

**Diagnose experimenteller Kompetenzen
in der laborpraktischen Chemielehrer*innenbildung**

Inaugural-Dissertation

zur

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Abstract

As an elementary component of scientific literacy, experimental competences are considered both a possible outcome and a prerequisite for meaningful laboratory work in the chemistry laboratory. Nevertheless, there is still a research desideratum, especially with regard to the specifics of chemistry as a subject and with regard to chemistry teacher education. The present study makes a contribution in this respect by conceiving, evaluating and applying a model and an assessment for experimental competences in their mutual interdependency under the guiding questions “What do we want our students to know?”, and “How will we know that they know it?” In contrast to existing approaches that address processes atomistically, a holistic approach to modelling and assessing experimental competences is pursued. Therein students' knowledge, abilities and skills are integrated and assessed in a concerted manner in a self-designed experimental process.

To this end, a competence model is developed based on extensive literature research and evaluated with the help of a survey among experts and video recordings of practical performance assessments in order to find out how suitable it is for representing experimental competencies. After several feedback loops with performance assessments and extensive revisions, the model forms a valid, empirically validated framework of experimental competences in laboratory courses. It consists of eight dimensions with a total of 38 aspects graded at four levels each. Based on this analytical foundation, coding guidelines for three different types of experimental problems are tested, formatively evaluated and further developed. Through this the evaluation of the data collected in the test procedures in form of video graphed actions, comments, interviews, laboratory reports and self-assessments is made possible, taking into account the criteria of qualitative research. For the evaluation and revision of the instruments, data of 33 practical performance assessments from 26 students of four cohorts are used.

Based on further 26 performance assessments from 12 participants, the instruments, which turned out to be adequately proven, are then used to diagnose general resources and difficulties of chemistry-students. Six of the participants took part at three survey times and two at two points in time, so that developmental processes could also be examined in a long-term case study. The results show that the students are able to formulate questions and hypotheses, plan suitable experiments, make observations, evaluate them appropriately and adequately assess their results in an open inquiry setting. In this respect, a significant increase in competences in experiment-specific knowledge, process-related abilities and above all practical skills can be determined in undergraduate chemistry laboratory education. However, it is also evident that questions and hypotheses are often designed around a well-known experiment and thus aim for

purely confirmatory, unambiguous effects. In this respect, students tend to lack epistemic insights and strategic knowledge to design reflected and reflexive scientific inquiry, including systematic control-of-variables-strategy and reflexion of errors and limitations. Regarding laboratory safety results a need for improving the interaction between safety-related knowledge and skills, information literacy and safety awareness becomes obvious. Therefore, in an outlook possible interventions are outlined to address these and further demands.