Students Active Learning in Science to
Foster Contemporary Scientific Literacy
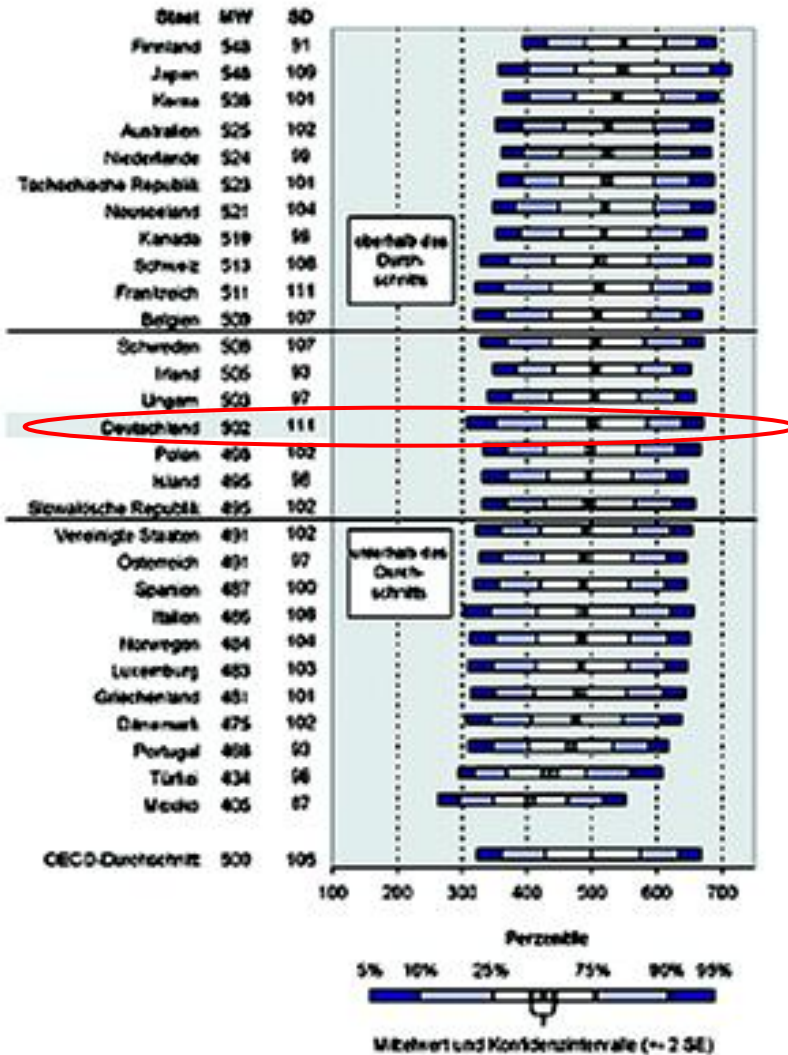
*How to motivate students
to learn science and
how to assess this*

Claus Bolte

SALiS Conference 2012 at Ilia State University
Tibilisi (Georgia), August 2012

How to motivate students to learn science and how to assess this

1. Introduction

2. Model of how to motivate students to learn science – The Model of Motivational Learning Environment Instrument (MoLE)

3. The MoLE-Instrument to assess students (intrinsic) motivation

4. Results from MoLE Research

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Percentilles regarding science competences (internationale scale) of the OECD member countries IPN - IPN-Blätter IV, 2004

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Introduction: Two Main Problems of the (German) Science Education Practice

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Students' experience with science lessons:

- In science lessons I always ask myself why the hell do I have to learn science?
- In science I am usually not on task and unconcentrated!
- Science is no fun for me at all!
- I really don't understand the concepts and the topics in the science lessons!

