

# **What competences do teachers focus at when formatively assessing their students in inquiry-based science education?**

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# Intro

- Inquiry-based science education (IBSE) as “a distinguishing feature of innovative science education programs since the 1960s science curriculum reform movement” (Duschl, 2003, p. 41)
- IBSE as a number of processes, such as: Orienting and asking questions, hypothesis generation, planning an inquiry, investigation, analysis and interpretation, modelling, conclusion and evaluation, communication, and prediction (Bell, Urhahn, Schanze, & Ploetzner, 2010); often equated with inquiry competences that can be acquired by students
- Roles of students and teachers in IBSE (Kessler & Galvan, 2007; McLoughlin, Finlayson & van Kampen, 2012)
- Formative assessment as a central approach to supporting students in their inquiry activities (Barron & Darling-Hammond, 2008; Black & Harrison, 2004; Ruiz-Primo & Furtak, 2007)

# Research question

What competences do science teachers focus at when formatively assessing their students in IBSE?

What is the teachers' reasoning for their choices of assessed competences?

The work presented in this paper is based on the ASSIST-ME project which was funded by the European Commission (Seventh Framework Programme for Research; grant agreement no: 321428)

# Design

- Explorative study because little is known about teachers' IBSE practices in Switzerland (Börlin, 2012; Labudde, 2000)
- Collaboration with  $n=20$  science teachers from primary (grades 1-6) and from upper secondary school level (grades 10-13) lasting for 3 semesters
- Teachers were asked to implement a formative assessment method in their classrooms in an IBSE unit (between 2 and 10 lessons) in order to assess one or several inquiry competences

# Data collection

- Form
- Teaching plans and teaching materials
- Individual, semi-structured interviews with a subgroup of teachers (5 primary, 7 upper secondary)

# Example of data set

einer anderen Gruppe, die dieselben Aufgaben hatte, eingeschätzt (Was ist gut? Was versteht man nicht? Was sollte ergänzt werden?). Diese Ergänzung kann die Gruppe dann vornehmen. Die Lehrperson erhält das Protokoll mit den Anmerkungen der Partnergruppe und den Ergänzungen und korrigiert das Protokoll. Jede Gruppe erhält ein individuelles Feedback von der Lehrperson.

6) Auf welche Handlungen oder Produkte der Schülerinnen und Schüler (wie Hefteinträge, schriftliche Lösungen, Diskussionsbeiträge, ...) wird die formative Beurteilung abgestützt?

Produkte der SuS	Konkretisierung (Diskussionsbeitrag, Hefteintrag, ...)
<input type="checkbox"/> Mündliche Äusserungen	Gruppengespräche und Protokolle
<input checked="" type="checkbox"/> Schriftliche Arbeiten	
<input type="checkbox"/> Andere	

ich habe mir gedacht es werde zu unübersichtlich, wenn das Protokoll nicht sauber ausgearbeitet ist, und dann noch an den Rand irgendwas drangequetscht wird, dann kann man es vielleicht nicht mehr lesen. Und ich habe ihnen auch gesagt, ....

- Mögliche Überlegungen für die Überarbeitung
- 1.) Ist das Protokoll vollständig (ist erkenntlich was zu welcher Aufgabe gehört)?
  - 2.) Werden alle Fragen beantwortet?
  - 3.) Sind die Erklärungen vollständig?
  - 4.) Sind die Erklärungen verständlich/logisch?
  - 5.) Gibt es Widersprüche in den Erklärungen?
  - 6.) Gibt es Graphiken, um etwas zu verdeutlichen?
  - 7.) Wäre eine Graphik hilfreich?
  - 8.) Was fehlt mir für das Verständnis?
  - 9.) Was hätte ich anders gemacht?
  - 10.) Welche Ergänzungen würde ich anbringen?
  - 11.) Was ist gut? (vielleicht mit Smiley versehen...)

