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Didactics of Biology

Developing pre-service biology teachers´ diagnostic and teaching skills with regard to biological models

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Background Information

Model competence forms part of the aspect content knowledge which deals with the way in which scientific knowledge develops (Shulman 1986). In biology education, models are often used as a medium to transmit information, visualizing the structure and function of the original. That models could be a tool for scientific inquiry is a prominent view in science but not in the classroom (Grosslight et al. 1991, Trier & Upmeier zu Belzen 2009).
Based on a theoretical framework of model competence (Upmeier zu Belzen & Krüger 2010; Table 1) we successfully developed trainee teachers' model competence (Fleige et al. 2012) but not their diagnostic or teaching skills. This was evident as their students did not develop model competence consistently.

Aims

This project aims at developing a pre-service biology teacher training program investigating learning cases (Levin 1995) as a tool for instruction in order to foster...
...pre-service biology teachers´ model competence.
...pre-service biology teachers´ diagnostic and teaching skills for model competence.

Furthermore, the study serves to evaluate the case method as a tool that can be used by instructors to foster the described competences.

Description of the study

Process

The study is being conducted in three major steps (see Figure 1):

(1) Pre-service biology teachers´ model competence is improved by the application of an evaluated program (Fleige et al. 2012).

(2) Pre-service biology teachers analyze learning cases with regard to fostering model competence.

(3) Pre-service biology teachers develop and teach lesson units which foster students´ model competence.

The pre-service biology teacher training program contains elements which foster content knowledge and pedagogical content knowledge. By using learning cases, this study combines theoretical and practical elements.

Learning cases

Learning cases are detailed, contextualised, narrative accounts of teaching and learning (Levin 1995) containing problems and dilemmas of real-world lessons that form the basis for discussion aimed at finding possible alternatives.
The learning cases constructed for this study each describe a biology lesson with the focus on fostering students' model competence (Excerpt; see Figure 2). They deal with problems created according to a catalogue of criteria that are said to help foster model competence (Fleige et al. 2012):

- not enough lessons with focus on model competence
- missing reflection in the lessons
- competence level in students´ answers not correctly identified by the teacher
- too many aspects of model competence taught in one lesson
- lesson focuses on content rather than on scientific inquiry
- content is not easily accessible

Table 1: Theoretical framework of model competence
(Upmeier zu Belzen & Krüger 2010)

	Level I	Level II	Level III
Nature of models	replication of the original	idealized representation of the original	theoretical reconstruction of the original
Multiple models	differences between model objects	different foci on the original	different hypotheses about the original
Purpose of models	describing the original	explaining investigated relationships	predicting connections between variables
Testing models	testing the model object itself	comparing the model with the original	testing hypotheses about the original with the model
Changing models	correcting errors in the model object	revising the model due to new findings about the original	revising the model due to falsification of hypotheses about the original with the model

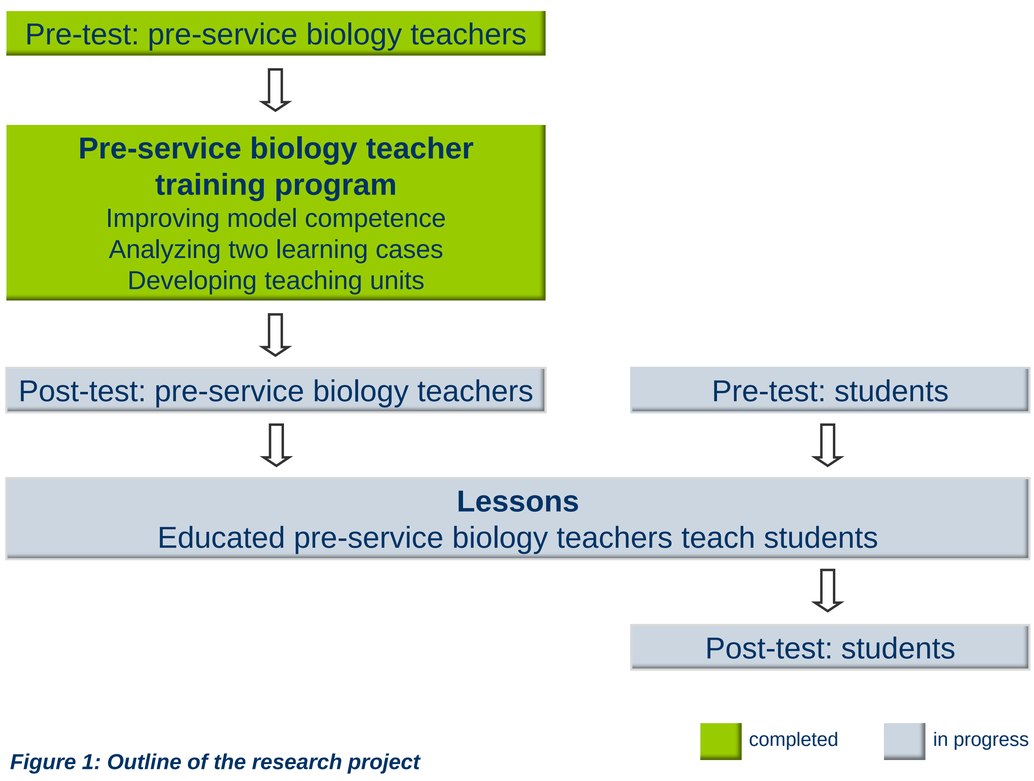

Figure 1: Outline of the research project

In this lesson students build their own plant cell model.

Excerpt from a dialogue:

Teacher: *Take a look at our models and decide to what extent they resemble real plant cells.*
Student 1: *Our models are built like the original cell. They are very similar but there are also some differences.*
Student 2: *Our models are much bigger and of different material.*
Teacher: *Yes, that is correct, but we can't be sure.*


Student model of a cell

Figure 2: Excerpt from a learning case. As highlighted in red, students' answers remain on level II (nature of models). They don't refer to assumptions or hypotheses (see Table 1).

Pertinence of the study

The German education system requires students to have an elaborated model competence as part of their scientific literacy (KMK 2005). Teachers, therefore, face the challenge of promoting their students' model competence. Fleige et al. (2012) revealed that, for this purpose, an elaborated model competence of the teacher is not enough. One can conclude from this that there is a need to improve pre-service biology teachers' diagnostic and teaching skills.

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