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4
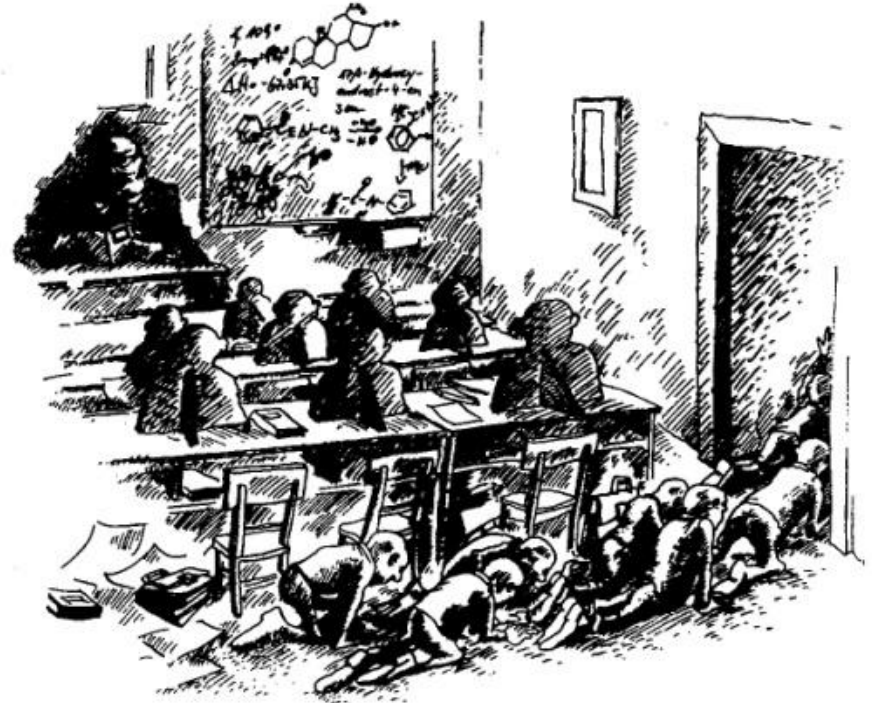
Theoretical based Model of (intrinsic) motivated (Science) Learning

## Students' experience with science lessons:

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Characteristics of Intrinsic Motivated (Science) Learning:

- Personal **Relevance** of the Topic taught in science
- Self-intention or **Willingness to Participate**
- Positive Emotions or **Satisfaction**
- Cognitive Differentiation, Learning Outcome or **Performance**

(U.Schiefele, Winteler & Krapp 1988; zit. nach Stork 1994, 32).

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Theoretical based Model of (intrinsic) motivated (Science) Learning
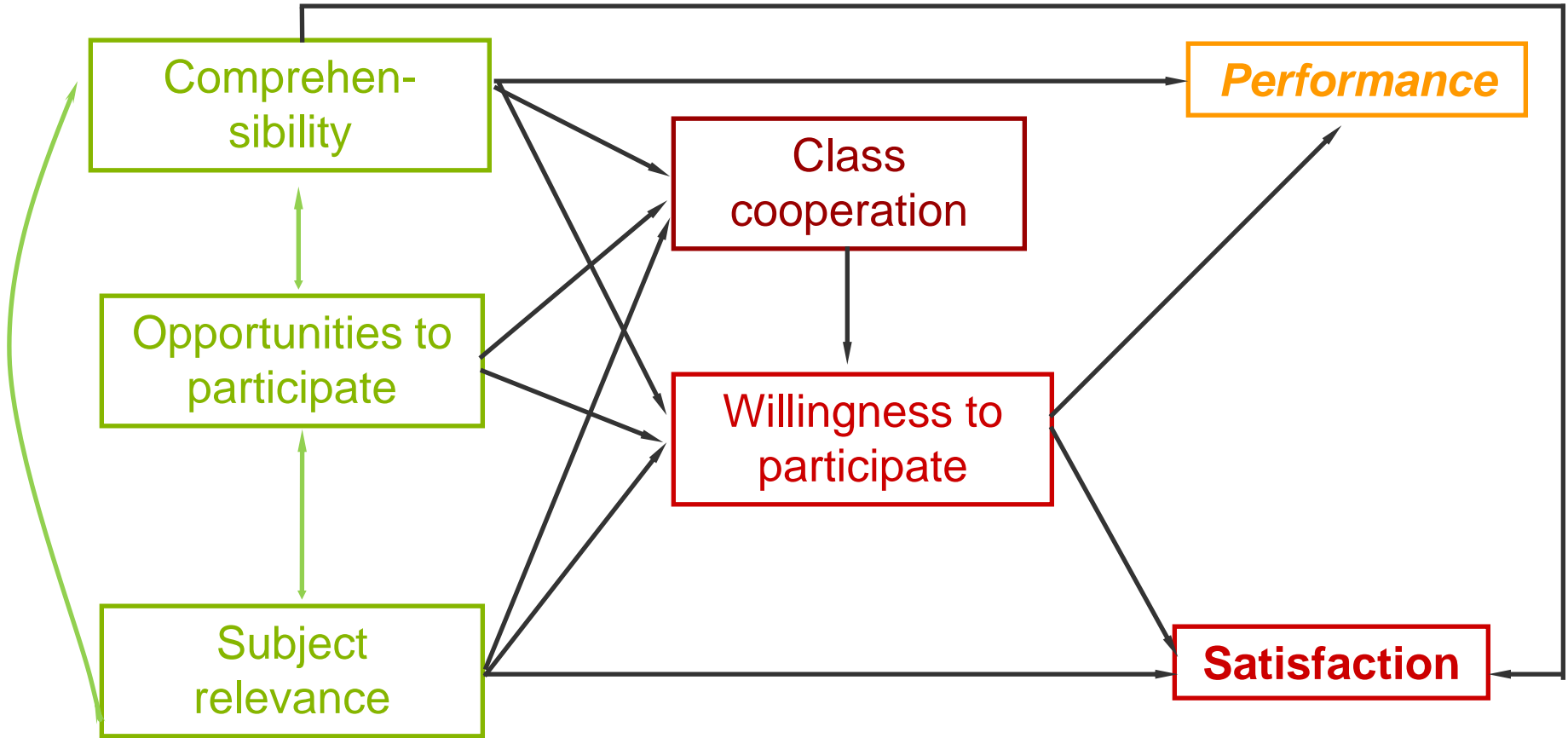
Theoretical Basis:

