Analysis of verbal data

Understanding the processes of collaborative learning

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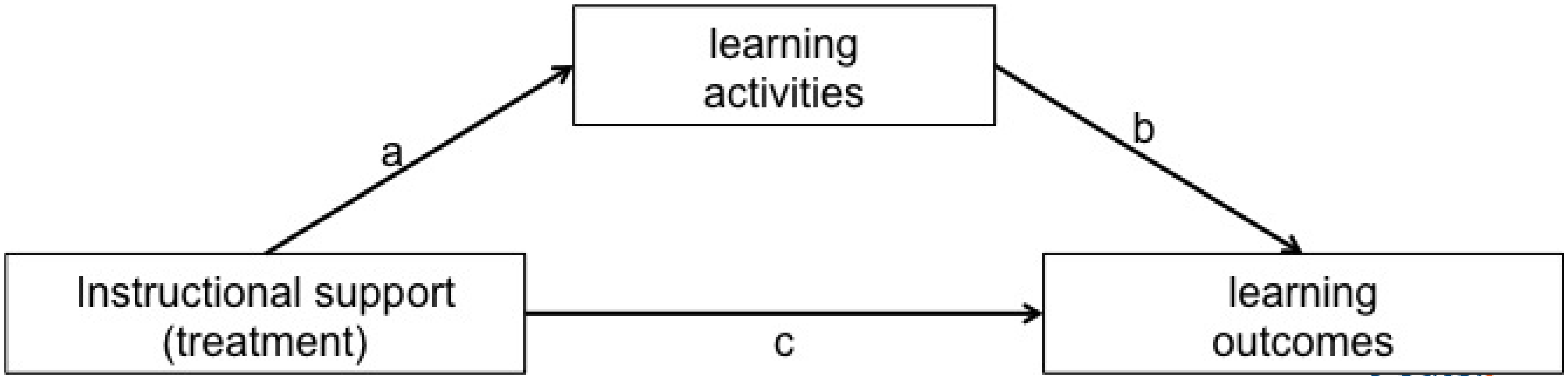
Overview

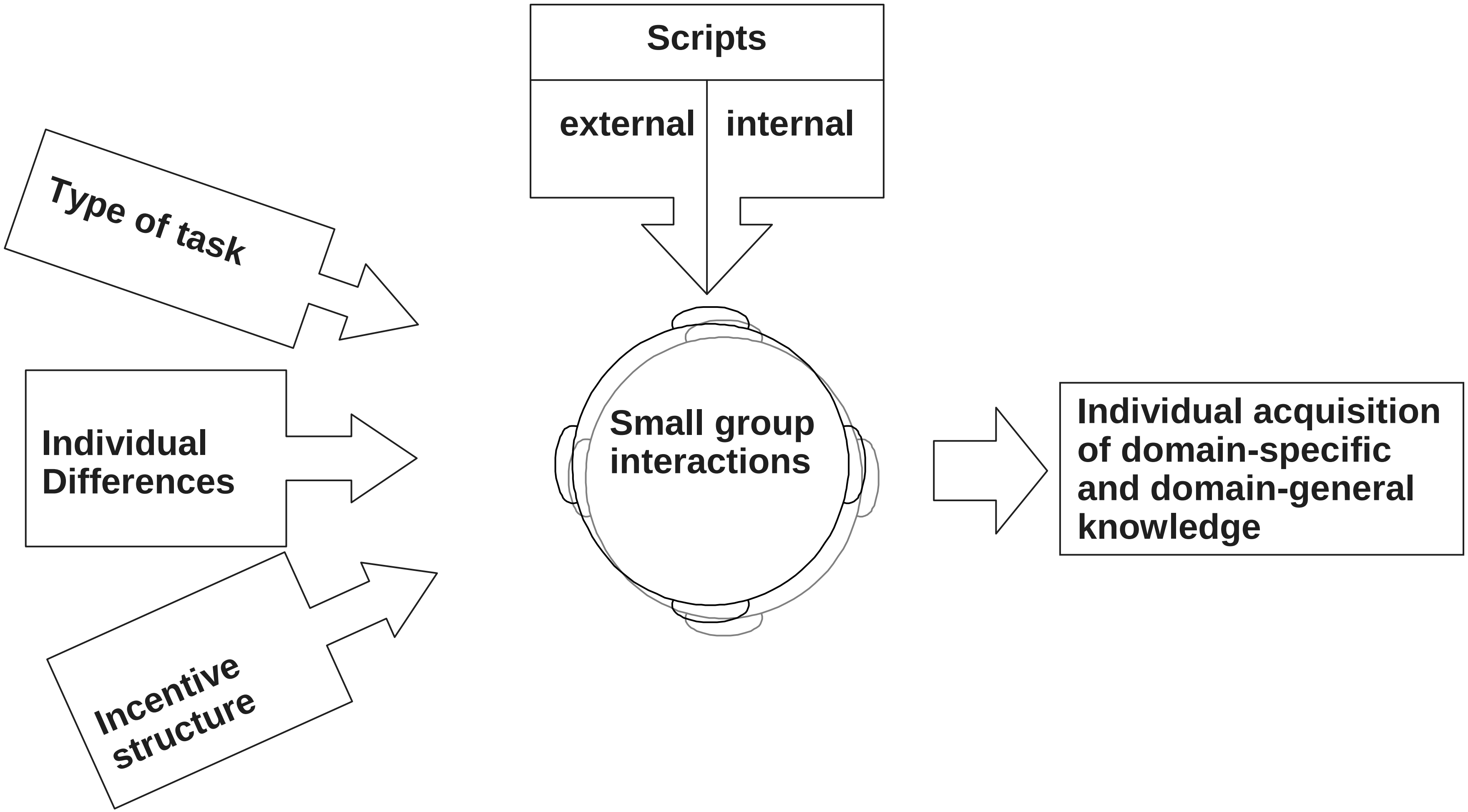
- Theoretical background of CSCL process analyses
- Steps in analysing CSCL processes based on verbal data
  - Analysing individuals in small groups
  - Transcription
  - Unit of analysis / Segmentation of verbal data
  - Categorisation
  - Determining reliability
  - Automatic analysis of verbal data
- Examples
  - Analysis of cognitive processes based on think-aloud data
  - High level analyses on the base of process analyses

General research paradigm

- Triangle of hypotheses:
  - Specific (learning) activities are positively related with a desired outcome. (b)
  - An instructional support facilitates the specific (learning) activities. (a)
  - The intervention fosters the desired outcome mediated by the specific (learning) activities. (c)



Framework on cooperative learning (O'Donnell & Dansereau, 1992)



