they use various media sources during their university studies. Correlations between media consumption and study performance have already been determined, showing significant differences between the low and high performers among first year students in economics and sociology (Maurer, Schemer, Zlatkin-Troitschanskaia, & Jitomirski, 2019). The first study year is particularly critical in terms of dropping out or changing subjects (Wolter, Diem, & Messer, 2013). Based on these findings, the question arises whether media consumption in this critical phase of the first academic year can affect students' decision to change their study subject or drop out of university.

As business and economics (B&E) is one of the biggest study domains worldwide (OECD, 2017) and a topic strongly represented in mass and social media, current research work focuses on this study domain. It is essential for students in B&E to stay informed about current news as well as read lecture notes and academic literature to gain knowledge in their chosen field. The students need the appropriate critical thinking skills to find relevant and reliable information and to evaluate sources and material as part of the notion of scientific thinking, a significant aim of higher education (Gojkov, Stojanović, & Rajić, 2015).

Katz (1974) argued that, according to the Uses and Gratification Theory, media consumption has multiple motivators, looking at the recipient of media messages as an active rather than passive consumer. Research has varied on other motivators but many studies have focused on three main ones: information seeking, social utility and entertainment (You et al., 2013; Go et al., 2016). Understanding how students' media use influences their study path is especially important, possibly influencing the decision to drop out of the B&E course before completing the degree.

Despite the high dropout rate of 26% in economics (Heublein, 2014), there is a lack of empirical studies on dropouts or subject changers in this domain (Arnold & Straten, 2012) and the potential impact of media consumption during studies is particularly under-researched. Information seeking for B&E



content through media consumption has the potential to act as concrete evidence of students' interest in their study subject, which extends beyond self-reported claims of interest.

### *Methodological approach*

The data base in the WiWiSET project consists of two surveys. In T1, 7,640 beginning students of B&E participated in a Germany-wide, large-scale assessment in the winter term 2016/17. 1,236 participants of the original sample also completed an online survey one year later (T2) to measure frequency of media consumption and trust in media (adapted from Rössler, 2011). After combining the two samples and conducting plausibility analyses, 709 students remained as the subsample that consists of two groups: students who continue their studies (group 1, N = 620) and university dropouts or subject changers (group 2, N = 89). The paper will be based on this subsample described in Table 1.

Table 1. Descriptive statistics for the subsample (N = 709).

<i>Variables</i>	<i>Group 1</i> (students who continued B&E)		<i>Group 2</i> (dropouts or subject changers)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age at first measurement point, M ± SD	20.14	2.43	20.81	2.13
Sex (female), %	51.77 (321/620)		51.69 (46/89)	
University entrance grade (1.0 - best grade, worse than 4.0 - fail)	2.25	.59	2.15	.23
At least one parent not born in Germany, %	24.35 (151/620)		31.46 (28/89)	
Attended business and economics course in school, %	39.26 (243/709)		36.36 (32/709)	
Vocational training in business and economics, %	15.16 (94/620)		20.22 (18/89)	

*Note.* SD = standard deviation, GPA = Grade Point Average (in Germany 1.0 is the best possible grade), deviations in sample size due to missing values

### *First results and next steps*

Although no significant results were found to support a difference in general media use between the two groups, first findings suggest that there is some evidence for a difference in consumption of course materials when preparing four courses and/or exams. The results indicate that group 2 students trust university materials (lecture notes and textbooks) less, which appears to lower their overall consumption of course materials although causality remains unclear. This lack of trust might discourage learning through media consumption when preparing for courses and/or exams. Group 1 uses learning media more frequently for study purposes, suggesting directed information seeking. These findings might act as an indicator for the need to increase exposure of student services in the form of academic course guidance to increase the knowledge base of B&E students thinking about dropping out or changing their study subject. Thousands of higher education institutions worldwide use online systems like Moodle for students to sign up to courses and as an e-platform for faculty

staff to distribute course materials (e.g., Moodle, 2019). A failure to sign up for these courses or an overview of who has (not) accessed the platform could act as an indicator for students considering dropping out of the program.

Next steps will include more in-depth analyses of differences between the two groups based on media consumption. Additionally, the general intellectual ability score will be included as a covariate. Adding trust as a mediator between media consumption and dropout rates while adding control variables is another step in a systematic data analysis.

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## 2.2 Competencies in Teacher Education

**PlanvoLL-D-Transfer (Planning Competence Measurement of Teachers – Transfer) | Albert Bremerich-Vos, Christiane Buchholtz and Johannes König**

### *Overall objective*

The KoKoHs project PlanvoLL-D conducted during 2016-2019 has proliferated new insights into the modelling and measurement of teacher planning competence by analyzing written plans of demonstration lessons in a standardized way. The new project PlanvoLL-D Transfer continues this and goes a step further by aiming at transferring this approach to different samples, to a standardized vignette test measuring teacher lesson planning competence, and to practical educational contexts.

### *Background of project idea*

Lesson planning of teachers as a research field has received little attention so far in terms of modelling and measuring relevant competences. However, as lesson planning constitutes a substantial part of a teacher's daily work and teacher education provides relevant learning opportunities for future teachers to develop correspondent planning skills, teacher competence research in this area is clearly needed. In the KoKoHs project PlanvoLL-D conducted during 2016-2019, we developed and applied a standardized method for analyzing written lesson plans, which highlights the demand of pedagogical adaptivity – both on a generic and on a subject-specific level. We investigated a competence model and the measurement of this planning competence skill using a database of about 400 written plans of teacher candidates' demonstration lessons. Although, out of this material, we reconstructed planning decisions and created indicators that served to quantify teacher candidates' skill of adaptive lesson planning, the coding of information taken from written lesson plans turned out to be very time consuming. Consequently, a standardized test measuring planning competence more efficiently seems to be a necessary transfer product of the KoKoHs project PlanvoLL-D.

### *Theoretical considerations*

The research agenda of the project PlanvoLL-D started with a particular focus on pedagogical adaptivity, i.e., the ways in which the cognitive level of the learning group fit with the assignments of the respective lesson (König et al., 2015; 2017; König, 2019). Taking this as a central demand teachers have to master, our competence model comprises both generic and subject-specific aspects. Adaptivity is, however, only one aspect of lesson planning. We therefore increased the scope and extent of our lesson planning competence framework by adding the demand of how a teacher structures his or her lesson, i.e., how a teacher plans the lesson sequencing to fulfill didactic functions and effective

time management (Krepf & König, 2019). We again analyzed written lesson plans and created indicators in order to quantify teachers' planning decisions in that area.

#### *Methodological approach*

As part of the transfer activities of the project PlanvoLL-D, demands of pedagogical adaptivity and structuring the lesson have further been reflected in the development of a test design framework that can be used for a standardized test measuring lesson planning. Currently, such a test development has started as part of the Cologne project funded by the BMBF program for increasing the quality of teacher education (Qualitätsoffensive Lehrerbildung, Project ZuS – Zukunftstrategie Lehrer\*innenbildung Köln). The test comprises several vignettes, each providing a planning situation as a complex stimulus followed by several test items measuring decision-making in such simulated planning situations.