- *Achievement Motivation Theory*
- *Socio psychology*
- *Pedagogical Interest Theory*
- *Learning and Classroom Climate Research*

How to analyse the motivational situation in my science classes? – The MoLE

MoLE-Instruments: Science, Biology, Chemistry and Physics Classes

Different Questionnaire Versions:

Comprehensibility
Opportunities to participate
Subject relevance
Subject orientation
Class cooperation
Willingness to participate
Satisfaction
Performance

➤ **Students' Perceptions in general (REAL)**

In my opinion the topics covered in chemistry class are...

very important [7] [6] [5] [4] [3] [2] [1] completely unimportant for me (for my everyday life).

➤ **Students' Inclinations/Wishes (IDEAL)**

That topics in chemistry class are a matter of my everyday life is...

very important [ ] [ ] [ ] [ ] [ ] [ ] [ ] completely unimportant

➤ *Students' Wish-to-Reality-Differences*

➤ **Students' Perceptions of Today's Lesson (TODAY)**

In my opinion the topics covered in chemistry class today are...
very important [ ] [ ] [ ] [ ] [ ] [ ] [ ] completely unimportant for me (for my everyday life).

Composition of the Sample

	Boys Sek.I/II	Girls Sek.I/II	total Sek.I/II	Teachers male/female	Total boys/girls/**total**
Chemistry	1101/*531*	1235/*494*	2336/*1025*	93/47	1632/1729/**3361**
Physics	155/ *41*	160/ *57*	315/ *98*	14/ 5	191/217/***408***
Biology	181/ *40*	210/ *81*	391/ *121*	15/ 8	221/291/***512***
Total	1437/*612*	1605/*632*	3042/*1244*	122/60	1944/2237/***4281***

Tab. 1: Sample

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Why the MoLE Instrument?
– Reliability

Chemistry	Total			Sekundarstufe I			Sekundarstufe II		
MoLE-Indicator	Real	Ideal	WRD	Real	Ideal	WRD	Real	Ideal	WRD
Satisfaction	.82	.60	.66	.80	.60	.66	.84	.59	.68
Comprehensibility	.65	.64	.60	.64	.63	.59	.66	.66	.61
Contents of the Science Subj.	.59	.70	.67	.45	.68	.55	.62	.69	.70
Subject Relevance	.67	.61	.54	.67	.62	.54	.69	.59	.54
Opportunities to Participate	.64	.61	.60	.61	.61	.56	.69	.58	.65
Class Cooperation	.79	.71	.68	.79	.71	.67	.79	.72	.71
Willingness to Participate	.59	.78	.37	.58	.78	.39	.58	.76	.35

