Mixed-age chemistry classes

conception and realization of inter-grade experimentation sets

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Mixed-age teaching

In the course of the restructuring of the German school landscape over the past 15 years, concepts have become established which, on the one hand, require a different approach to the heterogeneity of the student body and, on the other hand, demand the teaching of independent and more complex learning and work. One example of this is the approach of mixed-age teaching. By this is meant …

> „[…] *an alternative form of school organization in which students are not grouped into classes by year, but rather different age groups are integrated into one class.*“
>
> (Felbrich, Kuhl & Pant, 2017)

In this context, three different forms can be differentiated:

Forms of organization of mixed-age learning

- **multi-grade**-classrooms
- **multi-age**-classrooms
- **non-graded**-classrooms

At the Montessori School Jena, multi-age classes will be increasingly integrated into science classes starting in the 2017/18 school year, in the form of the three-year mix at ages 13 to 15, based on Maria Montessori's reform pedagogy.

Research interest

The present work supports this process in the subject chemistry with regard to the following aspects: A first part deals with the presentation of basic design criteria for learning and experimentation sets in the context of age heterogeneous learning. Based on a theoretically founded criteria catalog, such a set was developed as an example and placed in the focus of further investigations (Fig. 1).

Fig. 1: Materials of the set 'Acids & Bases' (left) and the materials of Experiment 1 'pH-Value and indicators' (right).

The central goal of the subsequent testing and evaluation of this set on the topic of acids and bases by students at ages 13 to 16 was to test the suitability of this material with regard to its use in promoting and optimizing chemical learning processes in the context of mixed-age teaching in lower second´-dary school. The following research questions result from this context:

1. **What design criteria must learning and experimentation sets meet in order to be used in the context of mixed-age teaching?**
2. **Are the materials developed appropriate for age heterogeneous learning?**

Study design and methodological approach

Basically, the format of this work followed the **design-based-research** approach, according to which a practice-oriented problem or question is answered in a theory-driven way. Therefore, it was necessary to establish interdisciplinary references between educational and scientific fields.

Due to the explorative character of the questions raised, the approach of this work was to be assigned to the tradition of **qualitative research methodology**. In this context, a process was realized that comprised a total of four central phases, alternating between theoretical-curricular and qualitative work steps (Fig. 2). The collection of the required evaluation material was realized with the help of specially designed guided short interviews, which were based on the work of Schecker et al. (2013) with regard to their structure and development and on the quality criteria according to Mayring (2010) with regard to the evaluation.

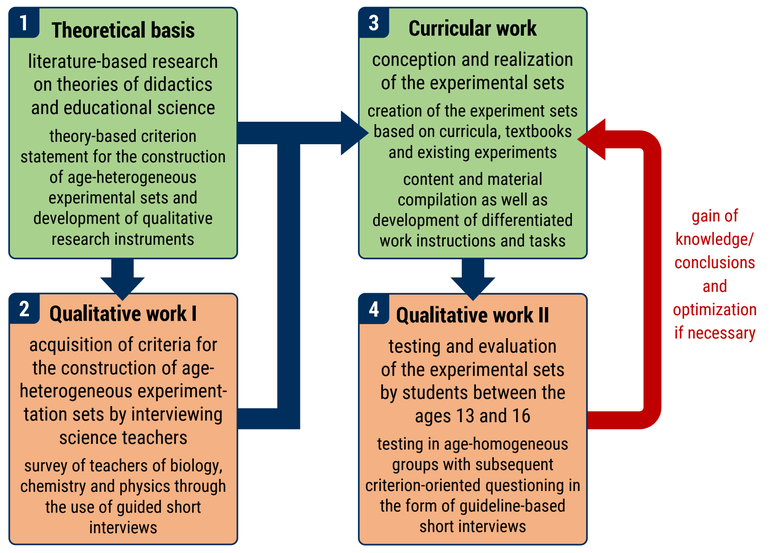

Fig. 2: Methodological procedure and research process with alternating theoretical-curriclar and qualitative work steps.