Against this background, our methodological approach in the project PlanvoLL-D-Transfer comprises four transfer components:

- 1) We will transfer all PlanvoLL-D approaches to different samples of teacher candidates who come from federal states different from Berlin and North Rhine-Westphalia as the two federal states in which PlanvoLL-D was conducted.
- 2) We again will collect written plans of teacher candidates' demonstration lessons and analyze them using the same approach as developed in PlanvoLL-D.
- 3) In addition to this, these teacher candidates will be tested using the novel standardized test developed in the project ZuS. This allows us to compare and validate our analysis of written lesson plans with a corresponding standardized test on planning competence. To our knowledge, such a validation procedure has not been carried out by any other study.
- 4) Both information from lesson plan analysis and test scores will be used to inform a selected group of teacher candidates and their educators in order to introduce them with relevant diagnostic information. Practical implications of this feedback supply will be evaluated.

#### *Current status of the project and next steps*

Data collection using the novel test instrument in a larger survey in the project ZuS will be carried out during summer 2019. The final instrument should be available in 2020. As a next step, a selection of federal states will be created and a data collection plan developed.

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## **Scientific Reasoning in Primary School Teacher Education** | Volker Brüggemann and Volkhard Nordmeier

### *Introduction*

In cooperation with the department of primary school teacher education of Freie Universität Berlin, the instrument developed and validated in Ko-WADiS and ValiDiS (Hartmann, Upmeier zu Belzen, Krüger, & Pant, 2015) will be used to investigate the scientific reasoning competence of pre-service primary school teachers.

### *Theory*

Due to the increasing shortage of teaching staff, the number of students in the teaching profession at Freie Universität has risen sharply. In the field of primary school teacher education, it was therefore decided to assess one of the new cohorts of students (primary school teachers in the subject area of science teaching) from the beginning of the bachelor studies to the end of their master degree. Various constructs, that are regarded as particularly relevant to this course of study are investigated (cf. Albrecht & Köster, 2013; Straube, 2016; Willich, Buck, Heine, & Sommer, 2011). In an earlier study, performance in scientific reasoning in the target group was low (Straube, 2016). The development of this competence and its relation to other constructs (especially self-concepts and specialist knowledge in the natural sciences) will therefore be considered in the evaluation. The purpose is to determine whether earlier findings are still valid even after a significant expansion of the student group.

### *Method*

In order to provide economic yet reliable test results, a computer-adaptive version of the Ko-WADiS instrument is used (Brüggemann & Nordmeier, 2018). In winter semester 2018/19, a pilot test will be carried out in the target group. The main study will take the form of a pretest in summer semester 2021, and a posttest in winter semester 2023/24. A full survey with 250 to 300 participants is planned.

### *Outlook*

The pilot study is being carried out at this moment. Data analysis is planned for the first half of 2019. With the collected data, IRT-based item parameters will be calculated, and the quality of the measurement will be assessed on the basis of model fit and reliability analyses. We will then investigate measurement invariance by comparing the item parameters in the new sample to the parameters from known test subject groups in order to identify any deviations in the response behavior (e.g. differential item functioning). Subsequently, we will carry out a comparison of the ability distribu-

tions of the pre-service primary school teachers and groups known from the ValidiS project, in particular pre-service secondary school science teachers. The instrument can then be adjusted as necessary by the end of 2019. All insights gained from the process will be published in an article in cooperation with the department of primary school teacher education. Another publication will follow after completion of the main study.

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## **icMAPS – International Comparison of Mathematics Anxiety of Pre-Service Primary School Teachers** | Lars Jenßen, Eva Norén and Audrey Cooke

### *Theoretical background*

In competence research, affective-motivational characteristics besides knowledge, situation-specific skills and performance are assumed as inherent parts of teachers' professional competence (Blömeke, Gustafsson, & Shavelson, 2015). As emotional issues have long been of interest in the field of mathematics education (McLeod, 1994), mathematics anxiety can be seen as a crucial emotion within this field (Dowker, Sarkar, & Looi, 2016; Ramirez, Shaw, & Maloney, 2018). Mathematics anxiety is defined as a conglomerate of negative emotions, e.g. fear, helplessness and shame, which occurs in math-related situations and which also has negative consequences for individuals, such as low achievement in mathematics (cf. Ashcraft, 2002; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016). It also seems to be highly prevalent for pre-service primary school teachers (e.g. 36,8% for Germany: Iwers-Stelljes et al., 2014). Empirical findings indicate that the level of math anxiety changes only slightly from pre-service to in-service teachers (Gresham, 2018) and that teachers' math anxiety has negative effects on students' achievement (Ramirez, Hooper, Kersting, Ferguson, & Yeager, 2018). Current studies show that math anxiety is a global phenomenon (Foley et al., 2017). As the results of PISA 2003 revealed, Sweden shows the lowest level of math anxiety, Germany's level of math anxiety is also below the international average and Australia's level of math anxiety is above the international average (Lee, 2009). For all three countries the level of students' mathematical competence is above the international average (ibid.).

### *Theoretical assumptions*

Based on our own preliminary studies, (pre-service) primary school teachers' math anxiety is assumed to occur in different math-related situations, e.g. during working on mathematical tasks, teaching math at school and taking an exam in math (Cooke, Cavanagh, Hurst & Sparrow, 2011). Following basic assumptions of Educational and Emotional Psychology, affective, cognitive, somatic/physiological and behavioral facets are seen as descriptors of the phenomenology of math anxiety (Pekrun & Linnenbrink-Garcia, 2014).

### *Aims of the project*

- International comparison concerning pre-service primary school teachers' math anxiety between Australia (Curtin University), Sweden (Stockholm University) and Germany (Humboldt-Universität zu Berlin)

- Knowledge about the development of pre-service primary school teachers' math anxiety during their Bachelor studies and triggering and maintaining conditions (e.g. opportunities to learn, mathematical competence)

### *Methodological approach*

Formal information:

- Sample: Pre-service primary school teachers during Bachelor studies
- Measurement points: Beginning of Bachelor's degree (1st semester) and end of Bachelor's degree
- Design: cross-sectional, longitudinal
- Assessment mode: online via specific tools

Instrument: MAPS (Mathematics Anxiety Scale for Pre-Service Primary School Teachers)

- content: four facets within three different (imaginary) situations (working on mathematical tasks at university level, being in a mathematics test situation, teaching mathematics at primary school in the future)
- adaption of an instrument regarding math anxiety from Australia (cf. Cooke et al., 2011)
- extended by items from a German mathematics anxiety questionnaire (in-house development at Humboldt-Universität zu Berlin for evaluating teacher education)

### *Current status and next steps*

- Project management: Dr. Audrey Cooke (Australia), Dr. Eva Norén (Sweden), Dr. Lars Jenßen (Germany)
- Pilot study for the questionnaire (MAPS) and its (international) validation in 2019
- Main study will start at January 2020

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**Investigating Cognitive Processes of Mathematics Teachers' Ability to Apply Knowledge for Mastering the Demands of Teaching and Reflecting Instruction** | Colin Jeschke, Nicole B. Kersting, Hannes Saas, Anke Lindmeier, Christiane Kuhn, Olga Zlatkin-Troitschanskaia and Aiso Heinze

*Background*

Recent approaches on modelling and measuring teacher cognition focus not only on the knowledge teachers need but also the ability to apply this knowledge for mastering the demands that teachers typically encounter (Kersting, 2008; Kuhn, Alonzo, & Zlatkin-Troitschanskaia, 2016). We defined a teacher's ability to apply knowledge for mastering the demands of teaching in the classroom (e.g., answering a student's question) as action-related competence (AC) and the ability to apply knowledge for mastering pre- and post-instructional demands (e.g., reflecting instruction) as reflective competence (RC) (Lindmeier, 2011).