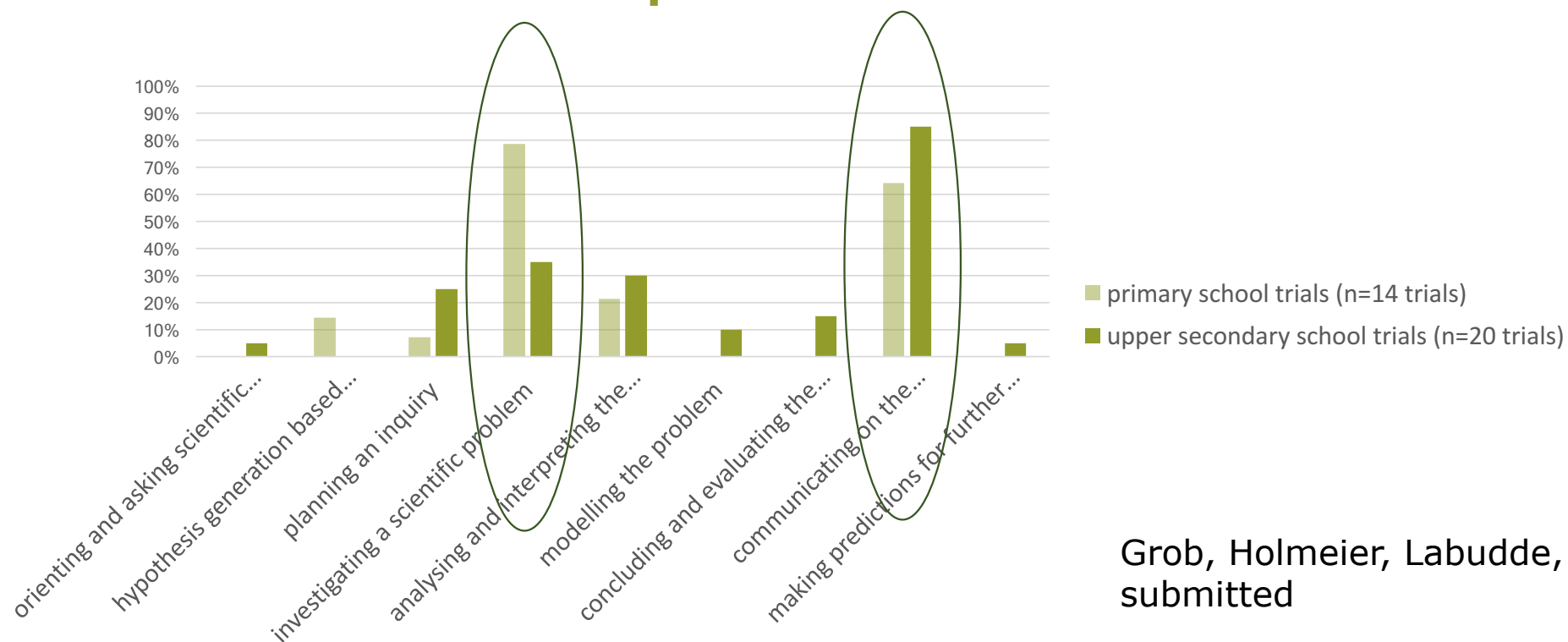
Statt die untenstehende Tabelle auszufüllen kannst Du gerne auch Deine ganz normale "Präp" kopieren und beilegen.

Dauer (Min)	Unterrichtsinhalt	Aktivitäten der LP und Aktivitäten der SuS
10 Minuten	Einführung in die Experimente (kurze Arbeitsanweisung)	Tipps geben, aber keine Lösungen verraten SuS beim Versuch mit der <u>Kundtschen Röhre</u> betreuen.
35 Minuten	Arbeiten in Gruppen: Durchführen der Experimente, Vermutungen anstellen und mit Beobachtung in Einklang bringen, Erklärungsansätze diskutieren und ausformulieren, eventuelle Unstimmigkeiten zu erklären versuchen.	

# Data analysis

- Triage based on deductive coding of the implementation forms, teaching plans and -materials (Mayring, 2010)
- Double-coding 18% of the data (10 implementations out of 54); Cohen's Kappa  $\kappa=0.83$
- Selection of 34 implementations for analysis

# Results I: Competences assessed





# Results I: Reasoning

Primary school teachers	Upper secondary school teachers
<ul style="list-style-type: none"><li>• relevance of a particular competence such as 'investigation'</li><li>• resource-based decision <i>"found a convincing rubric"</i></li><li>• choice of the competence was not a conscious decision <i>"just emerged"</i> or <i>"appeared suitable"</i></li></ul>	<ul style="list-style-type: none"><li>• relevance of a particular competence <i>"I think it is important to prepare for university"</i> (referring to 'communication')</li><li>• students' abilities <i>"had the impression that the students would be able to assess this"</i> (referring to 'communication')</li></ul>

# Discussion I: Competences assessed

- Primary school implementations: 'investigating a scientific problem' competence assessed most often  
→ can be directly observed from practical work
- Upper secondary school implementations:  
'communicating about the methodology and on the results' assessed most often  
→ vicinity to summative assessment  
→ importance of written communication at upper secondary school level

