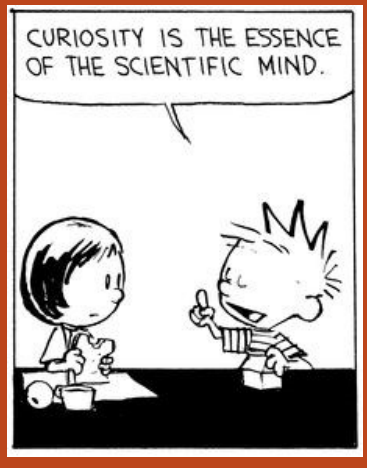
Questionnaires for quantitative educational research



Andries Koster

5th March 2020

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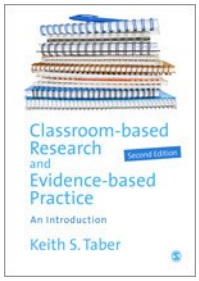
Educational research paradigms

Positivistic vs. interpretive

"The first paradigm may be considered to be 'positivistic'. Positivism is based on an assumption that it is possible to report unambiguous truth, in terms of observable phenomena and verified facts. … A positivist approach assumes that the aims, concept, methods and model of explanation employed in the natural sciences may be applied non-problematically "

"Research is positivistic if it assumes it is possible to produce definitive knowledge that is objective (i.e., it can be agreed on by all informed observers); whereas interpretivist research assumes that the research relies upon the (inevitably somewhat subjective) interpretation of a particular human being who will necessarily bring his or her own idiosyncratic experiences and understanding to the interpretations made" (p. 45)



Taber, K. S. (2013). Classroom-based Research and Evidence-based Practice: An introduction (2nd ed.). London: Sage.

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Qualitative *vs.* quantitative methodology

Qualitative	Quantitative
To gain understanding of underlying reasons and motivations. To uncover prevalent trends in thougth and opinion. • Focus groups • Structured interviews • Group discussions	To quantify data and generalize results form a sample to the population. To establish cause-effect relationships. • Surveys • Questionnaire • Observations
Observations support emerging conceptualisations	Prior conceptualisations determines measurements
Data-driven: may help in building (new or changed) theories. Open-ended.	Theory-driven: determines what data need to be collected. Uses specific hypotheses.
Emergent design	Planned data collection and analysis
Non-statistical data analysis.	Statistical data analysis

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Questionnaires

Surveys/questionnaires

- Are useful for collecting information about behaviour, that cannot be observed directly (assuming that respondents are willing to share that information).
- Can be used to gather data about abstract ideas or concepts that are otherwise difficult to quantify, such as opinions, attitudes and beliefs.

Constructs

- Questionnaires can be a tool to 'measure' relevant psychological **constructs**. A construct is the model, idea that the researcher is trying to measure. Constructs need to be clearly described, defined and communicated among researchers to be useful (exchange of results).
- Psychological, non-observable constructs (*e.g.* student motivation, teacher satisfaction) are not easily 'measured' in a reproducible way with a single item questionnaire. Scales (a group of questionnaire items) are usually needed.

Scales

- Good scales will have the advantage that the underlying (abstract) constructs can be measured in a reproducible, precise and consistent way and that results can be communicated to fellow researchers (publications *etc.*).

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Quantitative tools: beginnings

Step 1a: use a theoretical basis (literature review)

- To ensure that the construct definition aligns with relevant prior research and theory and to identify existing survey scales or items that might be used or adapted

Step 1b: Conduct interviews (focus groups)

- To learn how the population of interest conceptualizes and describes the construct of interest
- Can be the result of previous qualitative research

Synthesize literature review and interviews → Construct definition

- To ensure that the conceptualization of the construct makes theoretical sense to scholars in the field and uses language that the population of interest understands

Artino A.R. *et al.*, Med.Teacher 36, 463-474 (2014)