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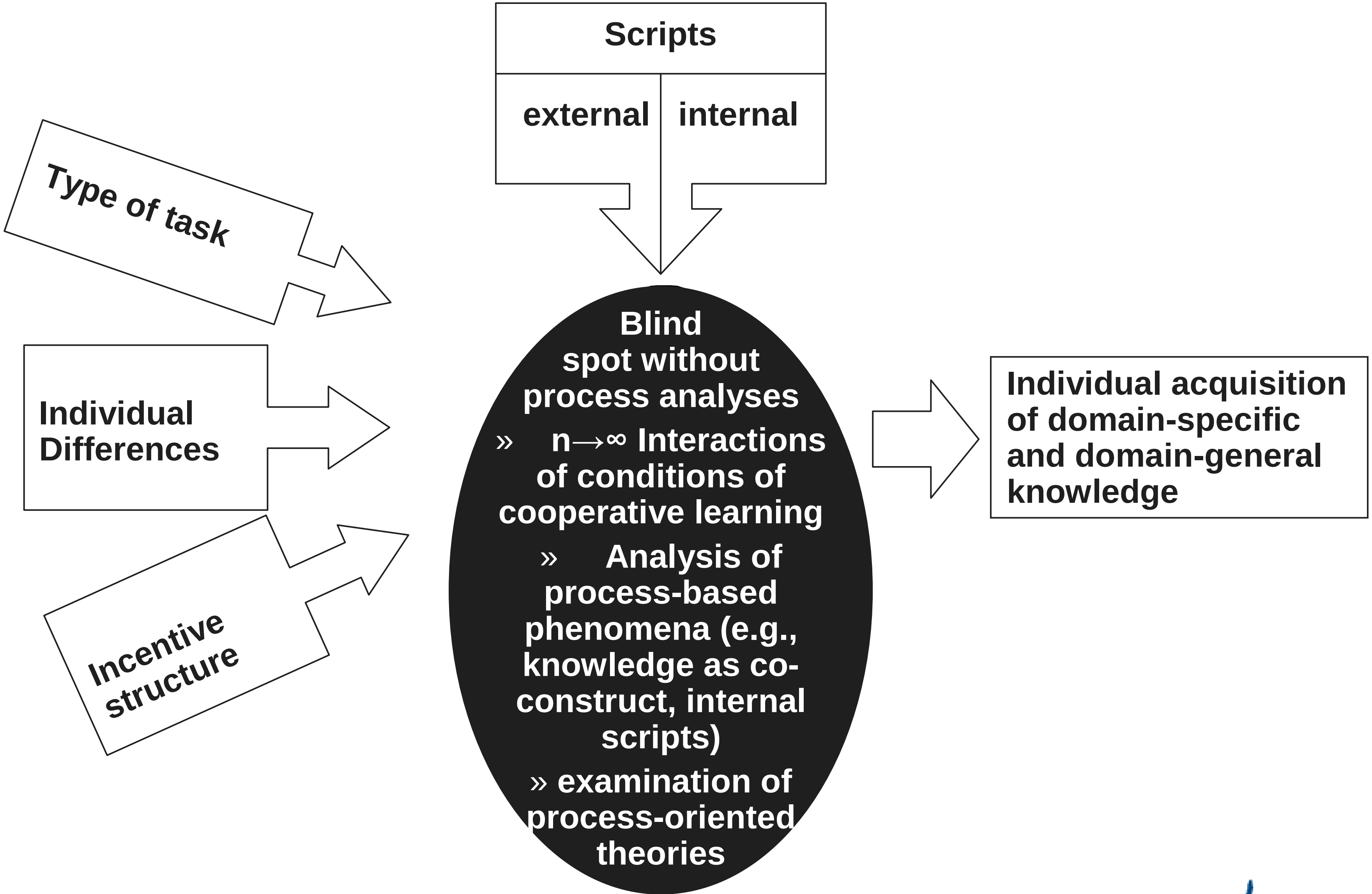
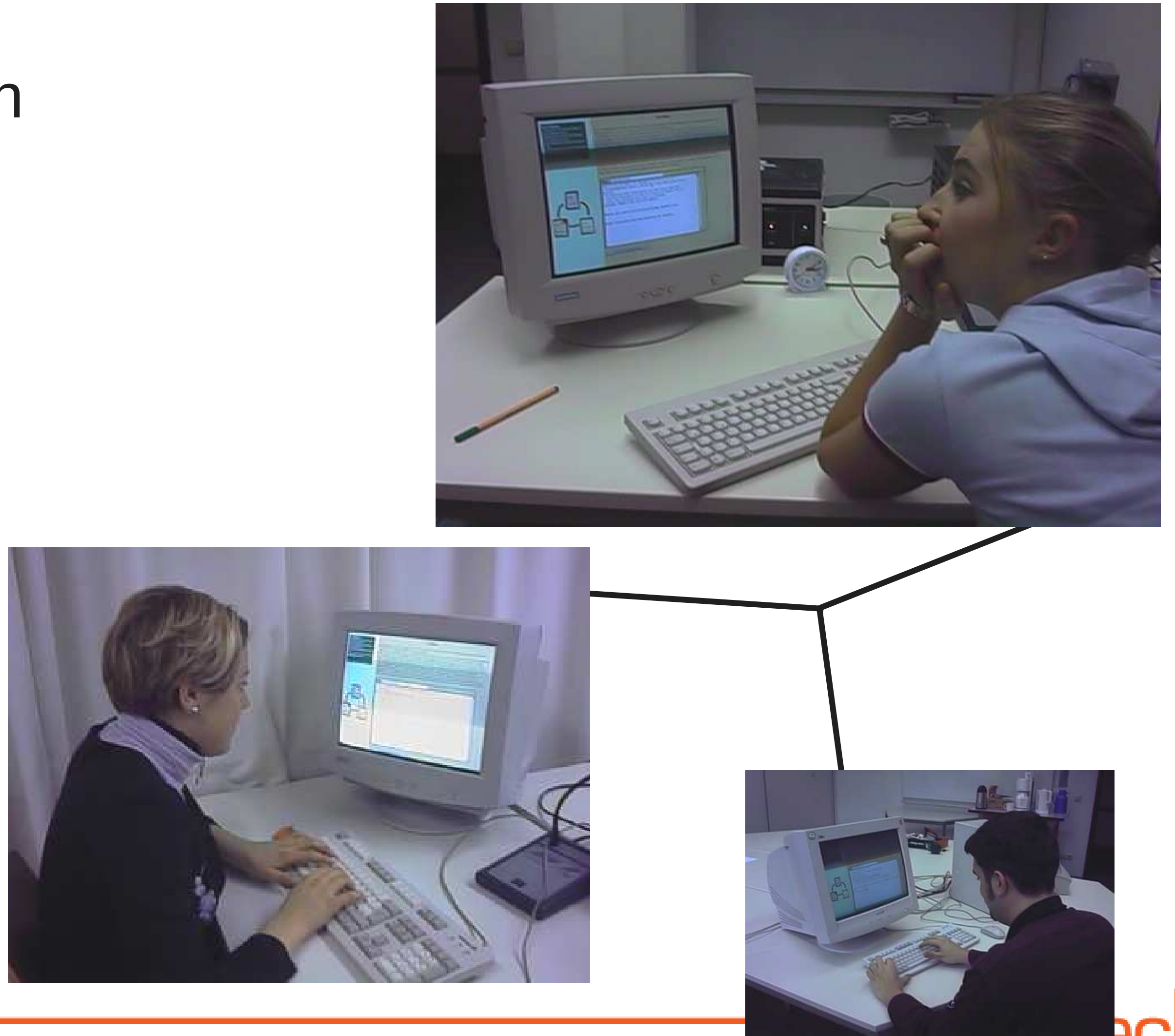


Text-based communication

Self-transcription
of dialogues



Joint, argumentative knowledge construction: Talking, Thinking, Learning

Example coding scheme:
Weinberger & Fischer, 2006

Granularity of segmentation

Fine granularity	Theoretical relation to learning?
signs	How many letters p do the learners use?
words	How many technical terms are being used?
speech acts	How do learners coordinate discourse?
sentences	How do learners structure their utterances?
propositions	Which concept do learners discuss? What claims are being made?
arguments	How do learners link concepts to construct arguments?
argumentations	What standpoints are being defended?
Coarse granularity	The granularity of the segmentation represents (different) types of knowledge in discourse (Chi, 1997)

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Example of Different Degrees of Fine-grainedness for Segmentation

Original messages

Jim:
The teacher attributes Michael's failure in an internal variable manner.
She argues that Michael is just plain lazy.