From a cognitive perspective, AC and RC are proposed to be different processes because – in contrast to pre- and post-instructional demands – instructional demands require spontaneous immediate reactions (Evans & Stanovich, 2013). In our previous work, we provided evidence that AC and RC are empirically separable (Knievel, Lindmeier, & Heinze, 2015) and that a teachers ability to apply knowledge for teaching is domain specific (ELMaWi project: Jeschke et al., 2019).

However, despite a considerable progress in the field of teacher cognition, research has not yet comprehensively explained what the mechanisms enable teachers to purposefully apply their knowledge and how teachers acquire this ability. According models of teachers' cognitive processes are lacking so far.

*Aim*

In this study, we aim to apply an approach to teachers' cognitive processes with Bayesian network models currently developed by the TeKno research group at the University of Arizona (Kersting, Smith, Vezino, Chen, & Stigler, submitted). In this initial study, we investigate if this approach can be used to further describe cognitive processes of mathematics teachers (AC and RC).

*Approach*

In order to assess RC and AC, standardized video vignettes with an open-ended response format have been developed in the ELMaWi study to validly simulate typical demands that mathematics teachers face when planning or reflecting on instruction (RC) or teaching in the classroom (AC). Teachers verbally respond to the video vignettes with their own words, which are recorded via microphone. The responds can be processed using standardized scoring schemes and trained coders.

In addition to this established procedure, we now intend to explore which knowledge is contained in teachers' responses given their AC and RC scores. This entails identifying specific knowledge and connections between different knowledge contained in teachers' responses using Bayesian probabilistic networks. In this functional approach, knowledge underlying teachers' AC and RC are described as pieces of knowledge connected by weighted pathways that determine which knowledge will be activated and applied in a specific teaching situation (Kersting et al., submitted). Accordingly computed knowledge network models might give insights in how knowledge is structured so that it is useful for teaching (AC) as well as planning and reflecting instruction (RC).

#### *Status of the study*

Currently, responses of mathematics pre-service and in-service teachers are examined with regard to appropriateness for Bayesian network modelling. We explore the potential to which the novel approach may be useful to complement our prior models and methodology.

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## **TEDS-Transfer** | Gabriele Kaiser and Johannes König

### *Background information*

The German teacher education system has a specific structure (König & Blömeke, 2013). Pre-service teachers first have to study at university with a strong focus on theoretical input, then, after graduation from university, they enter the second practical phase that is provided at training centers of each federal state. This second phase serves as induction. Pre-service teachers have to teach part-time and attend courses in pedagogy and subject-specific pedagogy. There is a gap between the two phases, not least due to differences in the curriculum. Teacher educators of the two phases have different types of qualifications. The two-phase structure has been criticized for this and reforms have been required to make initial teacher education in Germany more coherent (König et al., 2017). For example, the international teacher education study TEDS-M 2008 showed that among the 17 international participating countries, pre-service teachers in Germany perceived their initial teacher education curriculum least coherent (Hsieh et al., 2011). With regard to this coherence problem of the two-phase structure in German teacher education, diagnostic information on the competence level pre-service teachers have when they transit from university teacher education into the induction phase might be of great value when designing the curricula and appropriate learning opportunities of the second phase. The idea of TEDS-Transfer is to generate such information and to share it with teacher educators who in turn use the information for adaptive teaching in their pedagogy or subject-specific pedagogy courses and for restructuring their curriculum.

### *Theoretical considerations*

TEDS-Validate, as all other projects in the TEDS-M context, have proliferated innovative approaches of measuring teacher competence. A substantial number of standardized instruments have been developed, applied, and used to get insight into their validity. The TEDS instruments inventory therefore has the potential to being applied in various research and evaluation contexts. So, for example, they are capable to deliver relevant diagnostic information within and for the process of pre-service teacher professionalization. In detail, the TEDS instruments allow a thorough assessment of

- MCK, MPCK, and GPK as the relevant categories of teacher professional knowledge (Shulman, 1987) originally developed as paper-pencil tests that are also available as online-assessments;
- Perception, Interpretation and Decision-Making (PID) as situational facets of teachers competencies relevant in the mathematics classroom using video-vignettes related to mathematics pedagogy, general pedagogy, and classroom management;
- the ability to identify student errors;

- instructional quality using a novel observational instrument (Schlesinger et al., 2018).

The breadth of the TEDS instruments inventory allows a complete operationalization of novel understanding of teacher competence as being a continuum comprising cognitive dispositions, situational-specific skills, and performance (Blömeke et al., 2015; Kaiser et al., 2017).

#### Methods and design

The study will be conducted in two or even more federal states in Germany. Pre-service teachers will be surveyed at the very entrance into the second phase of initial teacher education. The study has two application levels:

- On the first level, assessment data can be interpreted as outcome of the first phase at teacher education, therefore informing education policy about the current status quo of teacher education at universities. This evaluation will be relevant with regard to current debates in the context of teacher education reform such as led by the “Qualitätsoffensive Lehrerbildung” (BMBF, 2014; König et al., 2018).
- On a second level, individual and group information (such as test scores) will be shared with specific teacher educators who function as cooperating partners in the project. Coaching will be provided to the educators giving them support to integrate diagnostic information in designing their seminar.

If possible a survey at the end of the second phase of teacher education will be carried out offering the educational seminars feedback and guiding information for a possible re-design of the curriculum and their courses.

#### Current status and next steps

The development of a network of teacher educators who work in the second phase of teacher education has already been started. There is evidence that training institutions are highly interested to cooperate, so that access to the field should be given in order to conduct TEDS-Transfer.