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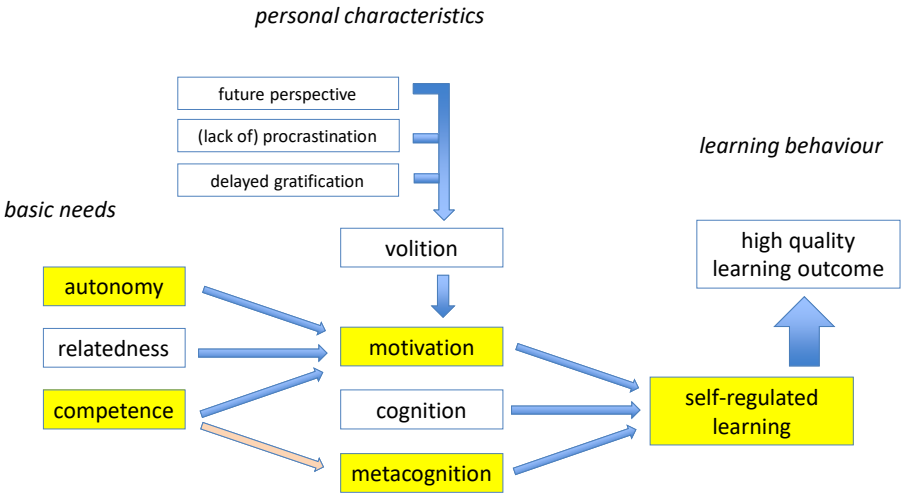
A model for effective learning



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Intermezzo 1

From your own teaching interest:

Which aspects of the teaching-learning environment do you want to investigate?

Do you know relevant constructs to use?

Discuss in dyads

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Constructing a new scale ?

Write items

- *Clear, unambiguous language aimed at target population?*
- *Avoid pitfalls: double-barreled items, double negatives*
- *Number of response items (4- , 5-, 7-point Likert scales?)*
- *Text of response answers:* e.g. *"strongly disagree" ... "strongly agree"*
- *Formulation of reversed items?*

Check face (content) validity

- *Panel of experts*
- *Are the items representative of the underlying construct?*

Pilot testing: interviews

- *Target population representatives*
- *Are the items clear, understandable, unambiguous?*

Rewriting and editing of questionnaire

- *Questionnaire*

Check statistical properties

- *Reliability, reproducibility*

Artino A.R. *et al.*, Med.Teacher 36, 463-474 (2014)

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Intermezzo 2

Epistemic justification scales

Justification for knowing

Justification by authority	Justification by multiple sources	Personal justification
AJ	**MJ**	**PJ**

Read and evaluate the items (handout)

Discuss in dyads

Bråten, I *et al.*, Int.J.Educ.Res. 66, 1-12 (2014)

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Intermezzo 2

	Justification by authority (aj)
aj01	If a natural science teacher says something is correct, then I believe it
aj02	I believe that everything I learn in natural science class is correct
aj03	Things that are written in natural science textbooks are correct
aj04	If a scientist says that something is a fact, then I believe it
aj05	When I read something about natural science that is based on scientific investigations, then I believe that it is correct
aj06	I believe in claims that are based on scientific research
	Justification by multiple sources (mj)
mj01	To be able to trust knowledge claims in natural science texts, I have to check various knowledge sources
mj02	To detect incorrect claims in texts about natural science, it is important to check several information sources
mj03	I can never be sure about a claim in natural science until I have checked it with at least one other source
mj04	Just one source is never enough to decide what is right in natural science
mj05	To decide whether something I read about natural science is correct, I have to check whether it is in accordance with other things I have read or heard about natural science
	Personal justification (pj)
pj01	What is a fact in natural science depends on one's personal views
pj02	Everyone can have different opinions about natural science, because no completely correct answers exist
pj03	Knowledge about natural science is only personal opinion – there are no facts

Bråten, I *et al.*, Int.J.Educ.Res. 66, 1-12 (2014)

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Using an existing scale ?