Carolyn:
I don't think so! The teacher is just making Michael feel bad.

Segmented messages

Jim:

The teacher attributes Michael's failure in an internal [manner]
[She argues that Michael is just plain lazy.]

[The teacher attributes Michael's failure in an] variable manner.
She argues that Michael is just plain lazy.

Carolyn:

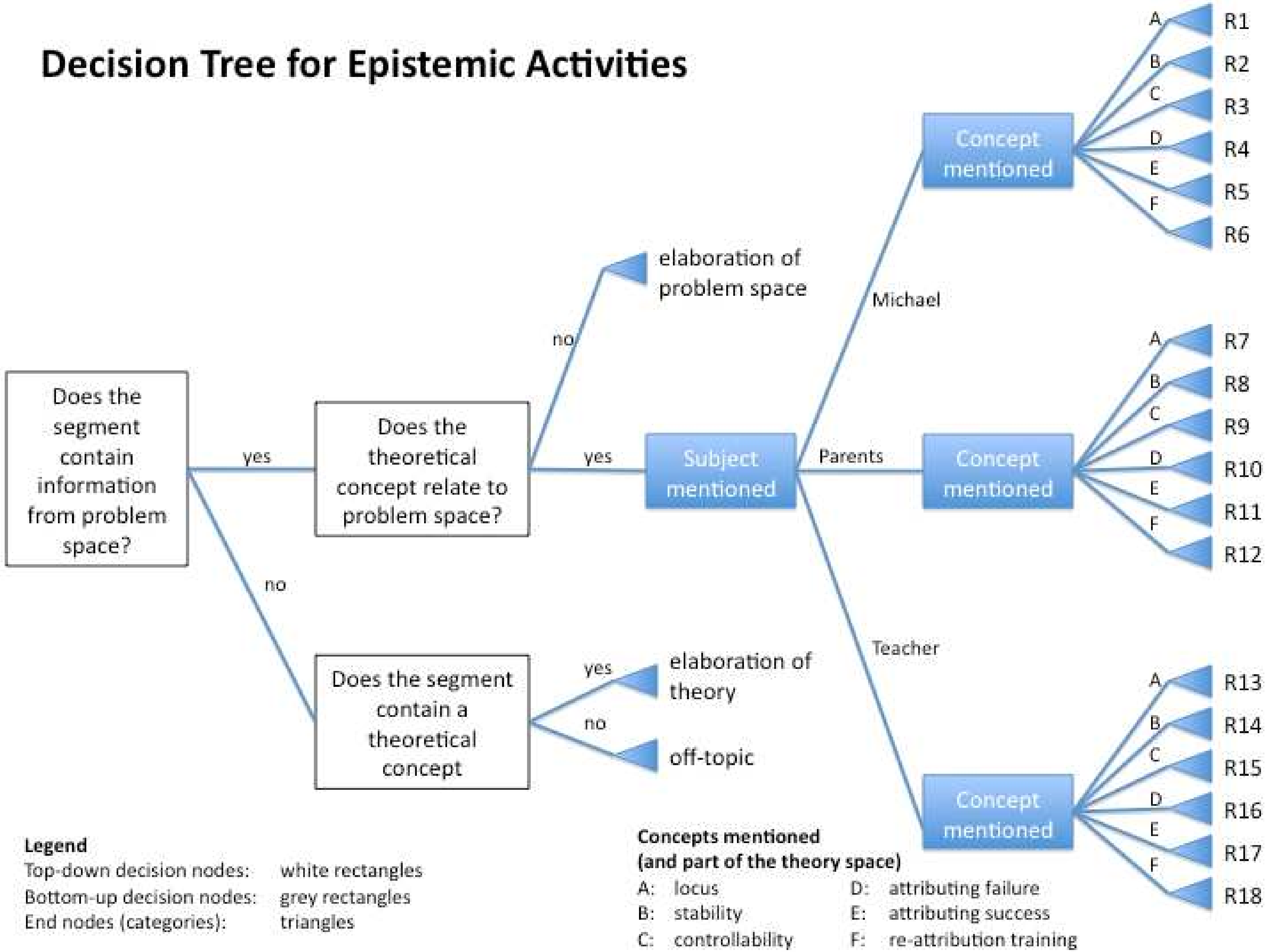
I don't think so! The teacher is just making Michael feel bad.

Categorisation

- Qualitative steps
  - (Development of) categories is related to state of the art of research
  - Generating hypotheses: Paraphrasing (Mayring), Coarse analyses (Forming clusters)

↓

- Development of a coding scheme
  - Exhaustive: Every segment is being coded
  - Exclusive: Only one category applies per segment per dimension
  - Documentation of rules, e.g., in the form of a decision tree


Decision Tree for Epistemic Activities
Does the segment contain information from problem space?
yes
no
Does the theoretical concept relate to problem space?
no
elaboration of problem space
yes
Subject mentioned
Michael
Parents
Teacher
Concept mentioned
Concept mentioned
Concept mentioned
A
B
C
D
E
F
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
Does the segment contain a theoretical concept
yes
elaboration of theory
no
off-topic
Legend
Top-down decision nodes: white rectangles
Bottom-up decision nodes: grey rectangles
End nodes (categories): triangles
Concepts mentioned (and part of the theory space)
A: locus
B: stability
C: controllability
D: attributing failure
E: attributing success
F: re-attribution training

Example for coding rules in form of a decision tree (Wecker, 2006)

1. Is there any talk in the segment at all (incl. mumbling)? yes: 2, no: 4
2. Is there any talk longer than 1 sec.? yes: 6, no: 3
3. Do the learners ask about the (i) reading progress (e.g., „Are you done?“), (ii) protest against scrolling down (e.g., „Stop!“), (iii) comment about any text (e.g., „Haha: ‚chacked'!“; „What means ‚focused'?“) or (iv) describe the current activity (e.g., „We are reading.“)?
    1. yes: Coding „Information intake“ for the current segment and all prior segments up to that segment that has been coded as „no activity (silence)“
    2. no: 4