Tab. 2: Reliability coefficients (Cronbach's a) of the seven MoLE-scales demonstrated by the analysis of the data concerning chemistry classes)

Why the MoLE Instrument?
– Validity of Constructs

Chemistry		Total			Sekundarstufe I			Sekundarstufe II		
MoLE-Indicator/Item-No.		Real	Ideal	WWD	Real	Ideal	WWD	Real	Ideal	WWD
Satisfaction	1	1/.8	7/.8	1/.8	1/.8	7/.8	1/.8	1/.8	5/.8	3/.8
	2	1/.8	7/.8	1/.8	1/.8	7/.8	1/.8	1/.8	5/.9	3/.8
Comprehensibility/ Requirements	3	7/.6	4/.8	5/.8	7/.6	4/.9	4/.8	1/.7	4/.8	5/.8
	4	7/.9	4/.8	5/.8	7/.9	4/.8	4/.8	7/.9	4/.9	5/.8
Subject orientation	5	5/.8	2/.9	2/.9	5/.8	2/.9	2/.9	5/.8	3/.9	2/.9
	6	5/.8	2/.9	2/.9	5/.8	2/.9	2/.9	5/.9	3/.9	2/.9
Relevance of Subjects	7	3/.8	5/.8	6/.8	3/.8	5/.8	6/.8	4/.8	6/.8	6/.8
	8	3/.9	5/.9	6/.9	3/.9	5/.9	6/.9	4/.9	6/.9	6/.9
Opportunities to Participate	9	4/.8	6/.9	4/.8	4/.8	6/.9	5/.8	3/.8	7/.9	4/.8
	10	4/.8	6/.8	4/.8	4/.8	6/.8	5/.8	3/.8	7/.8	4/.8
Class Cooperation	11	2/.9	3/.8	3/.9	2/.9	3/.8	3/.8	2/.9	2/.8	1/.9
	12	2/.9	3/.9	3/.9	2/.9	3/.8	3/.8	2/.9	2/.9	1/.9
Willingness to Participate	13	6/.9	1/.8	7/.8	6/.9	1/.8	7/.8	6/.9	1/.9	7/.8
	14	6/.7	1/.9	7/.8	6/.7	1/.9	7/.8	6/.7	1/.9	7/.7