More efficient

- *Constructs have been defined by other scholars, and are validated*
- *Development has been done by other researchers*
- *But ... adaptations may ne necessary*

Consider re-using existing validated questionnaires

- *Comparable context (higher education, study programme)?*
- *Published iterations?*
- *Cross-cultural validity?*

Some development steps may be necessary

- *Face validity?*
- *Translation and back-translation (native speakers)*
- *Pilot testing (n = 5-10): question ambiguity?*

Check statistical properties

- *Reliability, reproducibility*

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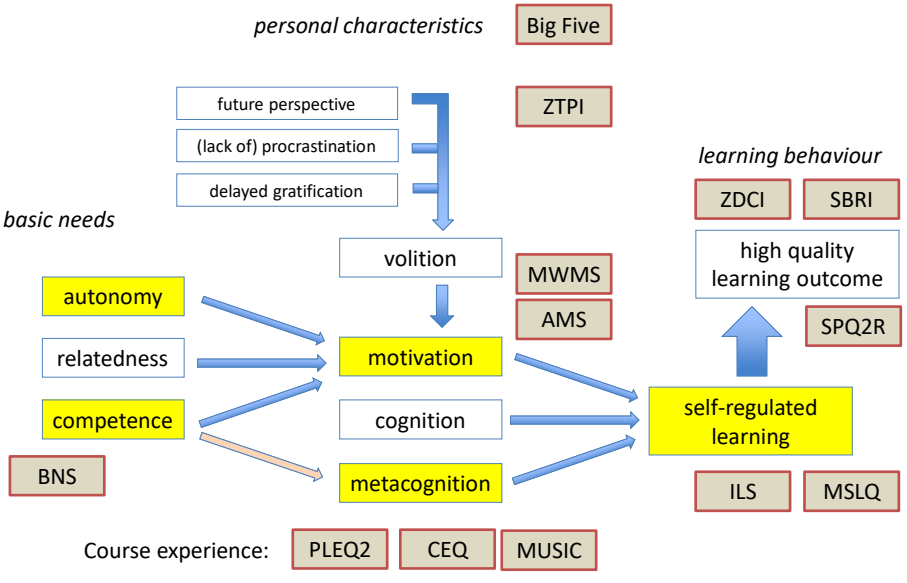
Available questionnaires/scales



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Examples: study and learning process

SPQ2R: study process (Biggs): 4 scales, 20 items

- *Deep motivation*
- *Deep strategy* — *Deep approach*

- *Surface motivation*
- *Surface strategy* — *Surface approach*

MSLQ: motivated strategies for learning (Pintrich): 15 scales, 81 items

Motivation scales:

- *Value: Intrinsic goal orientation, Extrinsic goal orientation, Task value*
- *Expectancy: control beliefs, self-efficacy*
- *Test anxiety*

Learning strategy scales:

- *Cognition: rehearsal, elaboration, organization, critical thinking*
- *Metacognitive self-regulation*
- *Management: study environment, effort, peer learning, help seeking*

Biggs J, Kember D, Leung DYP, Br.J.Educ.Psychol. 71,133-149 (2001) — 857 times referenced between 2004 and 2020 (Scopus)
Pintrich PR, Educ.Psychol.Rev. 16, 385-407 (2004) — 957 times referenced between 2004 and 2020 (Scopus)

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Scale reliability: Cronbach's Alpha

- Reliability is essential in scale development and refers to the amount of variance attributable to the true score of the latent construct.
- Reliability refers to the repeatability, stability or consistency of a tool. Internal consistency is determined by Cronbach's alpha.
- Internal consistency refers to the homogeneity of items within a scale. This coefficient should be as high as possible, preferably above 0.8.
- Reliability is a necessary pre-condition for validity.
- When an existing scale is used, reliability must be checked in new context.