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**All German – all English Approach? Teachers' Beliefs Concerning Teaching in Linguistically Diverse Classrooms: a Cross-Cultural Comparison** | Svenja Lemmrich, Mario Moya and Svenja Hammer

*Background and theoretical considerations*

Teachers of all subjects need to acquire and apply a wide range of linguistic competences to be able to teach multilingual learners that enable them to deal with classroom heterogeneity in such a way to promote and facilitate learning for all. Whilst Opportunities to Learn (OTL) in Teacher Education in Germany are very diverse, these have not been evaluated in terms of their impact and potential to improve learning experiences. In order to measure competencies in teaching multilingual learners and to evaluate the OTLs in Germany, the BMBF-funded interdisciplinary project DaZKom-Video develops a video-based test instrument based on the German-as-a-second-Language (GSL)-competency model and adding to the existing paper-pencil test, developed in the DaZKom-Project (Ehmke et al., 2018). The preoccupation for equipping in-service teachers with competences to teach children from varied linguistic backgrounds has also been shared by other countries in Europe such as the UK where several studies and publications on English as an additional language (EAL) in learning environments attest to the importance of the matter (Blackledge & Creese, 2010; Burns, 2018; Coleman, Galaczi & Astruc, 2007). Studies such as Copland & Neokleous (2011) indicate that students' mother tongues were not seen as a resource with a potential to scaffold the learning of the language of a larger community. According to Gogolin (2009) and Moya (2016), it appears that for a vast majority of pre- and in-service teachers, teaching multilingual learners is still challenging, even though there is compelling evidence that shows that multilingual learners have, indeed, some competencies and abilities as a result of their linguistic experiences in their mother tongues which monolingual learners do not possess. Since the situation in the UK and in Germany face similar challenges and, to some extent, the same needs concerning the teaching of multilingual learners it is interesting for both countries to take a closer, comparative look at Teacher Education to explore how the UK and Germany equip teachers with the necessary competences that enable teachers to create opportunities for learning for those students whose mother tongues are different from the national languages (German, and in the case of the UK, English only). Additional to a competency-test, the DaZKom-Project uses a paper-pencil scale on teachers' beliefs concerning teaching multilingual learners. Since a translated version of the scale on Beliefs about Multilingualism in School is already available and was used for a cross-cultural comparison between Germany and the US, the additional comparison with the UK is of much interest to map out teachers' beliefs across nations in relation to classroom heterogeneity. Some preliminary studies in this field appear to indicate that an appreciative attitude of teachers

towards multilingual learners is a crucial prerequisite for linguistically responsive teaching (Hammer et al., 2018).

#### *Methodological approach*

Teachers' beliefs concerning multilingual learners are measured with a paper-pencil survey instrument. The 50 items of the scale are statements that have to be rated on a response scale: 1) strongly disagree, (2) somewhat disagree, (3) somewhat agree, and (4) strongly agree. According to Hammer et al. (2018), the scale consists of four dimensions: (1) "Embracing the interconnected nature of language with culture and identity", (2) "Understanding language demand in content classrooms", (3) "Feeling responsible for the language development of multilingual students in content classrooms", and (4) "Valuing multilingualism" (Hammer et al., 2018, p. 7). The survey will end with one open-ended item to identify the nature of the respondents' beliefs. The sample will be pre-service teachers in Germany (n = 50) and the UK (n = 50). The results of a cross-cultural comparison between Germany and the US showed that even though teachers in Germany and the US agreed on several statements, the study also suggests statistically significant differences, e.g. concerning the teachers' feeling of responsibility for language teaching or their valuing of multilingualism (Hammer et al., 2018). For this reason, it is assumed that the planned collaborative study of Germany and the UK will reveal more interesting results. The data will be analyzed using a mixed-method approach and therefore combining quantitative scaling of the scales and a qualitative analysis of the open-ended item to identify possible relations.

#### *Current status and further steps*

Next steps are data collection in the upcoming summer and winter semesters. Since differences in teachers' beliefs may have a significant impact on teacher education programs, their measurement is crucial to understanding the quality of their OTLs. A further step is the application of translated versions of the DaZKom- paper-pencil and DaZKom-Video test in the UK in order to be able to compare the teachers' OTLs in both Germany and the UK. This comparison is the base for a fruitful mutual cross-cultural learning.

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## **Pre-Service Biology Teachers' Scientific Reasoning Competencies in an Experimental Setting** | Maria-Elisa Puhmann and Dirk Krüger

### *Project idea*

According to research results, students in biology education lack competencies in conducting scientific investigations (e.g., Hammann, Hoi Phan, Ehmer & Bayrhuber, 2006; Schulz, Prinz & Wirtz, 2012). These competencies are a part of scientific reasoning competencies, which are subdivided into four subcompetencies: formulating questions, generating hypotheses, planning investigations, analyzing data and drawing conclusions. Regarding the necessity to qualify teachers as precondition for competent biology education in school (Hilfert-Rüppel et al., 2009; Kultusministerkonferenz, 2005; Mayer & Ziemek, 2006), this project aims to evaluate the status of pre-service biology teachers' scientific reasoning competencies by a paper-pencil test and in a hands-on experiment.

Recent results referring to the competencies of students and prospective biology teachers are often based on quantitative data from paper-pencil tests. One example is the Ko-WADiS multiple-choice test instrument, which focuses on scientific reasoning competencies (Mathesius, Upmeier zu Belzen & Krüger, 2014). One source for evidence for a valid interpretation of the Ko-WADiS test scores is based on relations to other variables (see AERA, APA & NCME, 2014). To study this aspect of validity, we conducted a video study in which pre-service biology teachers were prompted to plan, perform, and evaluate an experiment. The qualitative analysis of the participants' performances in the hands-on experiment will be compared with their Ko-WADiS test results. The effectiveness of video studies with experimental settings to investigate competencies of conducting scientific investigations was shown by previous results (Kambach & Upmeier zu Belzen, 2015; Neumann, 2004; Walpuski, 2006). In total, 33 videos were recorded (main study: N=26 pre-service biology teachers; nBSc=21, nMSc=5). A category system to analyze the pre-service biology teachers' competencies was deductively developed based on the theoretical framework of scientific reasoning (Mayer, 2007) and empirical research (e.g. Arnold, Kremer & Mayer, 2012; Hammann, 2004; Hammann et al., 2006; Wellnitz & Mayer, 2008). Subsequently, in the analysis of video data the category system was inductively extended by adding new categories.

Analyzing the video transcripts, a variety of linguistic expressions used by the pre-service biology teachers became obvious. This is in line with results provided by Gyllenpalm and Wickman (2011) who emphasize an inappropriate use of terms like "experiment" and "hypothesis". Therefore, it will be analyzed whether the pre-service biology teachers' use such scientific terms accurately. These findings will be compared with the Ko-WADiS test results and the performances in the experimental setting (cf. Härtig, Neumann & Erb, 2017).

Additionally, confounding variables such as the pre-service teachers' motivation while experimenting and their confidence in dealing with their experimental setting will be analysed (cf. Härtig et al., 2017; Nehring, Nowak, Upmeier zu Belzen & Tiemann, 2015). Therefore, a linguistic and paralinguistic analysis is currently carried out to strengthen the reliability and trustworthiness of the data collected in the video study as a source of evidence for a valid interpretation of the Ko-WADiS test results.