Tab. 3: Factor values for the determination of the validity of constructs of the 7 MoLE-scales (demonstrated by the analyses of the chemistry classes)
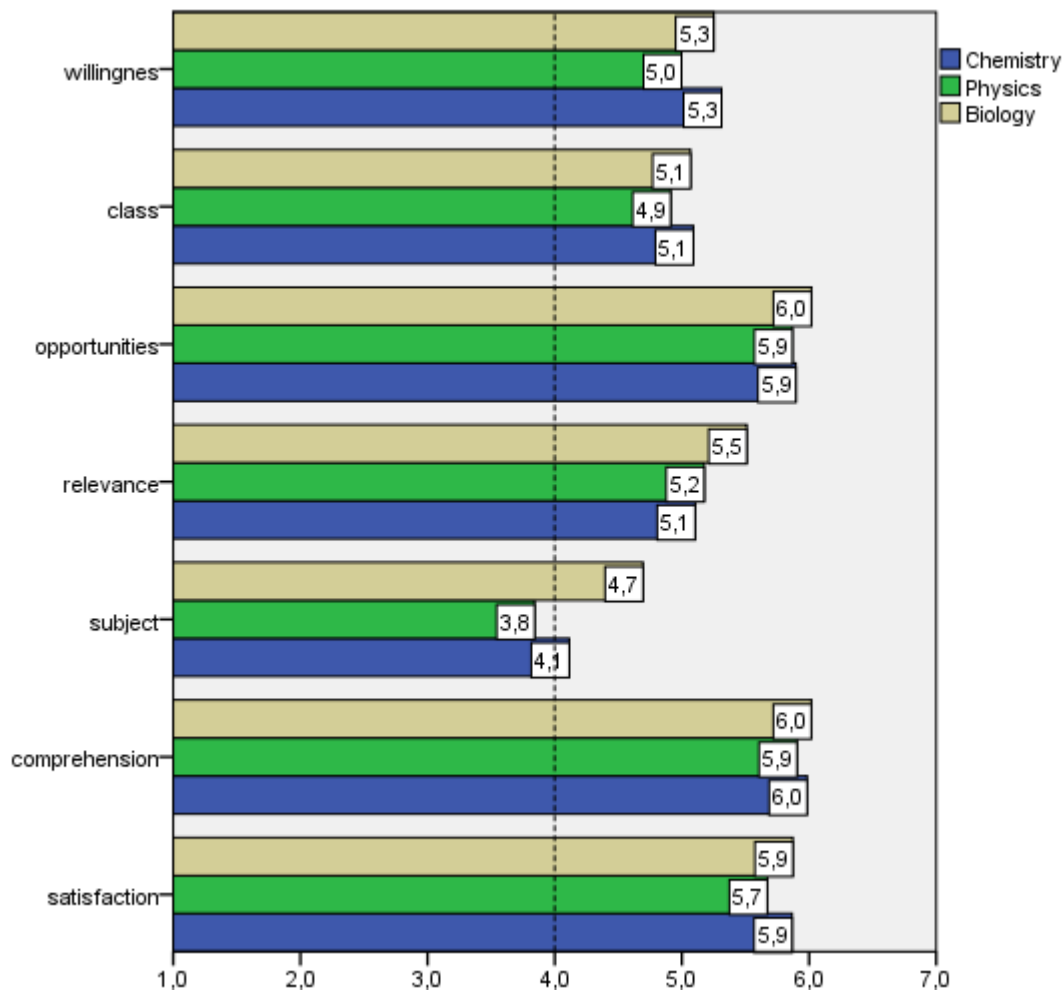
Why the MoLE Instrument?
- Validity of the MoLE Model's Structure
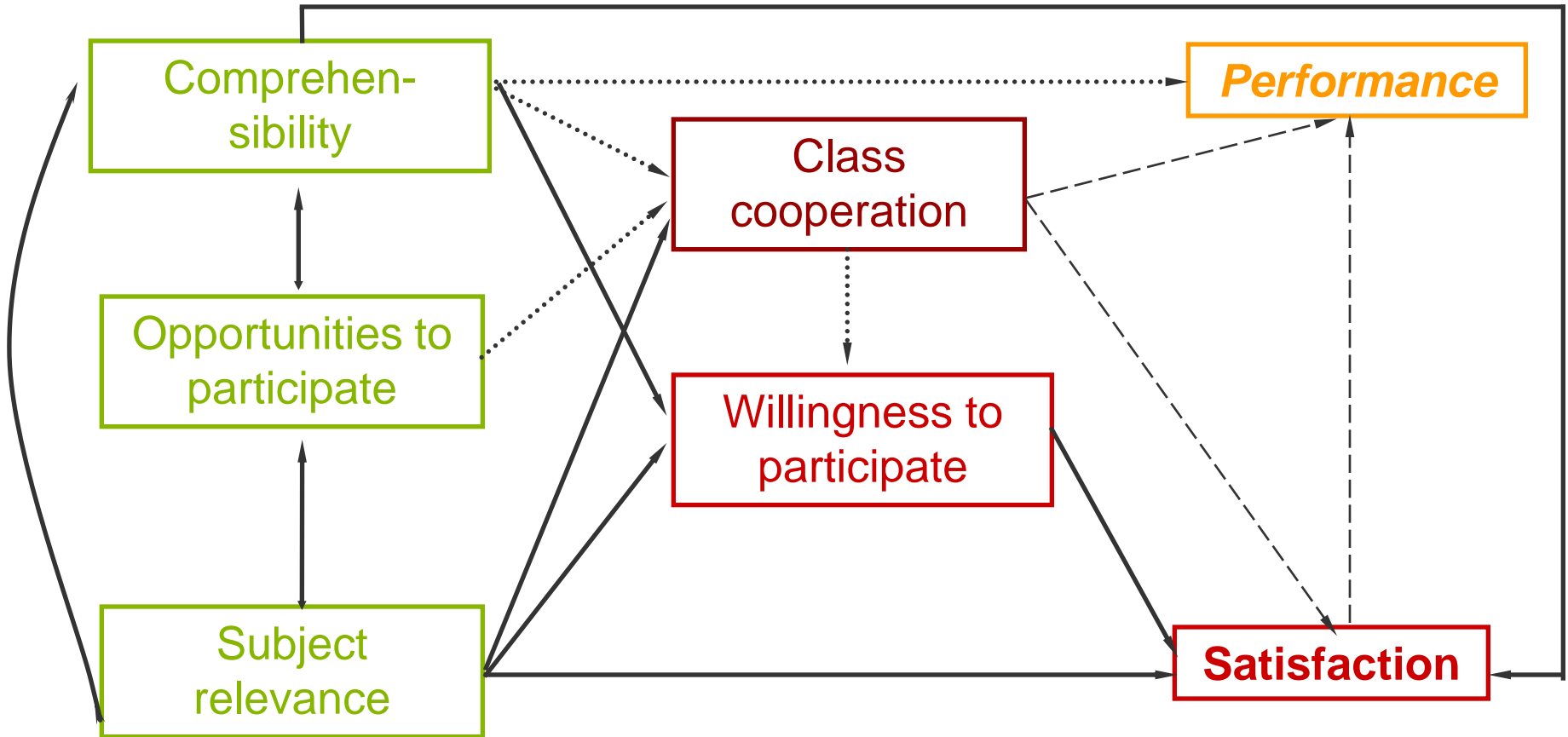
Significant path; expected and identified in all analyses