Kumar, A., J.Adv.Pract.Nursing 1, 1000103 (2015)

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Scale reliability: an example

Justification by authority scale (from JFK-Q)		mean	s.d.
If a natural science teacher says something is correct, then I believe it	aj01	3.02	0.88
I believe that everything I learn in natural science class is correct	aj02	2.80	0.91
Things that are written in natural science textbooks are correct	aj03	3.29	0.91
If a scientist says that something is a fact, then I believe it	aj04	2.61	0.94
When I read something about natural science that is based on scientific investigations, then I believe that it is correct	aj05	3.76	0.71
I believe in claims that are based on scientific research	aj06	3.93	0.73

scale = 1- 5

Data from UCU- and CPS-students (year 1-3, n = 92)

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Justification by authority: correlations

Inter-item correlations						Item-total correlation		alpha = 0.743
	aj01	aj02	aj03	aj04	aj05		explained variance	if item deleted
aj01						0.583 **	46.6 %	0.676
aj02	0.534 **					0.625 **	41.8 %	0.661
aj03	0.488 **	0.384 **				0.477 **	35.2 %	0.708
aj04	0.508 **	0.503 **	0.193 n.s.			0.478 **	36.1 %	0.708
aj05	0.307 **	0.421 **	0.435 **	0.317 **		0.551 **	36.2 %	0.692
aj06	0.003 n.s.	0.164 n.s.	0.125 n.s.	0.066 n.s.	0.367 **	0.186 n.s.	15.4 %	**0.774**

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Construct validity: Factor analysis

When more than 1 construct is measured in a questionnaire:

- **Exploratory factor analysis** is used to analyse scores on several items to see if they can be reduced to their underlying dimensions (**the constructs**).
- Items that are measuring one construct should load on one factor and those measuring another construct should load on a different factor.
- Factor analysis should explain a substantial amount of the variance in the scores.
- Based on the factor analysis, the researcher can decide which items from the scale should be retained or deleted.

Kumar, A., J.Adv.Pract.Nursing 1, 1000103 (2015)

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Factor analysis: justification scales

Epistemic justification scales

Justification for knowing: JFK-Q

Justification by authority **AJ**	Justification by multiple sources **MJ**	Personal justification **PJ**
6 items	5 items	3 items
alpha = 0.743	alpha = 0.571	alpha = 0.654

Justification by an authoritative source, by a personal source or by multiple sources form separate domain-specific dimensions of epistemic beliefs.

Bråten, I *et al.*, Int.J.Educ.Res. 66, 1-12 (2014)

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Factor analysis

Pattern Matrix[a]

	Component		
	1	2	3
aj01	,743	-,259	,018
aj02	,767	-,071	-,048
aj03	,725	-,017	,043
aj04	,636	-,073	-,118
aj05	,709	,293	-,028
aj06	,290	,595	-,147
mj01	-,279	,461	,009
mj02	-,025	,593	-,185
mj03	-,190	,662	-,046
mj04	,221	,508	,363
mj05	-,123	,563	,189
pj01	-,014	,004	,759
pj02	-,051	-,050	,778
pj03	-,052	-,064	,714

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Sort loadings (high – low)

Suppress small coefficients (< 0.25)

Pattern Matrix[a]

	Component		
	1	2	3
aj02	,767		
aj01	,743	-,259	
aj03	,725		
aj05	,709	,293	
aj04	,636		
mj03		,662	
aj06	,290	,595	
mj02		,593	
mj05		,563	
mj04		,508	,363
mj01	-,279	,461	
pj02			,778
pj01			,759
pj03			,714

Extraction Method: Principal Component Analysis.
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Factor analysis

	Component		
	1	2	3
aj02	0.767		
aj01	0.743	- 0.259	
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aj04	0.636		
mj03		0.662	
aj06	0.290	0.595	
mj02		0.593	
mj05		0.563	
mj04		0.508	0.363
mj01	- 0.279	0.461	
pj02			0.778
pj01			0.759
pj03			0.714

cross loadings

49.6 % of the variance is explained by he three factors

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Factor analysis: cross loadings

	Component			
	1 = AJ	2 = MJ	3 = PJ	
aj01	0.743	- 0.259		If a natural science teacher says something is correct, then I believe it
aj05	0.709	0.293		When I read something about natural science that is based on scientific investigations, then I believe that it is correct
aj06	0.290	0.595		I believe in claims that are based on scientific research
mj04		0.508	0.363	Just one source is never enough to decide what is right in natural science
mj01	- 0.279	0.461		To be able to trust knowledge claims in natural science texts, I have to check various knowledge source