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## **Adapted Primary Literature for Teacher Education** | Sebastian Schmid, Hannes Münchow and Sabrina Viehauser

### *Project idea*

One goal of pre-service teacher education is to equip students with the competencies they need to base their prospective educational practices on recent insights from educational sciences (European Commission, 2013). This implies that student teachers must achieve a certain degree of scientific literacy, understood as “the ability of people to understand and critically evaluate scientific content in order to achieve their goals” (Britt, Richter, & Rouet, 2014, p. 105). Yet, the tight curricula of pre-service teacher courses in educational sciences often leave little opportunities for deliberate attempts to promote the development of students’ scientific literacy. Teacher educators, who nevertheless pursue this goal, often face a lack of educational science texts that are appropriate for teaching purposes. Primary scientific literature presupposes content knowledge, methodological knowledge, and genre knowledge that student teachers generally lack. Thus, working with primary texts is usually too demanding for them. Teacher educators, who nevertheless use primary scientific literature in their classes, are therefore forced to devote a great amount of time on remediating comprehension problems and providing relevant background information, which leaves less time for deep-level elaboration, reflection, and evaluation of the texts’ argumentation. This problem is particularly severe in educational sciences courses for pre-service teachers because these courses are rarely complemented by courses on research methods.

In contrast to primary scientific literature, textbooks are specifically written to be understood by novices with little prior knowledge. However, in pre-service teacher education, textbooks are often both the starting point and the endpoint of students’ encounter with educational science literature. That is, they do not fulfill one of their intended functions in the course of academic socialization, which is to provide students with fundamental domain knowledge they can build on later when working with primary scientific literature. This is problematic, because textbook texts necessarily simplify matters, tend to neglect scientific controversies, focus on traditional rather than innovative approaches, and do not present recent research findings. Textbooks thus entail the danger of consolidating students’ absolutist epistemological beliefs (Kuhn, 1991). Consequently, an exclusive reliance on textbook texts does not seem to be a promising alternative.

Against this background, the project outlined here aims at the construction and evaluation of adapted primary literature (APL; e.g., Norris, Macnab, Wonham, & de Vries, 2009; Yarden, Norris, & Phillips, 2015) that is specifically tailored for pre-service teachers in educational sciences courses. APL is an educational hybrid genre that preserves the advantages of both scientific primary literature



and textbook texts while avoiding some of the disadvantages these genres have when used in teaching. For this purpose, scientific primary texts are rewritten by adding conceptual background information and removing technical details and scientific jargon. At the same time, the argumentation structure of the original text is maintained. This way, APL makes transparent how arguments are structured in scientific discourse and bridges the gap between introductory textbook texts and primary scientific literature. Most APL has been constructed for the high school context. In this context, evaluation studies yielded encouraging results with regard to students' inquiry and critical thinking skills (e.g., Baram-Tsabari & Yarden, 2005; Norris, Stelnicki, & de Vries, 2012). We assume that pre-service education in educational sciences can profit from APL based teaching as well.

**Adaptation of texts.** The selection of texts to be adapted includes both "classics" that are frequently cited in textbooks on educational science and educational psychology as well as important recent contributions. The texts are translated into German if necessary. The adaptation is empirically based: Teacher students are asked to read the original versions of the texts. For each paragraph, they write gist statements and note any comprehension difficulties they encountered. The gist statements serve to uncover potential misunderstandings. Students' notes are submitted to a qualitative content analysis in order to identify common misunderstandings and knowledge deficits. The results of this analysis are then utilized to rewrite the texts. The adapted texts can be implemented as hypertexts with links to additional in-depth explanations.

**Implementation.** The adapted texts are integrated in regular educational sciences courses for teacher students. Over these courses, students are presented with a sequence of increasingly challenging texts ranging from (a) introductory textbook texts, (b) APL, (c) annotated primary scientific literature, and (d) primary scientific literature. Texts are read at home and elaborated in the sessions using multiple didactical approaches (e.g., cooperative group work, discussions, and demonstrations).

**Evaluation.** The intervention is evaluated in a pretest-posttest field experiment. Competence increases of students in the APL courses are compared with competence increases of students in courses based on the original versions of the adapted texts. Students' competencies of dealing with academic literature are assessed by the argument structure test (AST; Münchow, Richter, von der Mühlen, Schmid, Bruns, & Berthold, in press) and other tests constructed and validated in the research projects KOSWO (Competencies of university students in dealing with scientific primary literature) and ASTRALITE (Assessment and training of scientific literacy).

**Sustainability and dissemination.** In the long run, the text corpus can be updated by continuously replacing texts. For dissemination purposes, the adapted texts will be published online.

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**Performance-Oriented Testing and Training in Teacher Education** | Christoph Vogelsang, Andreas Borowski, Christoph Kulgemeyer, Josef Riese, Peter Reinhold, Horst Schecker, David Buschhüter, Patrick Enkrott, Maren Kempin and Jan Schröder

*Objectives of teacher education*

The basic structure of teacher education is similar in all German federal states. At first, prospective teachers have to complete academic teacher education including content knowledge of usually two teaching subjects and additionally courses on educational sciences and subject-matter education. After completing their studies, students need to complete a teacher training, which comprises one to two years of practical school training at a school (Cortina & Thames, 2013). The underlying assumption of this model is that prospective teachers initially acquire professional knowledge (content knowledge, pedagogical content knowledge, pedagogical knowledge) during their university studies. This, in turn, should form the necessary basis for professional performance, i.e. adequately carrying out the professional activities of teachers (e.g. providing high-quality teaching). To train the use of theoretical knowledge in teaching situations, teacher study programmes at universities usually also include several internships at schools. The majority of the federal states implemented a six-month-long internship (practical semester) into their study programmes. During this internship, students are supposed to develop basic practical school skills, e.g. for planning or reflecting on lessons.

*Challenges of teacher education*

However, there are some difficulties in this model of teacher education. It is not clear whether student teachers actually learn to apply professional knowledge in teaching situations or acquire the desired basic practical skills during their school internships. One reason for this could be that practical teaching skills are just rarely a part of examinations. Examinations in academic teacher education primarily comprise knowledge assessments. The use of professional knowledge in real teaching situations is, therefore, not sufficiently reflected in existing degree programmes (cf. Biggs & Tang, 2011). On the other hand, it is also questionable whether the theoretical knowledge gained during university courses forms a basis for professional performance as assumed. Due to the sharp separation of study phases and practical school phases, there are few systematic opportunities to reconcile the two parts of teacher education. In particular, there is a lack of opportunities for the training of performance skills in settings with reduced complexity compared to the highly complex teaching situations in real school settings. This problem is particularly of interest for those who enter the teaching profession from the side and start their professional career without formal teaching qualifications. Physics teachers in particular account for a large proportion of this group (Korneck et al., 2010). For one thing, this group of prospective teachers usually has a high level of content knowledge, but due

to their insufficient amount of teacher training very little pedagogical (content) knowledge. For another, this group usually has to cope very quickly with the high complexity of school activities on their own.

