Computer-Based Assessment of Physics Teachers' Explaining Skills

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Aims

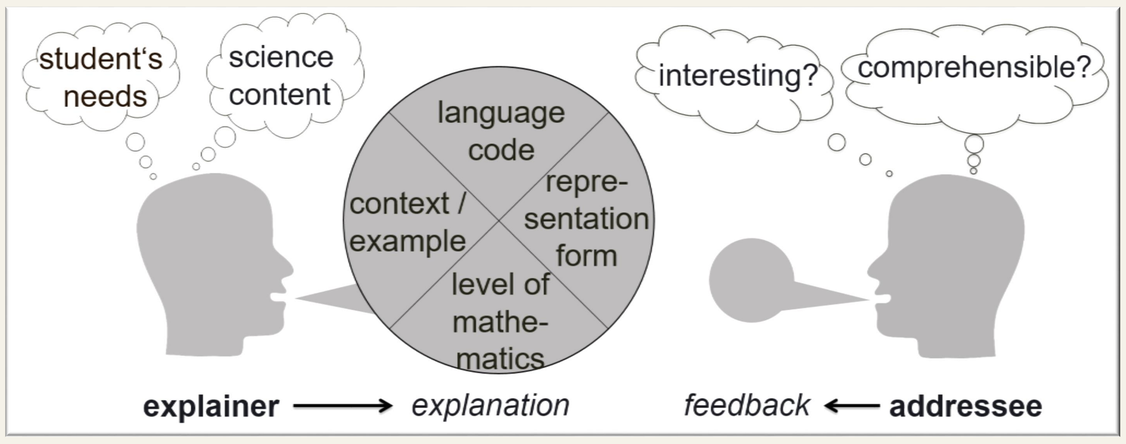
- Developing a standardized, computer-based, and interactive test instrument for *Explaining Skills* (ES)
- Predicting teachers' explaining quality in physics classrooms
- Exploring first empirical hints for an impact of physics teachers' ES on their students' achievements

Background

- Explaining situations are an important part of instruction, however barely researched
- An existing performance test for teachers' explaining skills (the *Dialogic Explaining Assessment*, DEA) is very time-consuming in application and data analysis
- A computer-based test is more effective and allows large-scale assessment – but can it predict the quality of teachers' instructions in actual physics classrooms?

A model on explaining science

- Science teaching explanations have the purpose to foster an addressee's understanding of a scientific content.
- The explaining has to be both **subject-adequate** (scientifically correct) and **addressee-oriented** (regarding addressee's prior knowledge and interests)
- Four variables can be modified to meet the addressee's needs: context or examples used, language code, representation form, and level of mathematics.