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Intermezzo 3

Reflect on the cross-loading items in the JFK-Q:

Why are some items cross-loading?
What does the loading suggest?
Take into account the sign (- or +)

Discuss in dyads

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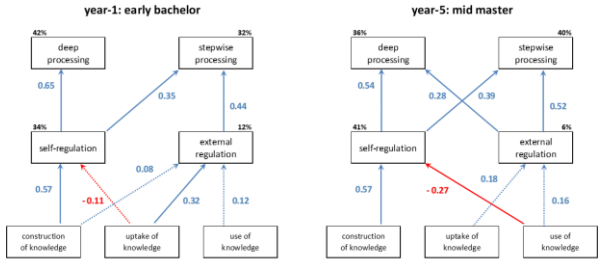
An application

- Good questionnaires/scales can be used to understand learning of students on a deeper level: relationships between constructs.
- Path-analysis and Structure Equation Modelling (SEM) can be used to investigate relationships and/or to study longitudinal development of students.



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Inventory of learning styles (Vermunt)

Aspects of student learning: constructs

processing strategies	deep processing *vs.* stepwise processing
regulating strategies	self-regulation *vs.* external regulation
conceptions of learning	construction, uptake or use of knowledge
learning orientations	personally interested, certificate-oriented or vocation-oriented

ILS: 120 items in 20 scales

Vermunt JD, Vermetten YJ, Educ.Psychol.Rev. 16, 359-384 (2004)

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Inventory of learning styles (Vermunt)

	Processing strategies	Regulation strategies
Meaning directed	**Deep processing** scale 1: relating and structuring scale 2: critical processing	**Self-regulation** scale 6: learning process scale 7: contents
	I try to combine subjects that are dealt with in the course into one whole. I compare my view of a course topic with the views of textbook authors.	To test my learning, I try to answer questions about the subject matter which I make up myself. In addition to the syllabus, I study other related literature.
Reproduction directed	**Stepwise processing** scale 3: memorizing and rehearsing scale 4: analyzing	**External regulation** scale 8: learning process scale 9: contents
	I memorize lists of characteristics of a phenomenon. I analyze the separate components of a theory step by step.	I study according to the instructions in the course manual. I test my learning solely by completing the questions, tasks and self-tests in the course material.

Vermunt JD, Vermetten YJ, Educ.Psychol.Rev. 16, 359-384 (2004)

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Inventory of learning styles (Vermunt)

	Mean scores ± s.e. (n = 30)			
	year-1	year-5	effect size	p (paired t-test)
Deep processing	2.79 ± 0.11	3.57 ± 0.12	1.24	< 0.001 ***
Self regulation	2.55 ± 0.12	3.03 ± 0.13	0.69	0.001 ***
Stepwise processing	3.02 ± 0.12	3.07 ± 0.13	0.09	0.69 n.s.
External regulation	3.44 ± 0.10	3.43 ± 0.09	0.01	0.94 n.s.

Effect size is the change in measured values between year-1 and year-5, expressed in terms of their common standard deviation. An effect size > 0.5 is considered a medium effect, an effect size > 0.8 is considered large (Cohen 1988).