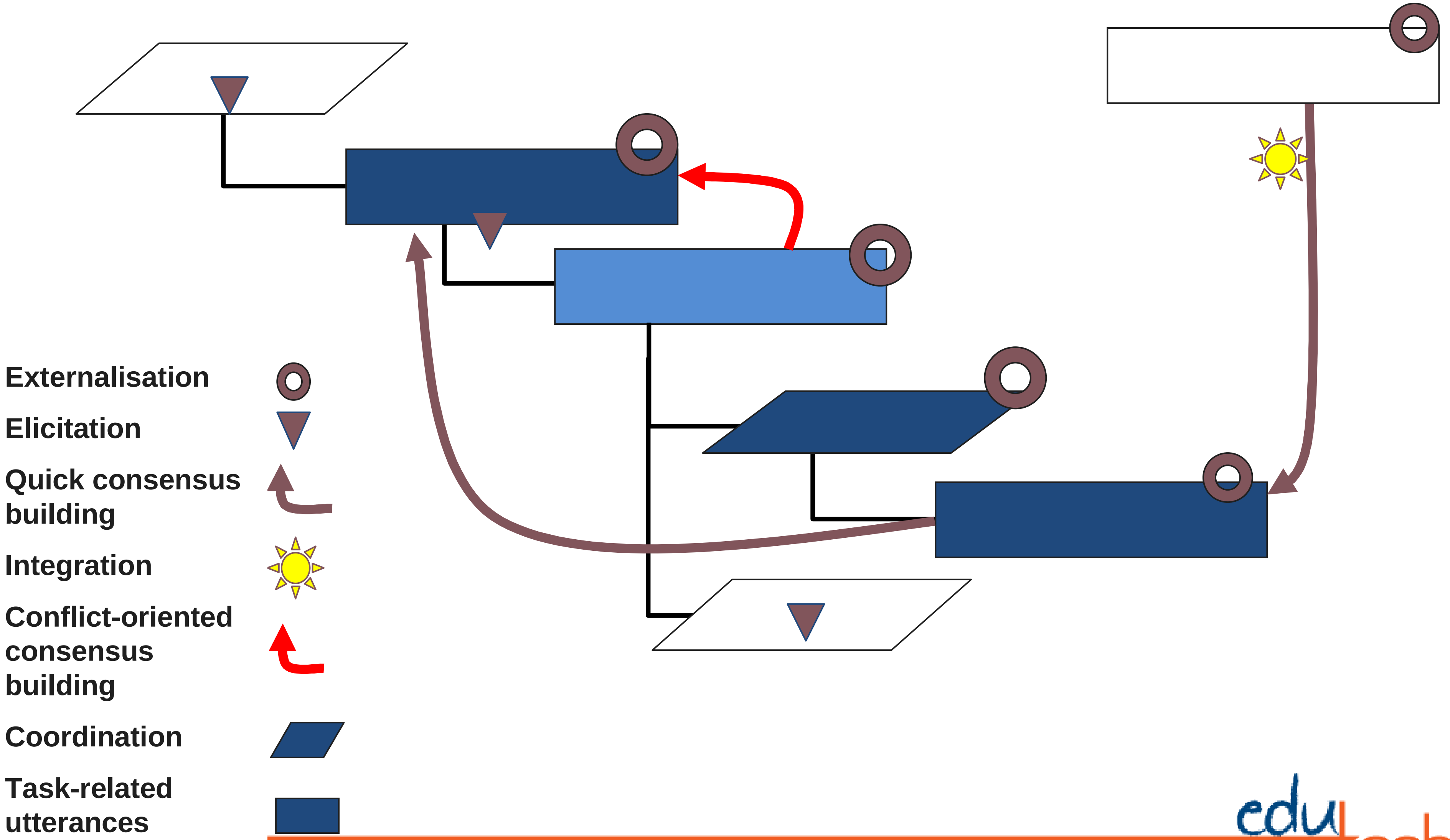
Example for a framework for analysing verbal data in CSCL environments (Weinberger & Fischer, 2006)

- Multiple dimensions:
  - Participation dimension
  - Epistemic dimension
  - Formal-argumentative dimension
  - Dimension of social modi of co-construction (incl. transactivity)

Multiple Dimensions of Argumentative Knowledge Construction

Dimensions	Question
Participation **(Words and messages; Cohen, 1994)** ▪ **Quantity** ▪ **Homogenity**	**Do learners participate (at all) in Online-Discourse?**
Epistemic Activities **(κ = .90; Fischer, Bruhn, Gräsel, & Mandl, 2002)** ▪ **construction of problem space** ▪ **construction of conceptual space** ▪ **construction of relations between conceptual and problem space**	**Do learners argue on task? Do learners construct arguments based on the relevant concepts?**
Argumentation **(κ = .78; Leitão, 2000)** ▪ **construction of single arguments** ▪ **construction of argumentation sequences**	**Do learners construct formally complete arguments and argument sequences?**
Social Modes of co-construction **(κ = .81; Teasley, 1997)** ▪ **Externalization** ▪ **Elicitation** ▪ **Quick consensus-building** ▪ **Integration-oriented consensus-building** ▪ **Conflict-oriented consensus-building**	**Do learners operate on the reasoning of their learning partners? How do learners build consensus?**

Macro-coding



Testing and documenting reliability

- Objectivity of coding -> interrater reliability
  - Two or more coders code the same segments
  - Similarity between codes is compared
    (-> Cohen‘s Kappa, Krippendorff‘s alpha, ICC)
- Objectivity requires training

Standard training process

- Explanation phase
  - Definition of dimensions and codes
- Modelling phase
  - Joint coding of example data
- Practice
  - Individual coding of example data
    - if objectivity sufficient -> training successful
    - if objectivity not sufficient -> modelling phase + feedback

Training material

- Rule of thumb:
  10% of the raw data per testing/practice
- Randomly selected data
  - All experimental conditions have to be represented
  - All codes need to be coded at least several times to test objectivity

Feedback: Crosstables

		S						
		1	2	3	4	88	99	Gesamt
D	1	13	7	0	0	0	1	21
	2	0	6	0	1	4	1	12
	3	0	1	1	2	1	0	5
	4	0	1	0	4	0	0	5
	88	0	0	0	0	5	0	5
	99	3	3	0	1	0	5	12
Gesamt		16	18	1	8	10	7	60

		Wert	Asymptotischer Standardfehler[a]	Näherungsweises T[b]	Näherungsweise Signifikanz
Maß der Übereinstimmung	Kappa	.456	.078	7.440	.000
Anzahl der gültigen Fälle		60			

Typical consequences of low objectivity

- Refinement of coding scheme, i. e. clarification of rules, additional examples
- Adaption of coding scheme
  - combination of codes
  - additional codes
- Beware of skewed data:
  - High objectivity due to code „other“

Micro-Coding

Lombard et al. - Criteria	1st wave of studies 00/01	2nd wave of studies 02/03	3rd wave of studies 03/04
size of reliability sample	**ca. 500 Seg.**	**199 Seg.**	**176 Seg.**
relationship of the reliability sample to the full sample	**105 participants 2821 segments**	**289 participants 6296 segments**	**243 participants 9825 segments**
N of coders	**2 students**	**6 students**	**5 students**
amount of coding	**50% each**	**ca. 17% each**	**ca. 17% each**
Reliabilityindices	**Seg.: 87% Epi.: κ = .90 Arg.: κ = .78 Soz.: κ = .81**	**Seg.: 83% Epi.: κ = .72 Arg.: κ = .61 Soz.: κ = .70**	**Seg.: 85% Epi.: κ = .89 Arg.: κ = .91 Ø Soz.: κ = .87**
Reliability of each variable	**---**		
amount of training	**ca. 500 h in each wave trained with 1000 to 1500 discourse segments**		
references	**Weinberger, Fischer, & Mandl, 2001; Weinberger & Fischer, 2006**		