#### *Performance assessments as a tool for teacher professionalization*

One way of meeting these challenges is to adopt approaches to training prospective health professionals for teacher education. In a certain sense, the structure of medical education is similar to teacher education and also faces the task of enabling students to use theoretical knowledge in performance situations. In medicine, however, a greater variety of methods has been used to assess professional skills (Miller, 1990). In particular, performance assessments have been implemented as an examination procedure in study programmes (Harden et al., 1975). In these assessments, certain professional activities are simulated under standardised conditions - often with trained actors - e.g. the recording of an anamnesis. Often several such tests are combined into a short series (Objective Structured Clinical Examinations). The focus of these examinations is on the actual performance of a person who is assessed by examiners. Such procedures also exist for the assessment of teaching abilities of medical trainers (Objective Structured Teaching Examinations, OSTE) (e.g. Sturpe et al., 2013). In addition to exam purposes, performance assessments are also used as learning opportunities to train practical skills (Objective Structured Teaching Exercises) (e.g. Macedo et al., 2015). In the Profile-P+ project, we developed performance assessments for planning and reflecting on physics teaching and explaining physics (Vogelsang et al., 2018). They demonstrate the possibility of developing such procedures for teacher training as well. Accordingly, they can also be used similarly for examination and teaching purposes.

#### *OSTEs for physics teacher education*

However, for the broad implementation of performance assessments in teacher education some development and research steps are still necessary. The assessments we have developed only cover a small part of the everyday tasks of physics teachers. Therefore, it is required to develop performance assessments for further relevant standard teaching situations, particularly for the compilation of entire series of assessments in the sense of an OSTE. The identification of these situations is a challenging task, requiring expert interviews, in particular from the field of subject matter education. The performance assessments of the Profile-P+ project were primarily developed to validate existing competence tests. They also need to be modified to be used as examination instruments. This requires, for example, studies on the acceptance of this new type of examination by teacher trainers and students and an adjustment of the scoring in such a way that it can also be used for valid grades in teacher study programs. Such improvements would also make performance assessments a suitable

ble instrument to support the selection and qualification of cross- and side-entry teachers in combination with existing professional knowledge tests. However, this requires further analyses of the validity of the procedures, in particular, an „evaluation of the consequences of the proposed uses“ (Kane, 2013, 1), i.e. consequential validity. Despite the works still required, performance assessments have a high potential to shed light on a blind spot in teacher education and to place the acquisition of more practical school skills in the focus of the first phase of teacher education programmes. Our experience in the domain of physics also offers a sound basis for transferring the concept to other subject domains.

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## 2.3 Domain-specific Competencies

**Analyzing Learning Processes in Higher Education Economics** | Jasmin Schlax, Olga Zlatkin-Troitschanskaia, Carla Marie Kühling-Thees, Judith Jitomirski, Marie-Theres Nagel, Roland Happ, Susanne Schmidt and William B. Walstad

### *Background and theoretical considerations*

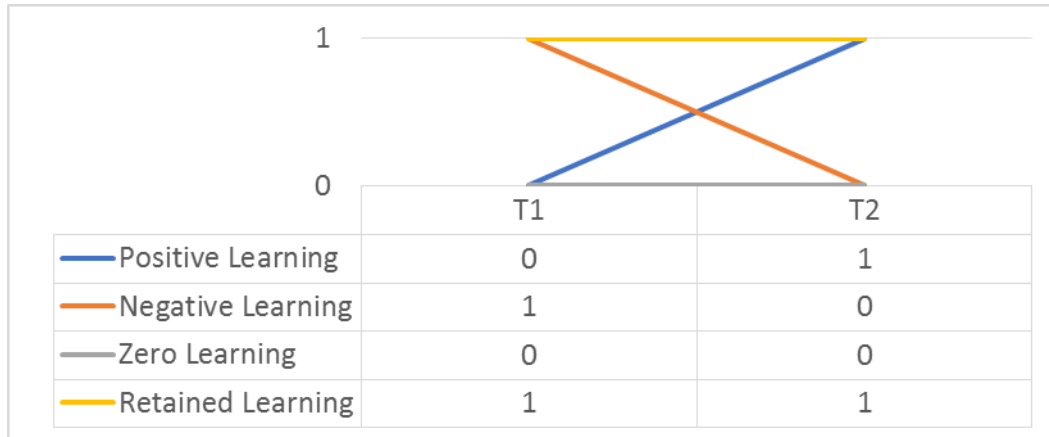
One of the main objectives of higher education is the acquisition of domain-specific knowledge (CHE, 2013), which is also true for one of the most popular study fields in Germany and internationally: economics (OECD, 2017). To effectively support students' learning, the growth of domain-specific knowledge over the course of studies should be measured validly (Shavelson, Zlatkin-Troitschanskaia & Marino, 2018) and reasons for possible low growth rates should be determined. Remarkably, there are only few instruments for measuring domain-specific knowledge or knowledge development (Zlatkin-Troitschanskaia, Pant, Lautenbach, Molerov, Toepper & Brückner, 2017) and a lack of longitudinal studies regarding the development of domain-specific knowledge (Schmidt, Zlatkin-Troitschanskaia & Fox, 2016). The WiWiKom I and II projects (Zlatkin-Troitschanskaia, Förster, Brückner & Happ, 2014; Zlatkin-Troitschanskaia, Jitomirski, Happ, Molerov, Schlax, Kühling-Thees, Pant, Förster & Brückner, 2019) aims to close this gap by developing and validating a short test to measure domain-specific knowledge in Business and Economics and its development over students' course of study.

Several statistical approaches are possible for the observation and analysis of knowledge over the course of the study. For example, difference scores are often used in knowledge tests to measure development between two measurement points. Difference scores can be calculated by subtracting the total scores of the knowledge test from both measurement points. As a result, a value is generated per person that reflects the change in the total score for the entire test.

Walstad and Wagner (2016) assume that this approach does not sufficiently reflect changes as positive changes and negative changes can average out and in this way be hidden behind what seems like no change. Instead, they suggest that the decomposition into different types of change per item – Positive (PL), Negative (NL), Retained (RL) and Zero Learning (ZL) – can offer a more differentiated view into knowledge growth. PL indicates that there has been an increase in knowledge between two measurement points. The opposite of PL is NL indicating a decrease. RL indicates constant knowledge and ZL stagnation (Fig. 1). Walstad and Wagner propose that the description of these four learning patterns at the item level and the calculation of scores allow for a more precise investigation of growth over students' course of study.

Based on a Germany-wide representative sample of economics students assessed in their first and second year of studies (Zlatkin-Troitschanskaia et al., 2019), this study examines the development of domain-specific knowledge via difference score and via individual learning patterns to extract the maximum amount of information from the data.

Figure 1. Disaggregated learning patterns.