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Detailed results

ILS-scale		change	year-1	year-5	effect size	p
Processing strategies						
ils0102	Deep processing	↑↑	2.79 ± 0.11	3.57 ± 0.12	1.24	< 0.001 ***
ils01	relating and structuring	↑↑	3.24	3.78	0.81	< 0.001 ***
ils02	critical processing	↑↑	2.34	3.37	1.47	< 0.001 ***
ils0304	Stepwise processing		3.02 ± 0.12	3.07 ± 0.13	0.09	0.69
ils03	memorizing and rehearsing		3.15	3.21	0.08	0.72
ils04	analyzing		2.88	2.92	0.07	0.74
Regulation strategies						
ils67	Self regulation	↑	2.55 ± 0.12	3.03 ± 0.13	0.69	0.001 ***
ils06	learning process	↑	2.67	2.96	0.40	0.03 *
ils07	contents	↑↑	2.30	3.16	1.01	< 0.001 ***
ils89	External regulation		3.44 ± 0.10	3.43 ± 0.09	0.01	0.94
ils08	learning process		3.33	3.16	0.30	0.17
ils09	contents		3.56	3.75	0.30	0.23
Conceptions of learning						
ils11	construction of knowledge	↑	3.25	3.62	0.71	0.001 ***
ils12	uptake of knowledge	↓	3.81	3.38	0.77	0.001 ***
ils13	use of knowledge	↑↑	3.63	4.09	0.84	0.002 **

Learning orientations: no statistically significant changes were seen.

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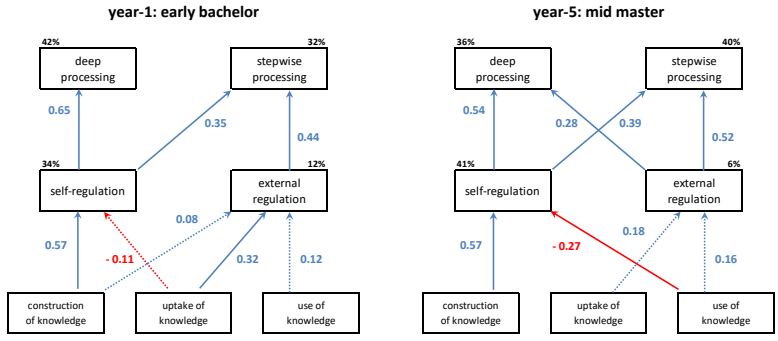
Mediation: causal relationships



- Use of deep processing strategies is mediated by self-regulation and depends on having a constructivist conception of learning
- Use of stepwise processing strategies is mediated by self- **and** external regulation and depends on having a reproductive conception of learning
- In year-5 deep processing becomes partly dependent on external regulation

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Appendix

Educational constructs for probing the mind of your students

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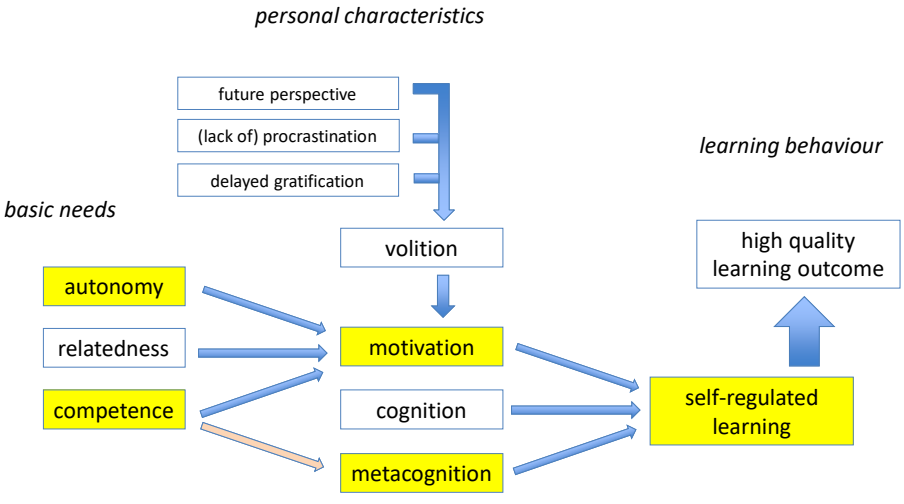
A model for effective learning



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Concepts and consequences

Self-determination theory (Ryan & Deci, Reeve)

- *Autonomy:* experiencing a sense of volition and psychological freedom in studying
  → autonomy-supportive teaching
- *Competence:* the feeling of being able and being effective in one's own studying
  → competency-based education
- *Relatedness:* experiencing a sense of closeness and friendship in studying
  → collaborative and cooperative learning
- *Motivation:* the (internal or external) motive for acting to achieve a particular goal
  → autonomous *versus* controlled motivation