Automatisation of coding

- Machine learning algorithms learn from already coded data
- Features of written text need to be extracted (e. g. word count, unigrams, bigrams, punctuation)
  - LightSIDE or TagHelper extract features and prepare them for the training of machine learning algorithms

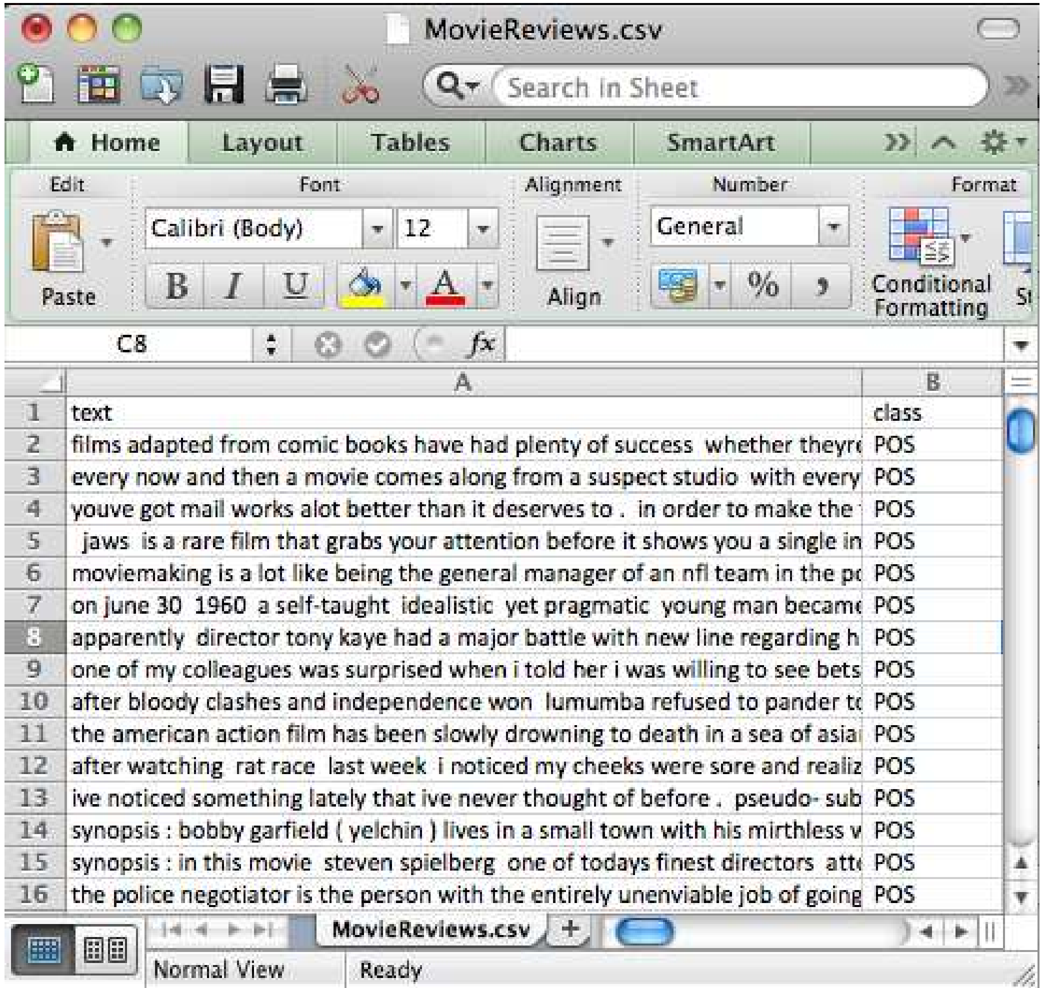
Automatisation: Step 1

- Get the software „LightSIDE“ (it‘s free):