Presentation of the experimentation set 'Acids & Bases'

Conceptually, it should be mentioned that the exemplary developed subject area is divided into four modules (Fig. 3). A module over-view available for each subject area serves as an orientation aid for the students.

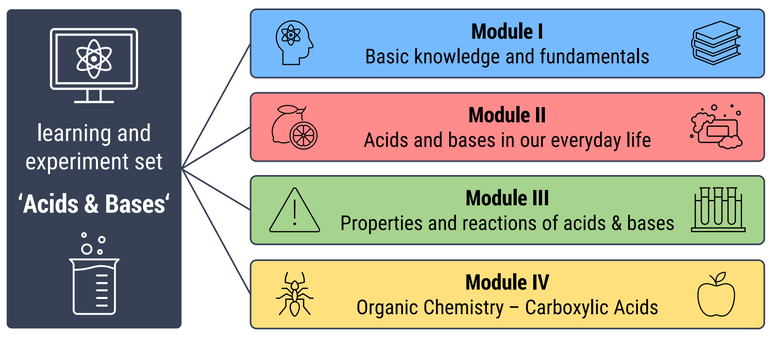

Fig. 3: Structure and modules of the designed experimentation set.

The modules are subdivided into individual stations, which are either of theoretical or experimental character. The work instructions generally have a differentiated character. This is applied in the form of a traffic light system (red, yellow, green) for the individual requirement levels. The stepped helps can be accessed via QR Code (Fig. 4).

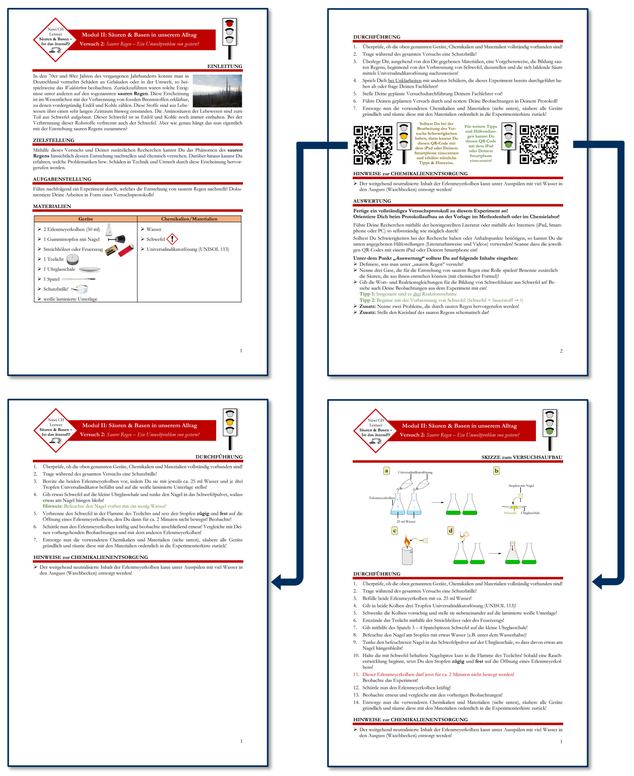

Fig. 4: Example of an experimentation guide on the topic of 'Acid rain'. The stepped helps can be accessed via QR code.

Results and outlook

On the basis of partial transcripts from the guided short interviews with the teachers, a comparison could be made with the theoretically determined design criteria. Synthesizing these results, three central fields with nine criteria were identified:

Fig. 5: Identified construction criteria for the designing process.

The overall transcripts of the short interviews, which were also used in the evaluation interviews, lead to the conclusion that the material developed is suitable for use in inter-grade science lessons. Superficially regarding to structural and material aspects, the results give reason to believe the present system can be retained and, if necessary, applied to further thematic sets. In summary, however, it must also be stated that a primary optimization of the tasks with regard to a higher level of demand for older learners seems to be necessary. On the basis of these results, it is conceivable to support further teaching development in the subject chemistry at the Montessori School Jena by designing further sets that can be justified in a spiral curricular or project-oriented way.

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