A LEARNING ENVIRONMENT FOR PRE-SERVICE PHYSICS TEACHERS ON HOW TO DIAGNOSE STUDENTS' CONCEPTIONS NOT COVERED BY PHYSICS EDUCATION TEXTBOOKS

Markus Sebastian Feser[1], Ingrid Krumphals[2]

1: Universität Hamburg, markus.sebastian.feser@uni-hamburg.de, 0000-0001-8503-0951

2: University College of Teacher Education Styria, ingrid.krumphals@phst.at, 0000-0002-0085-3615

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Pädagogische Hochschule Steiermark

Background & Overview

Profound diagnostic skills of teachers regarding students' conceptions are essential for adaptive and thus high-quality physics teaching [1]. Many typical students' conceptions are well described in physics education textbooks (e.g., [2]). However, there is also a variety of students' conceptions that physics teachers encounter in their classrooms and that are not covered by physics education textbooks ("off-textbook" students' conceptions; e.g., conceptions regarding subsidiary topics within school physics). Consequently, diagnosing ("off-textbook") students' conceptions is an everyday and important, as well as challenging task for physics teachers.

During teacher education, pre-service physics teachers should be adequately prepared for this important task. Nonetheless, there is a lack of (research on) learning environments for pre-service teachers that allow them both to learn and practice diagnosing "off-textbook" students' conceptions today.

In this study, we have developed and piloted such a learning environment. Our poster presents the design of the developed learning environment (content and structure) and reports first insights regarding its implementation.

Content of the learning environment

The developed learning environment is attached to an existing module implemented in the physics teacher education program for the south-eastern region of Austria regarding the diagnosis of students' conceptions addressed within physics education textbooks (for details see [1]). This existing module was expanded by adding a learning environment (in total a unit of 2 ½ hours) focusing on "off-textbook" students' conceptions.

Keeping in line with this focus, we chose students' conceptions about the viscous behavior of liquids as the content of the learning environment. The viscous behavior of liquids is evident in many everyday situations (e.g., dropping a spoon into a honey jar). Despite this, there is a lack of research on high school students' conceptions about the viscous behavior of liquids (as far as we know, there are only two studies on this topic [3; 4]). Additionally, to the best of our knowledge, to date there is no (contemporary) physics education textbook that explicitly addresses this topic. Therefore, it is reasonable to classify students' conceptions about the viscous behavior of liquids as "off-textbook" students' conceptions.

Figure 1: Dropping a spoon into a honey jar.

The core element of the learning environment is an authentic video vignette in which high school students try to explain why a spoon slowly sinks when dropped into a jar of honey (see Figure 1). During their explanations, the high school students verbalize their conceptions regarding the viscous behavior of honey. In the learning environment, the pre-service teachers' task is to identify and interpret these verbalizations (for more details see [5]).

Structure of the learning environment

In the learning environment the participants work in small groups and plenary phases in order to practice diagnosing "off-textbook" students' conceptions. In detail, the learning environment is structured as follows:

1. **HOMEWORK: CLARIFICATION OF THE PHENOMENON**
   Prior to the unit, the participants have to clarify as a homework why (from a physics point of view) a spoon slowly sinks in a honey jar.
2. **COMPARISON AND DISCUSSION (HOMEWORK)**
   At the beginning of the learning environment the participants are instructed to exchange and discuss their results of their homework (as group activity and in a plenary phase).
3. **REPETITION OF PRIOR PEDAGOGICAL CONTENT KNOWLEDGE**
   In a plenary phase, the participants' prior knowledge regarding students' conceptions and diagnosis is activated and repeated.
4. **GROUP EXERCISE ON DIAGNOSING STUDENTS' CONCEPTIONS**
   The participants practice to diagnose students' conceptions regarding the phenomenon they clarified as a homework (using authentic video vignettes and transcripts of students' statements).
5. **REFLECTION OF THE EXERCISE**
   The unit ends with a plenary to share thoughts and reflect on the exercise. Thereby, the participants discuss challenges resulting from dealing with "off-textbook" students' conceptions in physics classes.

First implementation

In May 2021, we piloted the learning environment for the first time as an online and team-teaching unit for pre-service physics teachers (N = 11, 6th semester) at the University College of Teacher Education Styria (Austria). Since coping with the diagnostic process is particularly demanding for pre-service physics teachers, our accompanying research aims to identify learning barriers within our developed learning environment. Hence, we used a short questionnaire to receive initial feedback regarding elements of the learning environment that the participants perceived as (less) beneficial and/or helpful.

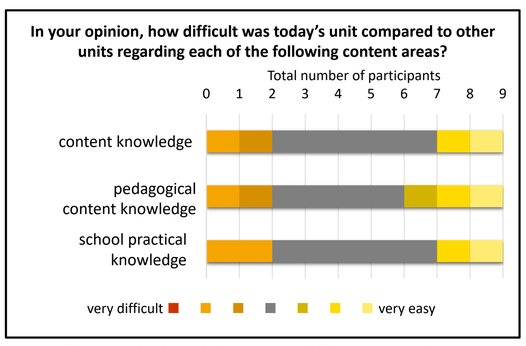

Figure 2: Participants' difficulty ratings regarding different content areas.

Besides several other insights, the feedback from the short questionnaire reveals a heterogeneous perception of difficulty among the participants regarding different content areas (see Figure 2).

Outlook

In order to collect valid empirical data for our accompanying research, the entire pilot session (including all group activities) was also videotaped. The feedback from the short questionnaire showed – in addition to supporting elements – learning barriers (for some pre-service physics teachers) within the learning environment. Therefore, the focus of the qualitative analysis of this video data is to identify and characterize these learning barriers.
The transcription and analysis of this video data is currently in progress and will be completed in 2022.

References

[1] Krumphals, I. & Haagen-Schützenhöfer, C. (2021). Development of a Learning Environment to Enhance Preservice Physics Teachers' Diagnostic Competence in Terms of Students' Conceptions. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(6), Article em1972.
[2] Driver, R., Guesne, E., & Tiberghien, A. (Eds.). (1985). *Children's ideas in science*. Open University Press.
[3] Faltin, L., & Feser, M. S. (2021). Secondary school students' conceptions about the viscous behaviour of liquids. *Physics Education*, *3*(56), Article 035018.
[4] Bystrianska, M. (2012). Testing misconceptions in physics for elementary school. *Paper presented at the 13th International Scientific Conference of PhD Students and Young Scientists and Pedagogues*
[5] Faltin, L., Feser, M. S., & Krumphals (in press). Schülervorstellungen zum viskosen Verhalten von Flüssigkeiten. In S. Habig (Eds.), *Unsicherheit als Element von naturwissenschaftsbezogenen Bildungsprozessen. Gesellschaft für Didaktik der Chemie und Physik, Online-Jahrestagung 2021*.