Metacognition (Flavell, Veenman)

- Insight in own knowing and learning, based on self-reflection
  → portfolio's, SWOT analysis, personal development plan

Self-regulated learning (Zimmermann)

- The ability to adapt learning (knowledge, skills, behaviour) to circumstances
  → goal-directed learning, deliberate practice

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Focus on learning, not on teaching

- The teaching-learning environment comprises all components in the teaching system:
  - the curriculum and its intended outcomes
  - the assessment tasks
  - the teaching methods and teacher behaviour
  - the physical environment and the regulations
- Use constructive alignment to design students' assessment, learning activities, focusing on level-3 teaching

Level 2. Focus: what the teacher does
Learning is a function of teaching. The possibility is entertained that there may be more effective ways of teaching than what one is currently doing. Learning is seen as more a function of what the teacher is doing than of what sort of student one has to deal with.

Level 3. Focus: what the student does
Learning is the result of students' learning-focused activities, resulting from their own perceptions and inputs, and of the total teaching context. Focus must be on all components in the systems.

John Biggs

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Effective teaching

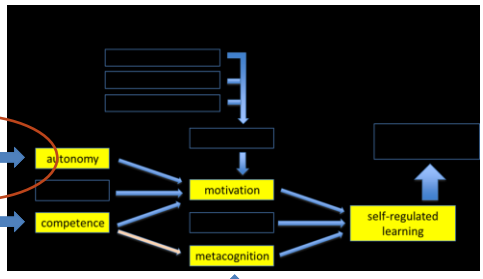
Content/context:
- Authentic learning (*e.g.* cases)

Teaching/learning environment:
- Inquiry based
- Problem- and project based
- Collaborative
- Cooperative

Teaching/coaching:
- Autonomy supportive
- Competency-based
- Organize and stimulate reflection

Efficient teaching is not always effective teaching:

Controlled motivation → efficient
Autonomous motivation → effective



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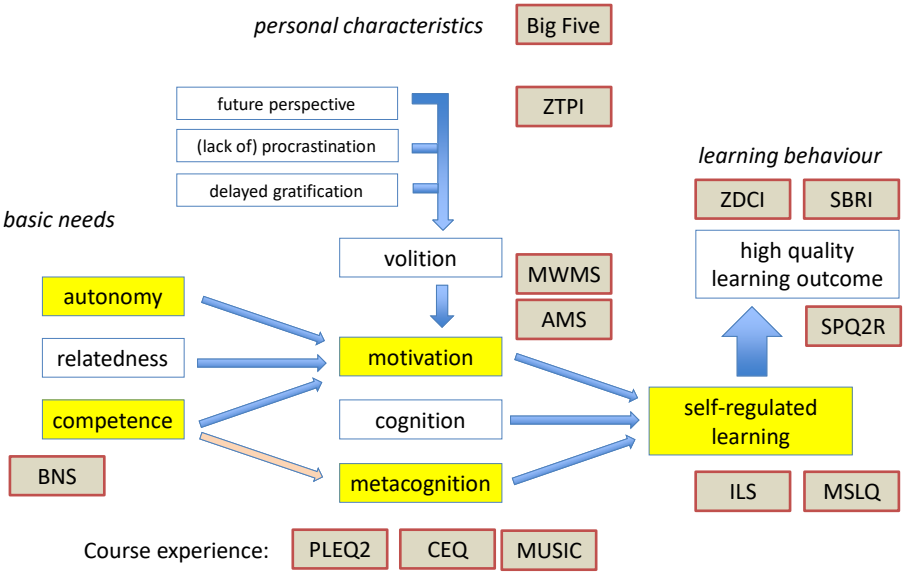
Available questionnaires



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Personality and psychological

Big Five (Goldberg)

- *Openness (to experience)*
- *Conscientiousness*
- *Extraversion vs. introversion*
- *Agreeableness*
- *Neuroticism vs. emotional stability*

ZTPI: Time perspective (Zimbardo, Boyd): 5 scales, 56 items

- *Future*
- *Past-negative*
- *Past-positive*
- *Present-hedonistic*
- *Present-fatalistic*

Zimbardo PG and Boyd JN, J.Pers.Soc.Psychol. 77(6), 1271- 1288 (1999).