Notes. 0=wrong answer, 1=right answer

#### *Methodological approach*

The underlying data base was collected in two surveys in the WiWiKom II project (Zlatkin-Troitschanskaia et al., 2019): In the winter term of 2016/2017 (T1), we assessed 7.679 business and economics students at 49 universities, followed by 1.868 students at 23 universities in the winter term of 2017/2018 (T2). The present analyses refer to the partial sample (n=748, 23 universities) that took part in both surveys. For a description of the sample, see Table 1. Despite the relatively high drop-out rate in T2, the sample is nonetheless very valuable, as no comparable data set currently exists in Germany.

The questionnaire used in T1 consists of sociodemographic questions (e.g., gender, age, migration background, vocational training), an economic knowledge test, and a scale for fluid intelligence (BE-FKI, Schipolowski, Wilhelm, & Schroeders, 2017). The economic knowledge test comprises 25 items from the WiWiKom test (Zlatkin-Troitschanskaia et al., 2019). The questionnaire used at T2 consists of comparable sociodemographic questions regarding the course of study (e.g. attended lectures and courses at university, grades, achieved credit points, satisfaction with academic subject) and the same economic knowledge test used in T1. The learning patterns were calculated per item (as you can see in Walstad & Wagner, 2016): if, e.g., an item was first answered incorrectly in T1 and then correctly in T2, a PL score of 1 was assigned for this item. The same procedure was used for NL, ZL, and RL and for each item. Finally, all respective scores per item were combined to a total score for



each pattern (possible range from 0 to 25). In doing so, information regarding the frequency of each pattern at the item and the person (or institutional) level can be gained.

Table 1. Descriptive statistics for the sample (N=748).

Variables	Values
age in years T1, mean $\pm$ SD	19.99 $\pm$ 2.383 (748)
female, % (n)	49.67 % (474/748)
another language other than German as preferred communication language, % (n)	2.42 % (744/748)
at least one parent not born in Germany, % (n)	27.94 % (748/748)
GPA in school, mean $\pm$ SD	2.26 $\pm$ 0.581 (743/748)
business and economics course in school, % (n)	34.81 % (747/748)
vocational training in business and economics, % (n)	16.04 % (748/748)
BEFKI (intelligence), mean $\pm$ SD	8.86 $\pm$ 2.674 (748)
Economics-related knowledge in T1	13.99 $\pm$ 4.221 (748)
Economics-related knowledge in T2	14.48 $\pm$ 4.897 (748)

*Note.* SD = standard deviation, GPA = Grade Point Average (in Germany 1.0 as the best possible grade), deviations in sample size due to missing values.

### *First results and next steps*

Based on the sample of 748 economics students, both approaches provide hints that we cannot find exclusively desirable learning paths regarding the development of domain-specific knowledge over the course of studies. In this sample, the difference score indicates a small but significant increase in the level of knowledge in the first academic year. The small change (including the fact that an entire year of studies has passed between T1 and T2) may also be due to the fact that some participants show a negative change in the overall score. Furthermore, all learning patterns can be discovered both at the item and at the person level. However, we can see that there is no change for most items (RL or ZL). The disaggregated view indicates that especially in the first academic year, a high degree of RL occurs, i.e., already existing knowledge may be repeated frequently. Similarly, although less frequently, NL, which points to a loss of knowledge, can be observed, possibly as a result of the acquisition of domain-specific misconceptions (Brückner & Pellegrino, 2016). Considering the relatively low level of PL, i.e., the acquisition of new knowledge, the overall difference in the mean test scores is smaller than would be possible if NL and ZL could be reduced in favor of the other two (and the more desirable) learning patterns. Although the disaggregated approach shows poorer reliability and validity than the difference score, information can be derived over all participants, at the person or institution and the item level. Furthermore, PL and NL can no longer be hidden behind "no change". In addition, a distinction can be made between RL and ZL, which is important for educational and learning practice as RL is a desirable pattern. In summary, the disaggregated approach can be considered an addition rather than a replacement of the traditional approach. It offers more qualitative insights into learning.

The next research steps should look at explaining differences in terms of variance in the learning patterns and the difference score, both at the item level (content, item characteristics) and the person level (socio-demographic, cognitive and study-related explanatory variables). Regarding further steps within the project WiWiKom II we aim to analyze the further development after 2 years of studying (T3) and after reaching the bachelor's degree (T4, in winter term 2019/20).

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## **Diagnosing Student Competencies about the Concept of Energy in a Digital Learning Environment** | Marcus Kubsch and Mutlu Cukurova

### *Background*

Digital learning environments are certainly on the rise and one of the potential benefits of digital learning environments over more traditional delivery approaches (e.g. textbooks) is their flexibility to adapt learning materials to the individual needs of different learners. Learning environments that dynamically adapt to the needs of the learner, such as dynamically changing the content level or providing timely and tailored feedback, promise to support learning better than traditional static learning environments (Kerres, 2012). To adapt learning environments to the needs of learners, the initial step for adaptive systems is to accurately detect what students already know (Hattie, 2009). However, standard assessment and evaluation methods often do not deliver the fine grain sized diagnostic information needed to dynamically adapt learning environments (Pellegrino, Chudowsky, & Glaser, 2004). The project “Diagnosing student competencies about the concept of energy in a digital learning environment” aims to develop assessments that allow a digital learning environment to dynamically adapt to the current understanding of the concept of energy. To do so, we will draw on the framework of evidence-centered design (Mislevy & Haertel, 2007), apply diagnostic classification models (Rupp & Templin, 2008), and utilize approaches from the emerging field of learning analytics to provide real-time adaptation of the online learning environment. Energy is a well-suited domain for such a project as there is substantial theoretical and empirical research on the teaching and learning of energy to inform the design of the assessment and pedagogy models of the system.

### *Theory*

We draw on evidence-centered design (ECD) (Mislevy & Haertel, 2007), to develop the assessments. ECD emphasizes the evidentiary base for specifying coherent, logical relationships among the (a) learning goals that comprise the constructs to be measured (i.e., the claims articulating what students know and can do); (b) evidence in the form of observations, behaviors, or performances that should reveal the target constructs; and (c) features of tasks or situations that should elicit those behaviors or performances.

Diagnostic classification models (Rupp & Templin, 2008) allow to attribute student answers to individual skills and thus to attribute a student to a certain skill pattern, e.g., with respect to energy we might find that a student has mastered the skills “forms of energy” and “transformations of energy” but still lacks understanding of “dissipation of energy”. The ECD process provides us with the information needed to map student answers to certain skills.

Digital learning environments are rich data sources that provide additional information which can support competency diagnosis. The field of learning analytics provides opportunities to collect and interpret data that might better reflect the implicit learning processes of students. For example, when a student interacts with a digital learning environment, response time, cursory behaviors (speed, area covered, hovering actions etc.), number of trials etc. may all provide valuable information to estimate guessing and slipping parameters in diagnostic classification models. Digital learning environments and the data they produce also allow us to go beyond tests or quizzes to learn about students' skills through activities that are not designed specifically as tests (Shute & Ventura, 2013), e.g., setting up exploratory simulation environments that allow students to express their ideas on key constructs can also provide us valuable information about students' skills in that area (see Newton's Playground examples in Shute & Ventura, 2013).