Significant path; expected but only identified in some analyses

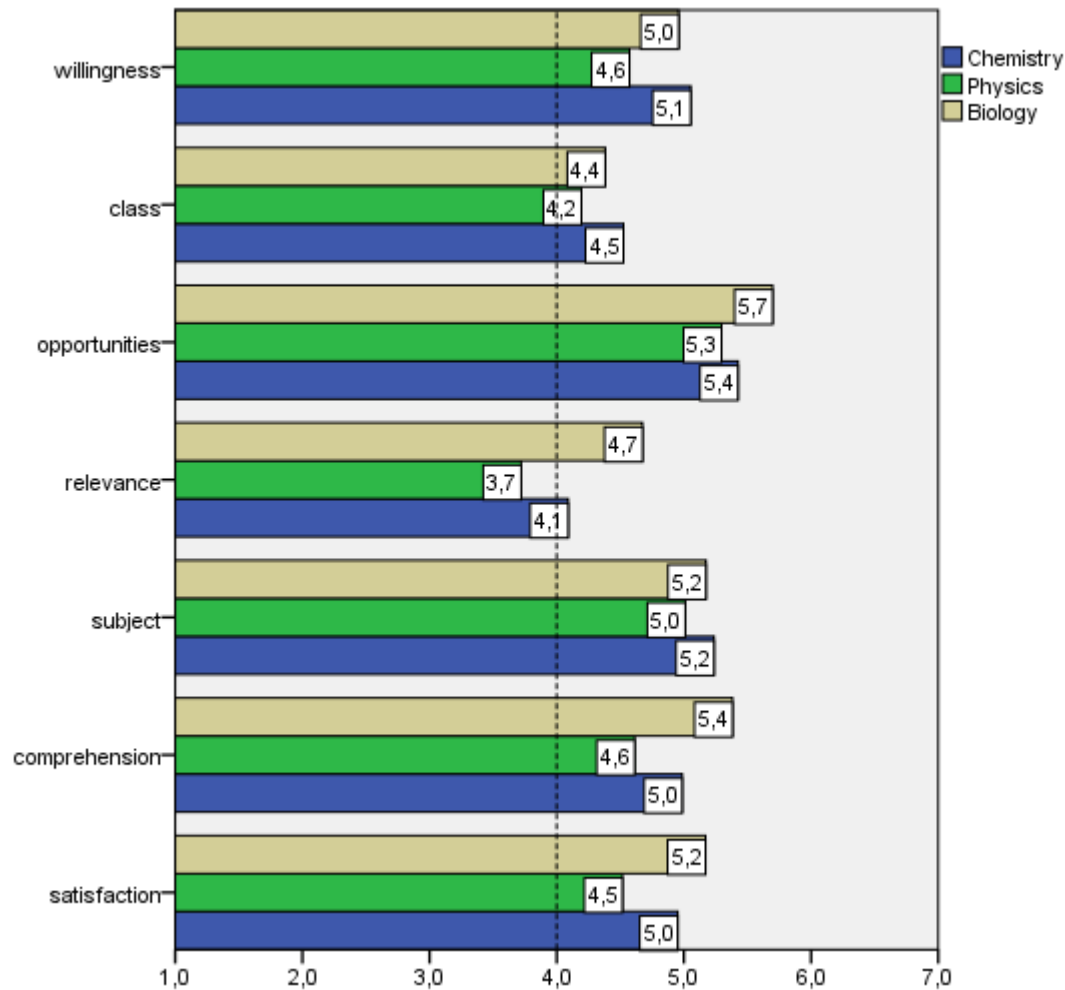*Significant path; not expected but identified in some analyses*

