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Sigrid Blömeke & Olga Zlatkin-Troitschanskaia (Eds.)

The German funding initiative “Modeling and Measuring Competencies in Higher Education”: 23 research projects on engineering, economics and social sciences, education and generic skills of higher education students

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The German funding initiative “Modeling and Measuring Competencies in Higher Education”

23 research projects on engineering, economics and social sciences, education and generic skills of higher education students

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Ko-WADiS – Evaluating the Development of Scientific Inquiry Competencies in Academic Science Teacher Education

Straube, P., Stiller, J., Mathesius, S., Hartmann, S., Nordmeier, V., Tiemann, R., Upmeier zu Belzen, A., Krüger, D.

Relevance and aims
According to various researchers, there is a need for empirical, competence-based studies in academic science teacher education (Reinhold, 2004; Schecker & Parchmann, 2006; von Aufschnaiter & Blömeke, 2010; Zlatkin-Troitschanskaia & Kuhn, 2010). Such studies will be necessary to evaluate the success of university courses, and to develop academic education (Wissenschaftsrat, 2008). Thereby, modeling and assessing competencies serve as a basis for policy control.

Project Ko-WADiS sets out to establish a reliable instrument to evaluate the development of competencies in the field of scientific inquiry during the phase of academic science teacher education. It is conducted in collaboration of the departments of biology education and physics education at Freie Universität Berlin and the departments of biology education and chemistry education at Humboldt-Universität zu Berlin.

Research questions
The main research questions of project Ko-WADiS are: What empirical evidence can be found to support a theoretically predicted model of competencies? How do competencies in the field of scientific inquiry develop during the phase of academic science teacher education?

Theoretical background
Competencies in the field of scientific inquiry are often described as science syntactic knowledge (Abell, 2007) and thus constitute a component of teachers' professional knowledge (Baumert & Kunter, 2006). Scientific inquiry competencies are assumed to be a fundamental part of scientific literacy (American Association for the Advancement of Science [AAAS], 1993; Bybee, 2002; National Research Council [NRC], 2012) and play a key role in the education of (future) science teachers (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland, 2010). "Scientific inquiry refers to characteristics of the scientific enterprise and processes through which scientific knowledge is acquired" (Schwartz, Lederman, & Crawford, 2004, p. 611). According to Mayer (2007), the way of acquiring scientific knowledge is a complex problem solving process. Based on assumptions made by Mayer (2007) and Upmeier zu Belzen and Krüger (2010), the underlying theoretical model of the competence structure in the field of scientific inquiry consists of two domains: conducting investigations and using models. These domains can be further divided into sub-dimensions (fig 1).

Figure 1. Domains (blue) and sub-dimensions (grey) of scientific inquiry.
Research design
To assess these competencies, a paper-pencil test with 146 multiple-choice items was developed. A pilot study (N ~ 650) is scheduled for summer 2013. The instrument will be used in a longitudinal survey assigned to different text booklets (multi-matrix design) in order to answer the central research questions. The longitudinal survey will start at the end of summer semester 2013. Every student will be tested twice during the bachelor stage and twice during the master stage of academic teacher education. Data will be analyzed using methods of Item-Response-Theory.

The project is funded by the Federal Ministry of Education and Research as part of the program Modeling and Measuring Competencies (KoKoHs). The first stage of the project ends in April 2015.

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References


Project Ko-WADIS

Evaluating the development of scientific inquiry competencies in academic science teacher education

Jurik Stiller, Sabrina Mathiesius, Philipp Straube, Stefan Hartmann, Volkhard Nordmeier, Rüdiger Tiemann, Annette Upmeier zu Belzen & Dirk Krüger

Educational Significance & Aims

Modelling and assessing competencies is currently promoted as the basis for policy control (e.g. Klome, Leutner, & Kenk, 2010), particularly in the area of primary and secondary education. Most recently, a transfer of the term competency to the field of teacher education can be stated (Kunter, 2010). Von Auerschwitz and Bilmeke (2010) now demand a competency-oriented teacher education research in the natural sciences (see also Schecker & Parchmann, 2006; Reinhold, 2004). Of particular importance are the skills in terms of scientific inquiry, understood as a component of teachers' professional knowledge (see Baumber & Kunter, 2006). These have mainly been investigated in the field of primary and secondary education. However, in higher education, so far only a few studies exist (e.g. in physics Wöltkowiski, Riese, & Reinhold, 2011). For an evaluation of skills in scientific inquiry, there is a lack of adequate measurement instruments.

In this project, this desiderate is met through a large-scale assessment of science student teachers’ competencies in the field of scientific inquiry. Therefore, a paper-and-pencil-test with multiple-choice (single-select) items has been constructed, based upon theoretical models of Mayer (2007) and Upmeier zu Belzen and Krüger (2010; see figure 1).

Competence structure model

Methodology

- longitudinal large-scale assessment of science student teachers’ competencies in the field of scientific inquiry

- multiple-choice (single-select) items in paper-and-pencil-booklets

- \( N = 3,500 \) student teachers (biology, chemistry and physics) in Berlin, Innsbruck and Vienna in different stages of their studies

Research questions

- What empirical evidence can be found to support this theoretical predicted model of competencies?

- How does the competencies in the field of scientific inquiry develop during the phase of academic teacher training?

Outlook

By 2015, information about the structure and development of science students teachers’ competencies in the field of scientific inquiry shall be elicited, and thereby tangible recommendations concerning the conception of university courses shall be derived.

Selected project publications


References


References