http://ankara.lti.cs.cmu.edu/side/download.html

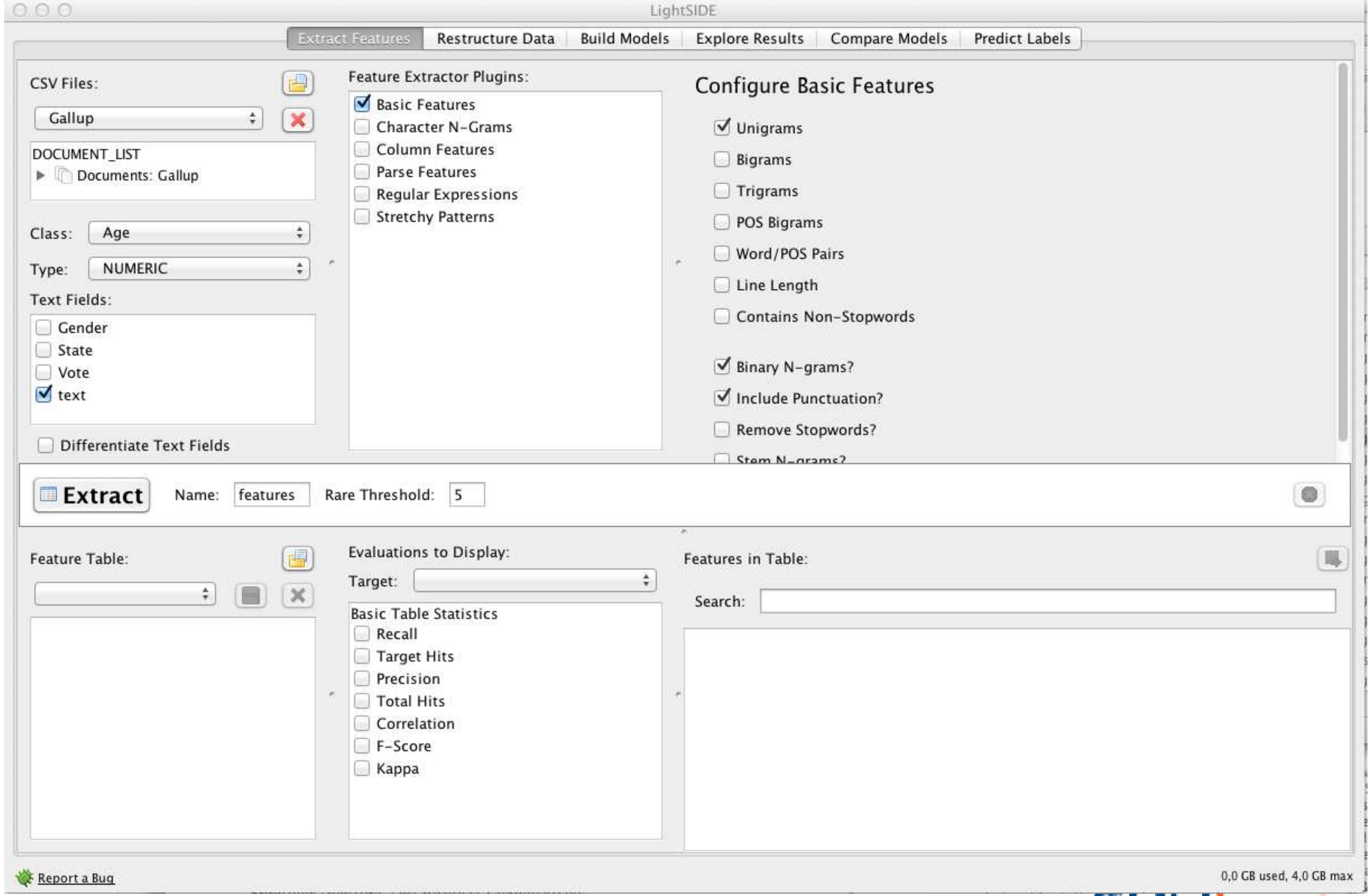
Automatisation: Step 2

- Prepare your data
  - First column: text
  - Second column: code
- Save as csv-file
- Load file csv-file into LightSIDE



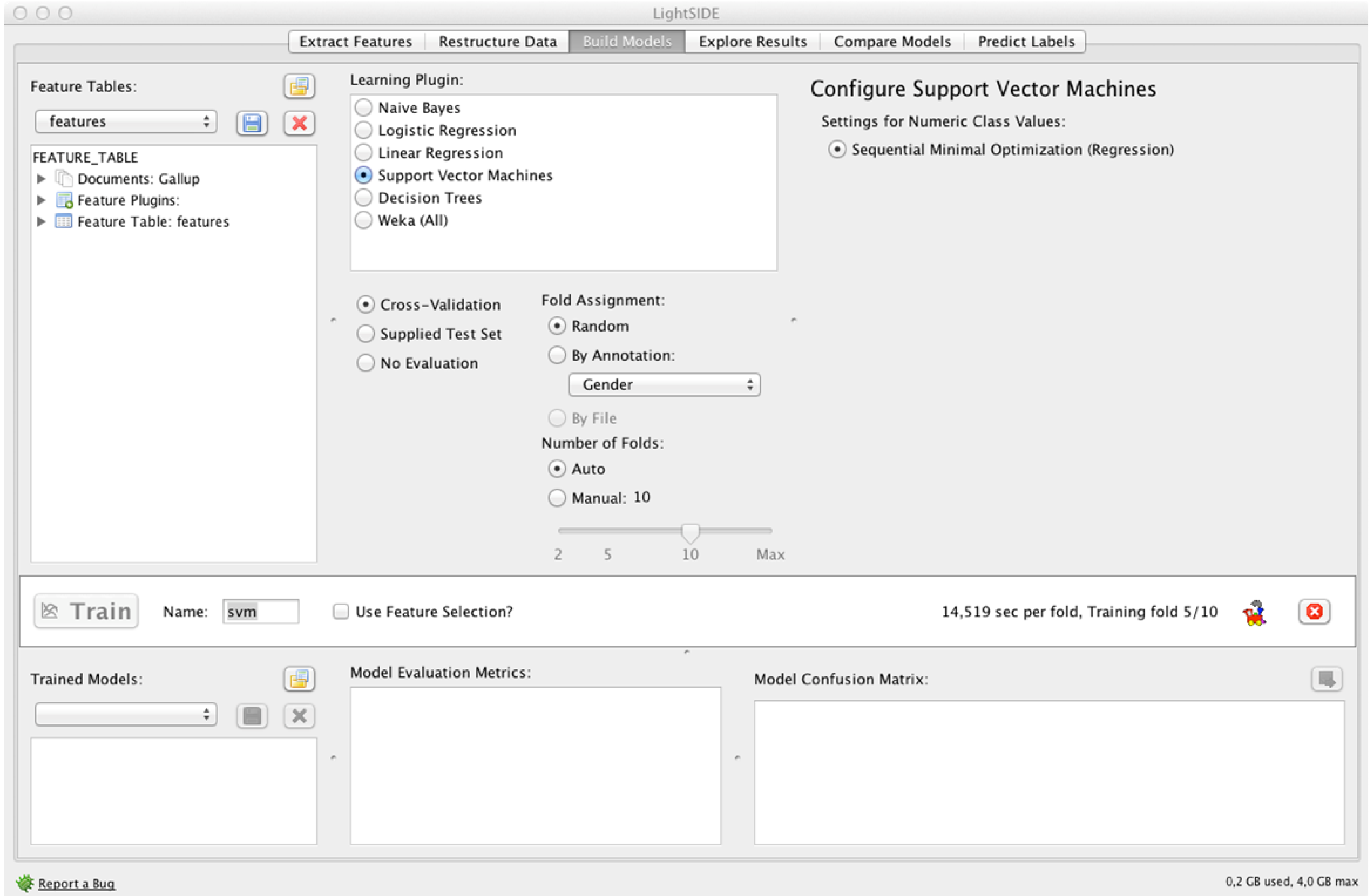
Automatisation: Step 3

- Extract features



Automatisation: Step 4

- Train model



Automatisation: Step 5

- Improving models
  - exclude rare features
  - exclude missleading features
  - add semantic rules

Automatisation: final step

- Apply model to new material
  - Must not be different from training material -> change of context, topic, sample may cause problems

- Automatically coded data require careful supervision

Automatisation: Does it work?

Table 2 Comparison without and with the layer of extracting attributes to automate the content analysis

	Without extracting attributes		With extracting attributes	
Segmentation layer II	Cohen's Kappa	Percent Agreement	Cohen's Kappa	Percent Agreement
Kappa $_{\text{SIDE-Training Material}}$	0.84	96.7 %	0.98	99.6 %
Kappa $_{\text{SIDE-Testing Material}}$	0.86	97.0 %	0.97	99.3 %
Major choice	0.80	96.7 %	0.95	99.1 %
Math	0.86	96.6 %	0.96	98.9 %
Class reunion	0.87	97.0 %	0.97	99.3 %
Between-culture variance	0.90	97.7 %	0.99	99.7 %
Text-analysis	0.83	96.9 %	0.98	99.6 %
Coding layer III				
Kappa $_{\text{SIDE-Training Material}}$	0.70	75.6 %	0.77	81.3 %
Kappa $_{\text{SIDE-Testing Material}}$	0.61	67.8 %	0.81	84.5 %
Major choice	0.63	71.2 %	0.77	82.9 %
Math	0.67	72.3 %	0.78	82.6 %
Class reunion	0.47	58.5 %	0.76	81.0 %
Between-culture variance	0.53	63.1 %	0.85	87.5 %
Text-analysis	0.68	75.0 %	0.87	89.2 %

Checklist for argumentation analyses

- Theoretical framework
- Research questions and methods that can address those questions in a valid manner
- Explicit and theory-based set of rules for segmentation and categorization
- Testing and documenting reliability (see Lombard et al., 2002)
- Replication

Testing and documenting reliability: Part 1

(Lombard, Snyder-Duch, & Braaken, 2002)

- the size of and the method used to create the reliability sample, along with a justification of that method;
- the relationship of the reliability sample to the full sample;
- the number of reliability coders and whether or not they include the researchers;
- the amount of coding conducted by each reliability and non-reliability coder;

Testing and documenting reliability: Part 2

(Lombard, Snyder-Duch, & Braaken, 2002)

- the index or indices selected to calculate reliability and a justification of these selections;
- the inter-coder reliability level for each variable, for each index selected;
- the approximate amount of training (in hours) required to reach the reliability levels reported;
- where and how the reader can obtain detailed information regarding the coding instrument,
- procedures and instructions (for example, from the authors).