## Discussion II: Reasoning

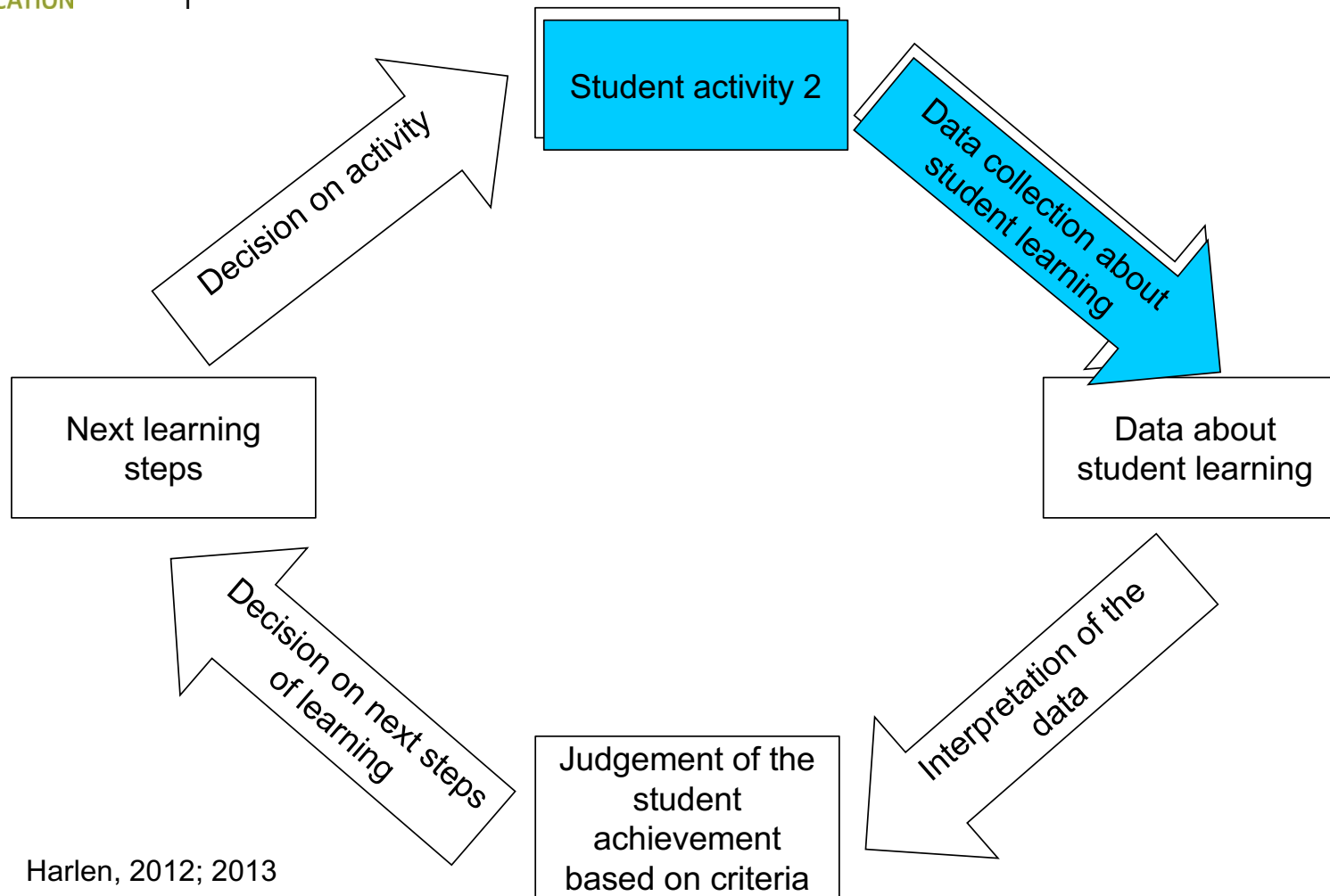
- Context of the concrete inquiry unit or the curriculum were never mentioned
  - Choice taken unconsciously or based on personal conviction as to which competences are important
- teaching materials on the “rarely chosen inquiry competences”
- better understanding of how teachers plan inquiry units

# References

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# Inquiry-based science education

- «Umbrella term» (Furtak et al., 2012)
- Definitions vary between different authors (Bell et al., 2010; Bybee, 2000; Furtak et al., 2012)
- Features for operationalisation (how can it be recognized in the classroom?)
  - Research-type activities (e.g. Bybee, 1997)
  - Competence orientation (e.g. Abd El Khalick et al., 2004)
  - Dimensions of openness (Priemer, 2011)



Harlen, 2012; 2013

# Formative assessment II

- Features for operationalisation (how can it be recognized in the classroom?)
  - Clarity in expectations (e.g. Andrade & Valtcheva, 2009; Black et al., 2004)
  - Diagnosis of student level with respect to expectations (Ruiz-Primo et al., 2010)
  - Feedback (Furtak & Ruiz-Primo, 2008)
  - Use of feedback (e.g. Andrade & Valtcheva, 2009; Paris & Paris, 2001)
- Methods of formal formative assessment in the context of inquiry (Barron & Darling-Hammond, 2008; Black & Harrison, 2004; Ruiz-Primo & Furtak, 2007)
  - Written teacher assessment (Arter & McTighe, 2001; Burke, 2006; Moskal, 2003)
  - Peer-assessment (Dochy et al., 1999; Leahy et al., 2005; Topping, 2003)
  - Self-assessment (Andrade, 2010; Harrington, 1995)