#### *Current status and next steps*

Currently, many of the individual parts of the project have been developed (Gersner et al., 2018; Kubsch, Nordine, Neumann, Fortus, & Krajcik, 2018; Neumann, Kubsch, Nordine, Fortus, & Krajcik, 2018) or are in the last stages of development. The next steps will be putting the pieces together in pilot implementations.

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## **Cognitive Processes of Students in Sustainability Management | Anton Repp**

### *Project idea*

Over the past decade, universities have been intensifying their efforts to systematically integrate sustainability issues into their curricula. This applies in particular to the development of sustainability-related management skills in business study programs (Brock, de Haan, Etzkorn & Singer-Brodowski, 2018). However, the validation of the underlying competence models and the measurement instruments remain a key challenge (Blömeke & Zlatkin-Troitschanskaia, 2015).

The aim of the research project Ko-NaMa was to develop and test a competence model to assess learning outcomes in the field of sustainability management in higher education business study programs (Seeber, Hartig, Dierkes & Schumann, 2016). A multidimensional structure of competencies was assumed, which differs according to knowledge representation (i.e. declarative vs. schematic and strategic knowledge) and content area (i.e. business management and sustainability from a social point of view as well as sustainability management). A simulation- and computer-based test was developed to measure complex skills in sustainability management such as decision making and justification under economic, ecological and social perspectives. In this simulation, the students have to cope with different business situations along the entire value chain of a virtual company. The final test-assessment consisted of several components and included 184 items to measure declarative knowledge about business administration, sustainable development from a societal perspective and sustainability management, as well as 73 items in 13 complex business situations to evaluate the application of different types of knowledge. 850 students from 18 German universities have participated in the Ko-NaMa-Assessment. This sample was used to test the theoretical assumed competence structure (Seeber et al., in publication). The results have shown that the different types of knowledge can be regarded as disjoint dimensions. However, the assumed relationships between the dimensions are ambiguous. Findings also indicate the need for further investigations of the interactions between knowledge on the one hand and interests, attitudes and internalized ethical norms towards sustainability on the other.

The theoretically and methodologically important question as to whether the desired competence construct is measured with the survey instrument is mainly determined by the test results. Until now, less attention has been paid to the cognitive processes that lead to a specific item solution. Competence diagnostics is faced with the challenge that numerous mediating processes take place between the latent competence construct and the observable performance, making direct proof difficult (Blömeke, 2013). The cognitive processes of the test participants often remain unaffected by the typically conducted validity checks of survey instruments, even though their importance is empha-

sized in theoretical validation work (e.g., Kane, 2013). Despite theoretical localization and content validation, it cannot be assumed that the test participants' understanding of the terms converges with the test developers' understanding. Since task processing depends on individual patterns of interpretation and thinking, it is necessary to analyze the cognitive reactions of the test participants and the task characteristics to identify possible sources of measurement errors (Schaper, 2014). This requirement is of importance in sustainability management, which is characterized by dealing with uncertainties and deviations. It is therefore necessary to analyze the cognitive processes of students when working on test-item in the field of sustainability management.

From a multitude of different approaches for assessing cognitive processes, only methods based on verbal data offer access to construction-relevant content aspects for cognitive validation (Gorin, 2006). In think-aloud interviews, the interviewee is asked to express his thoughts, emotions and impressions aloud while working on test items. In this way, the method provides insights into the open and hidden cognitive processes of the participant. During the actual interview, the interviewer remains in the background in order not to influence the interviewee during the task processing (Schnell, 2016). The selection of suitable items to study the cognitive processes of students is of crucial importance for cognitive validation. The situated items of the business simulation from the Ko-NaMa assessment appear particularly suitable for this. They are more aligned with performance measurement. For a valid interpretation of the test values and to ensure comparability with the findings of the Ko-NaMa study, systematic selection should be made from the pool of Ko-NaMa-items based on task-related and validation-relevant criteria. Students of economics in advanced Bachelor's or Master's degree programs appear to be suitable for sampling, as the processing of Ko-NaMa-items requires a basic understanding of business administration. Based on cognitive psychological theories, the thoughts, memories and decision-making processes are then described. For this purpose, the audio-visual recording of the interview after the transcription is examined by content analysis. This allows an evaluation of the fit between the intended item characteristics and the understanding of the test participants. In addition to the cognitive processing of different types of knowledge in business contexts (Brückner, 2017), this also allows deeper insights into the associated decision-making and justifications in sustainability-relevant business situations.

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## **The First-Impression Effect as a Condition to Entrust Professional Activities to Young Residents** | Kristina Schick, Melanie Zimmerhackl, Martina Kadmon, Sigrid Harendza, Martin Gartmeier and Pascal O. Berberat

### *Project idea*

Senior physicians entrust professional activities to young residents in their daily routine. Entrustable professional activities (EPA) describe parts of everyday clinical work, which are usually entrusted in a stepwise manner (Ten Cate et al., 2015; Ten Cate, 2018). Previous studies investigated the conditions at which particular tasks are entrusted to young residents. These conditions are the supervisors and young residents personality, the relationship between the supervisor and the young resident, the type of task, and the situation (Sterkenburg, Barach, Kalkman, Gielen, & Ten Cate, 2010; Ten Cate et al., 2015; Ten Cate et al., 2016). In addition to these findings, Wood (2014) emphasized the impact of the first impression on further decision making processes. Our study investigates the effect of supervisors' first impressions of young residents on the level of entrustment of professional activities to them. The study is part of the KoKoHS-project ÄKHOM (competences of physicians – Hamburg Oldenburg Munich), simulating a first day of residency in three phases (consultation hour, patient management phase, and handover phase). In this context, the following research questions will be answered:

1. How important is the first impression to the level of professional activity entrustment to young residents?
2. Could supervisors already entrust professional activities to young residents after only a 2 min. contact during a welcome session?
3. Will differences in entrustment level be observed between an assessment of 5 hours with multiple meetings between supervisor and young resident and a "thin slices"-video-observation (60 sec.)?

We use the "thin slices"-method to investigate the impact of first impression effect on the entrustment level of professional activities (Wood, 2014). Senior medical students participated in "ÄKHOM". At the end of the five-hours-assessment, the ÄKHOM-supervisors filled out a questionnaire with entrustment levels for different EPAs to the participants in the role of residents. For this study, we used the videotaped welcome session between participants in the role of residents and their supervising physician and the videotaped handovers. The videos were "sliced" in 60 seconds units and one slice of a specific video was randomly selected. The sliced videos were assessed using six EPAs from the EPA-questionnaire of the project "ÄKHOM". We selected the six EPAs from the entire EPA-questionnaire using Principal Components Analyses. Senior physicians (N = 66) watched 12 video

slices in a random order and entrusted the six EPAs to the particular young resident shown in the video slice (six introduction session with supervising physician and six handover-talks with peers). Currently, we finished the data collection. The next steps will be analyzing the data and examining our hypotheses.

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