Conclusions

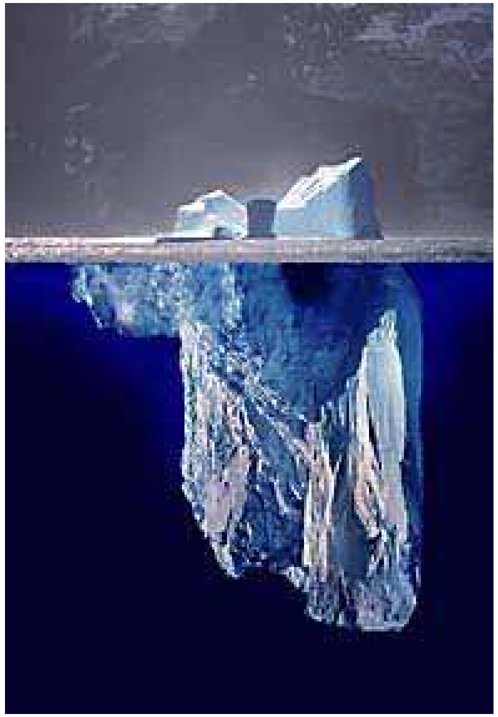
- CSCL is an ideal context to investigate collaborative and individual knowledge construction processes, which can be reliably assessed with a multi-granular and multi-dimensional framework (Weinberger & Fischer, 2006).

but

- which requires major training efforts
- which captures most, but maybe not all cognitive processes of knowledge construction

Example 1

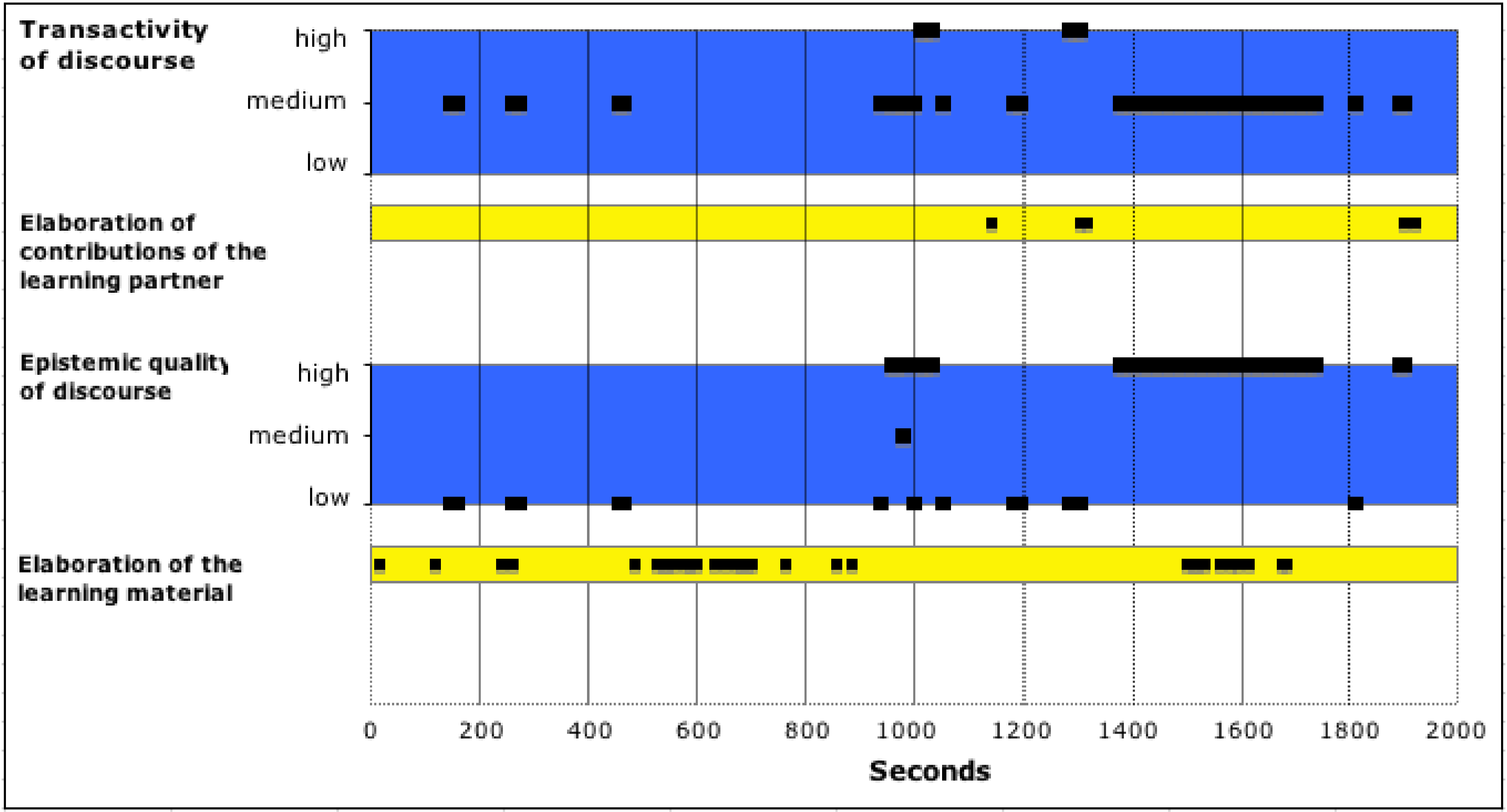
- Analyses of cognitive processes of learning through think-aloud protocols in CSCL