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Motivation and psychological needs

AMS: academic motivation (Vallerand): 5 (or 7) scales, 28 items

- *Amotivation*

Extrinsic	*Controlled motivation*
Introjected	
Identified	*Autonomous motivation*
Intrinsic	

Variants: MWMS, ASRS, IMI, etc (see Self-determination website)

BNS: basic psychological needs (Chen): 6 scales, 24 items

Autonomy-satisfaction	
Competence satisfaction	*Need satisfaction*
Relatedness satisfaction	
Autonomy frustration	
Competence frustration	*Need frustration*
Relatedness frustration	

Vallerand RJ, Adv.Exp.Soc.Psychol. 29, 271-360 (1997)
Chen B et al., Motiv.Emot. 39, 216-236 (2015)

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Study and learning process

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Pintrich PR, Educ.Psychol.Rev. 16, 385-407 (2004)

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Inventory of learning styles (Vermunt)

ILS scale		α	loadings
F1: Meaning directed	1. relating and structuring	0.81	0.768
	2. critical processing	0.66	0.797
	5. concrete processing	0.70	0.691
	6. self regulation (process)	0.76	0.727
	7. self regulation (contents)	0.71	0.666
F2: Application directed	13. use of knowledge	0.70	0.749
	14. stimulating education	0.85	0.641
	15. cooperative learning	0.83	0.552
	19. vocation oriented	0.62	0.441
F3: Reproduction directed	3. memorizing and rehearsing	0.79	0.740
	8. external regulation (process)	0.56	0.739
	9. external regulation (contents)	0.62	0.600
	12. uptake of knowledge	0.75	0.620
	17. certificate oriented	0.67	0.567
F4: Undirected	10. lack of regulation	0.73	0.751
	20. ambivalent	0.76	0.815
not used	4. analyzing		
	11. construction of knowledge		
	16. personally interested		
	18. self-test oriented		

Vermunt JD, Vermetten YJ, Educ.Psychol.Rev. 16, 359-384 (2004)

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Learning outcomes

ZDCI: cognitive development (Zhang, *mod.* Zhu): 4 scales, 48 items

- *Dualism*
- *Multiplicity*
- *Relativism*
- *Commitment*

SBRI: science epistemic beliefs and reading self-efficacy
(taken from Bråten, Dai): 7 scales, 46 items

- *Science reading self-efficacy*
- *Science reading task value*

- *Personal justification*
- *Justification by authority*
- *Justification by multiple sources*

- *Simple and certain knowledge*
- *Attainable truth*

Zhang L, J.Adult Devl. 11(2), 123-138 (2004); Zhu J and Cox MF, J.Engineer.Educ. 104(3),345-362 (2015)
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Perception of TLE

CEQ: Course Experience Questionnaire (Ainley, Johnson): 5 scales, 24 items

- *Good teaching*
- *Clear goals and standards*
- *Appropriate assessment*
- *Appropriate workload*
- *Generic skills*

PLEQ2: Perception of Learning Environment (Nguyen): 6 scales, 40 items

- *Support of collaborative learning*
- *Support of individual student*
- *Impact of language proficiency on teamwork*
- *Handling of individual opinions in teamwork*
- *Organization of group learning*
- *Attitude towards cultural diversity*

MUSIC: (Jones): 5 (7) scales, 26 items

- *Empowerment*
- *Usefulness*
- *Success*
- *Interest,* with subscales *Situational Interest* and *Individual Interest*
- *Caring,*with subscales *Academic Caring* and *Personal Caring*

Richardson JTE, Assessm.Eval.High.Educ. 30(4), 387-415 (2005)
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