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11

Students wishes – the IDEAL-Assessments

Comparison of the Mean-sores of the estimation of MoLE IDEAL-scales for chemistry, biology, and physics classes - Sek. I
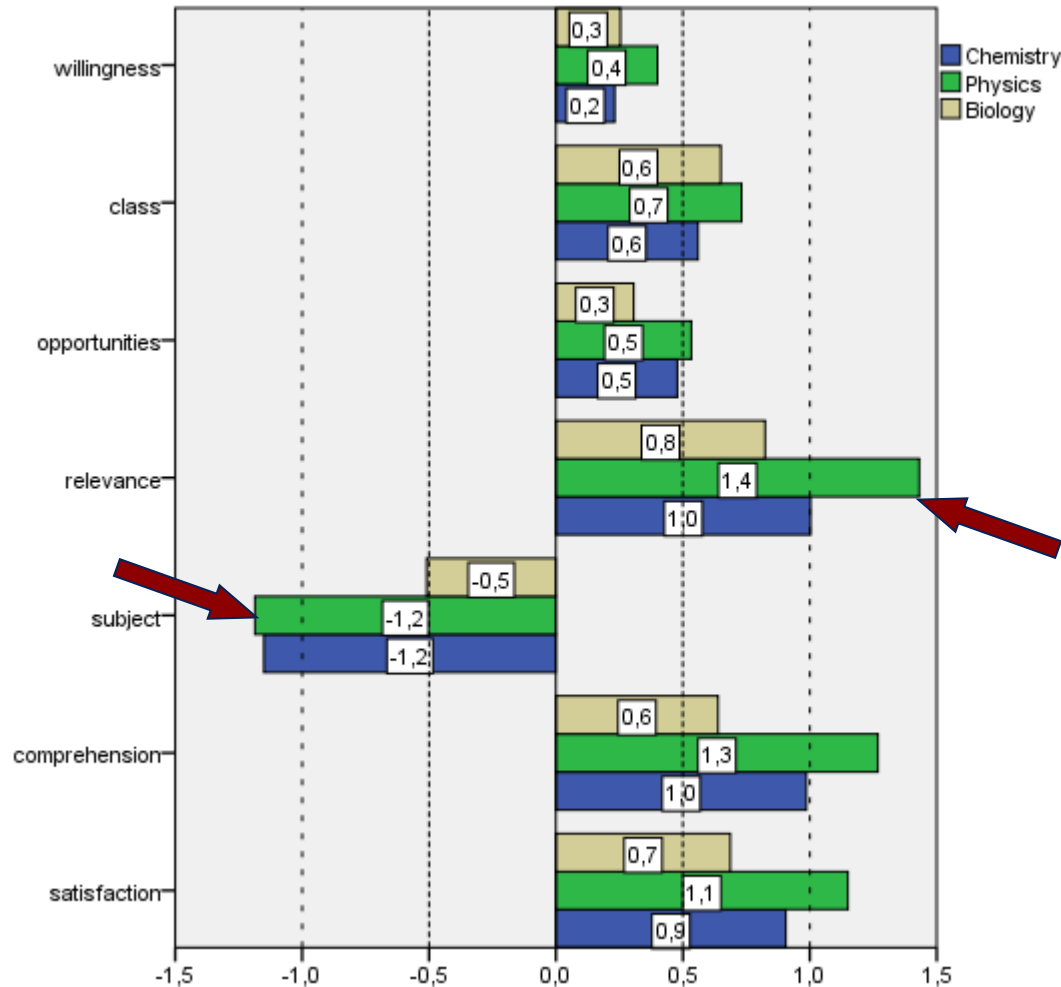
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How to evaluate Students Gains – the MoLE
Students assessments in general – the REAL-Version