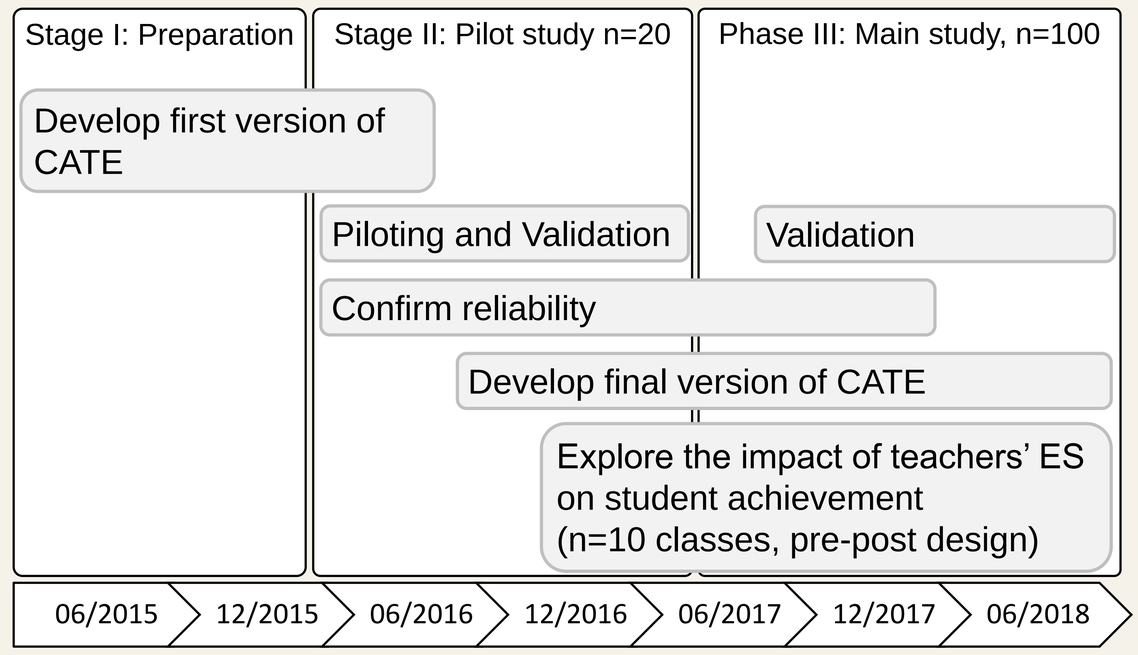


Model of explaining science (Kulgemeyer & Schecker, 2013)

Test instrument: CATE

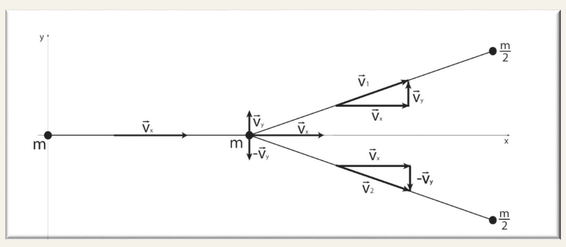
- The Computer Based Test for Explaining Skills (CATE) uses video vignettes, based on real explaining situations
- Each vignette shows a teacher explaining a physics phenomenon to a student. The video stops when a teacher's response to a student's prompt or question is needed
- The test person has to decide how the teacher should react to this feedback, regarding aspects of explaining quality
- ES are measured with *Two-Tier Multiple Choice* Items:
  - *Tier 1*: Test person selects the best way to continue explaining
  - *Tier 2*: Test person gives a reason for his or her choice

Road map



Sample topic

- Saving Earth from collision with an approaching asteroid by blowing it up into two pieces which pass Earth on both sides
- Grade 10 high school physics: Mechanics, conservation of momentum
- Different representation forms available, e.g.:



Sample item

The teacher is explaining the conservation of momentum. Currently he is talking about calculating the value of momentum:	
T:	*Momentum is the product of mass and velocity. Thus, in a formula you would write p equals m times v. Mass has the unit kg and velocity the unit m/s. Thus, the unit of momentum is kg m/s or N s.*
S:	*Okay … Guess I didn't quite get that.*
T:	*I see, it might be a good idea to have an example for the conservation of momentum.*

***Tier 1*: How should the teacher continue?**

a) Let's think about a billiard table. If a ball hits a second one right in the middle, it transfers all its momentum to it. The point is that the total momentum of both balls is the same before and after the hit. It's neither increasing nor decreasing.
b) Imagine I stood up and started running. This would give me a certain momentum. As my weight is 80 kg and I'm running 5 m/s my momentum would be 400 kg·m/s. The point is that in theory, I would never lose this momentum. Only if I transfer some of the momentum to the ground, I can stop my movement.
c) Imagine two identical point masses. The first one is at rest and the other one has a certain momentum. As it hits the first one, all its momentum is transferred to the first one. The first point mass starts moving and the second one stops. All in all the sum of the momentum of both point masses stays the same during the whole process. It is conserved.
d) ….

***Tier 2*: Why did you choose this answer?**

This tier consists of adaptive multiple choice single select answers, depending on the selection in tier 1.

Bibliography:
Kulgemeyer & Schecker (2013): Students Explaining Science. In: *Res Sci Educ* 43 (6), S. 2235–2256.

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