Comparison of the Mean-scores of the MoLE REAL-scales for chemistry, biology, and physics classes - Sek. I
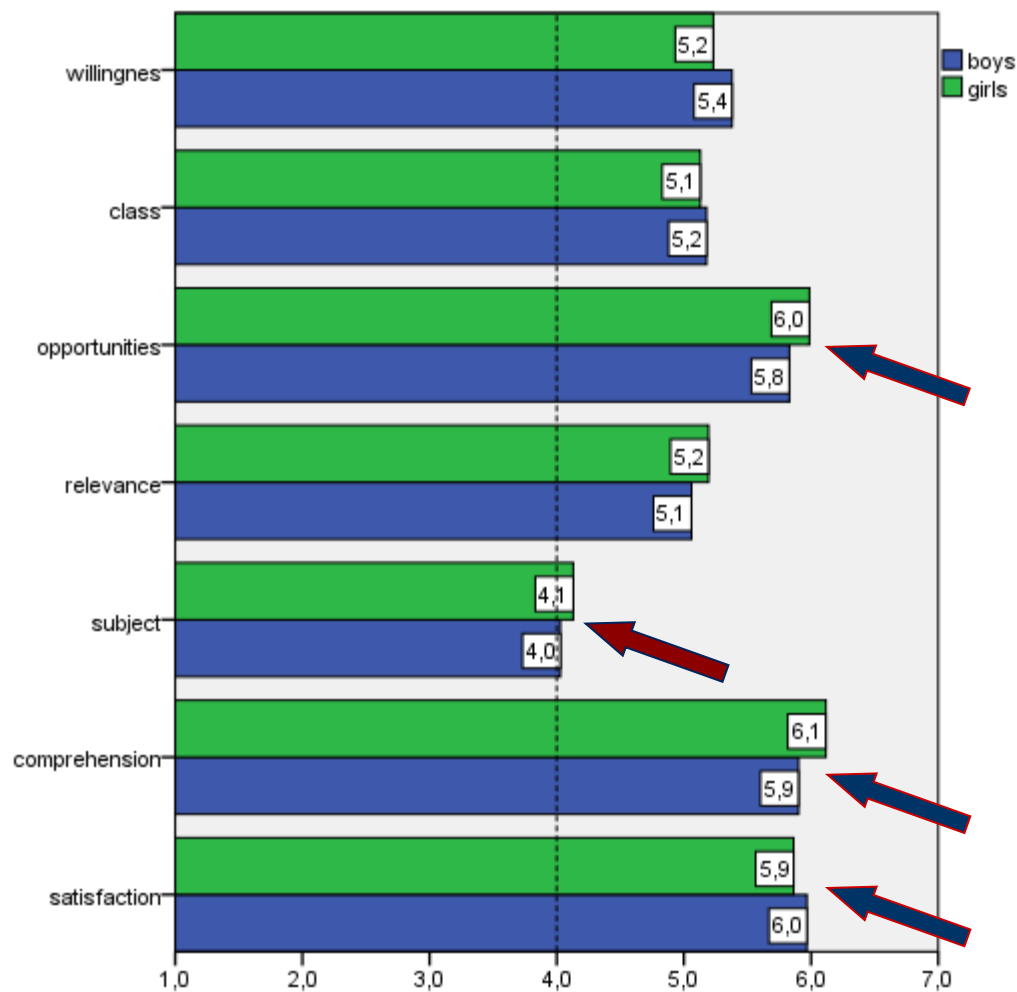
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13

Comparison of the Mean-Wish-to-Reality-Differences for chemistry, biology, and physics classes – Sek. I

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Comparison of the Mean-scores of the MoLE IDEAL-scales for chemistry classes – Sek. I

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Comparison of the Mean-scores of the MoLE REAL-scales for chemistry classes – Sek. I

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Comparison of the (Mean-Wish-to-Reality-Differences for chemistry classes – Sek. I

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