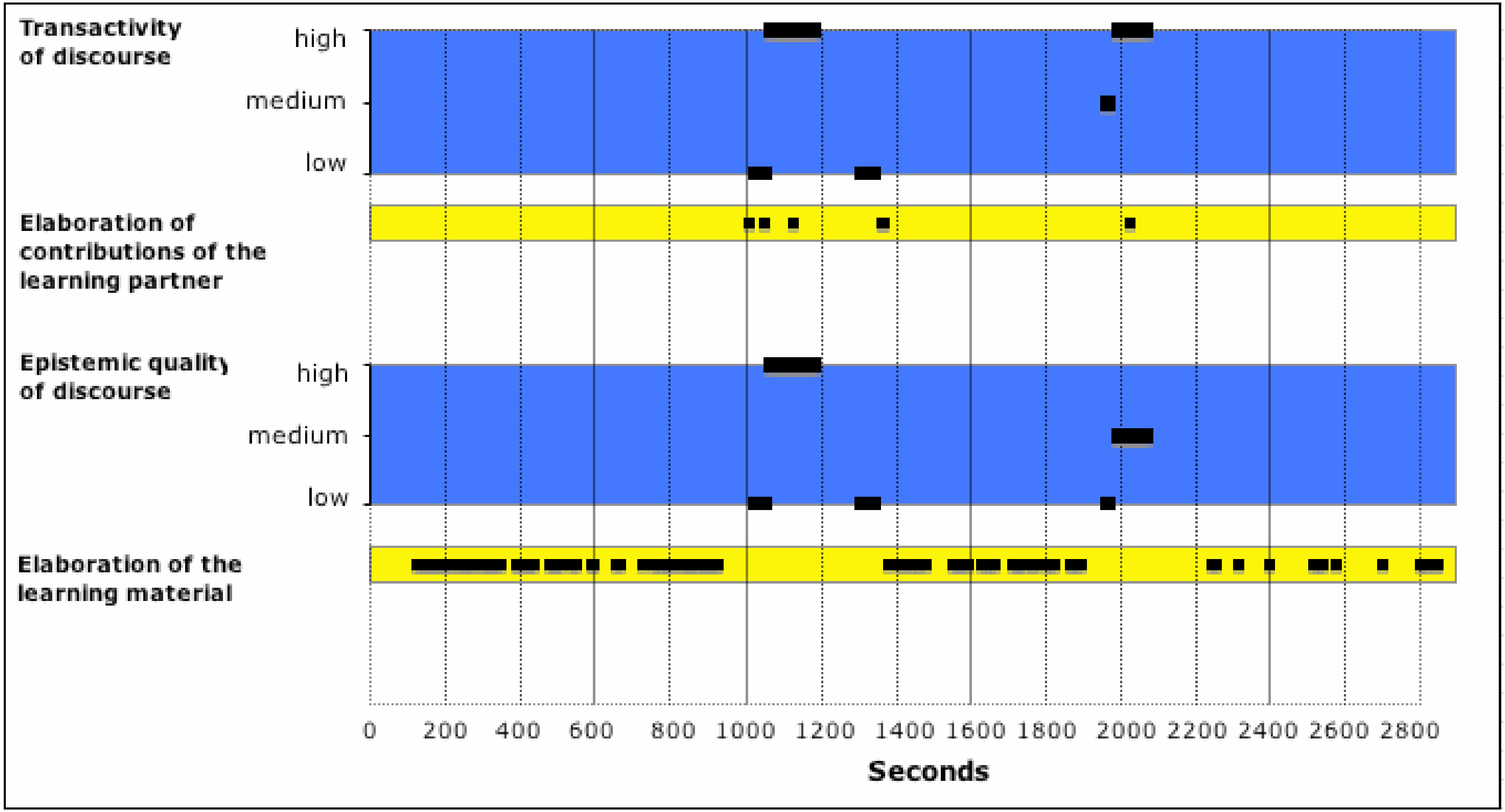
Analysis of cognitive processes

- Think-aloud protocols
- 10-Sec segments
- coding ($\kappa = .78$):
  - Elaboration depth
  - Elaboration focus
    - Elaboration of content
    - Elaboration of peer contributions

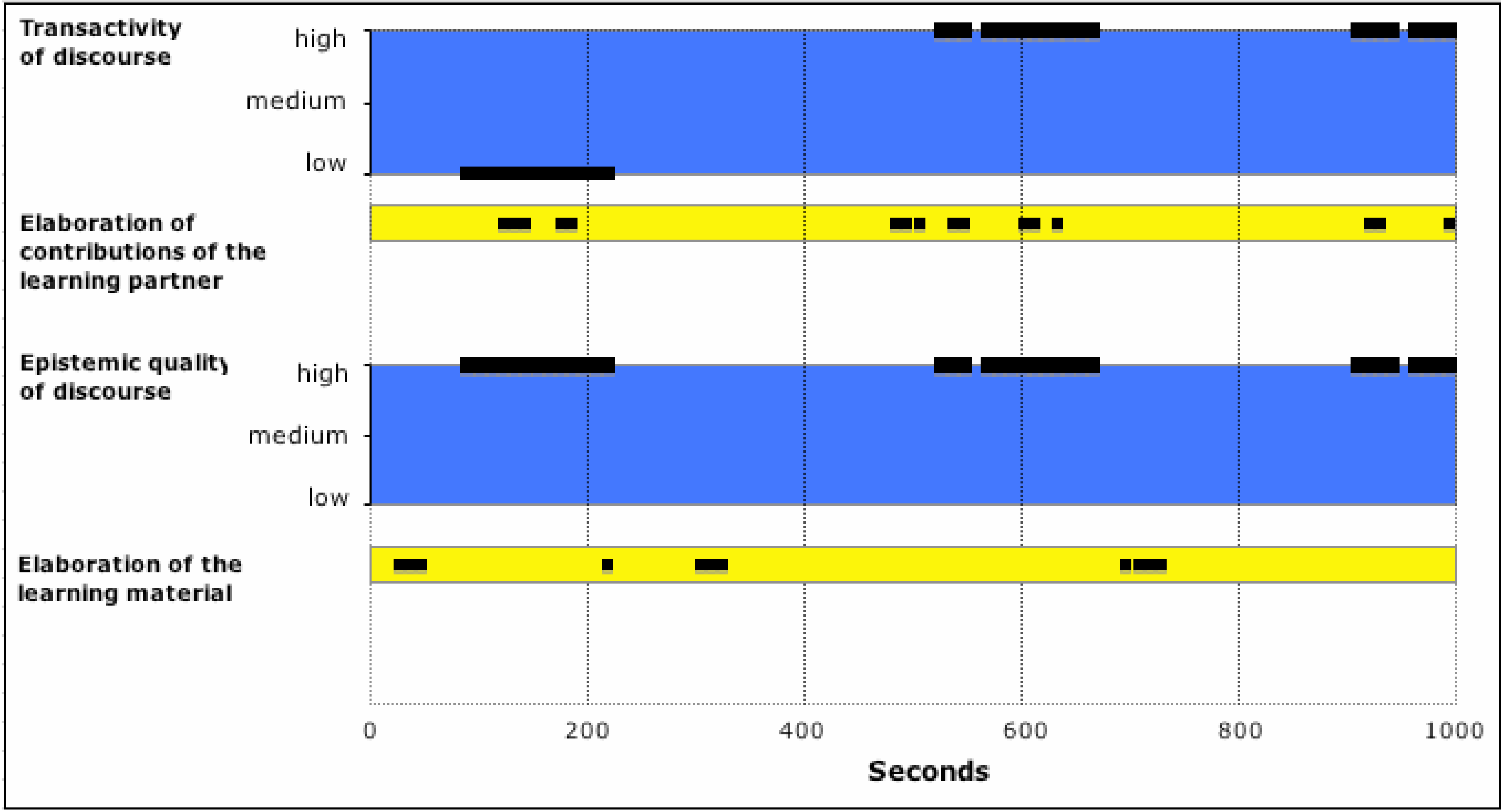
Good learner, no script



Learner with script, role of analytic



Learner with script, role of critic



Example 2

- CSCL-assumption learners are influencing each other
- Requirement for analysis is indenpendence of observations
- Analyzing individuals, groups, or both with **multi-level modeling**

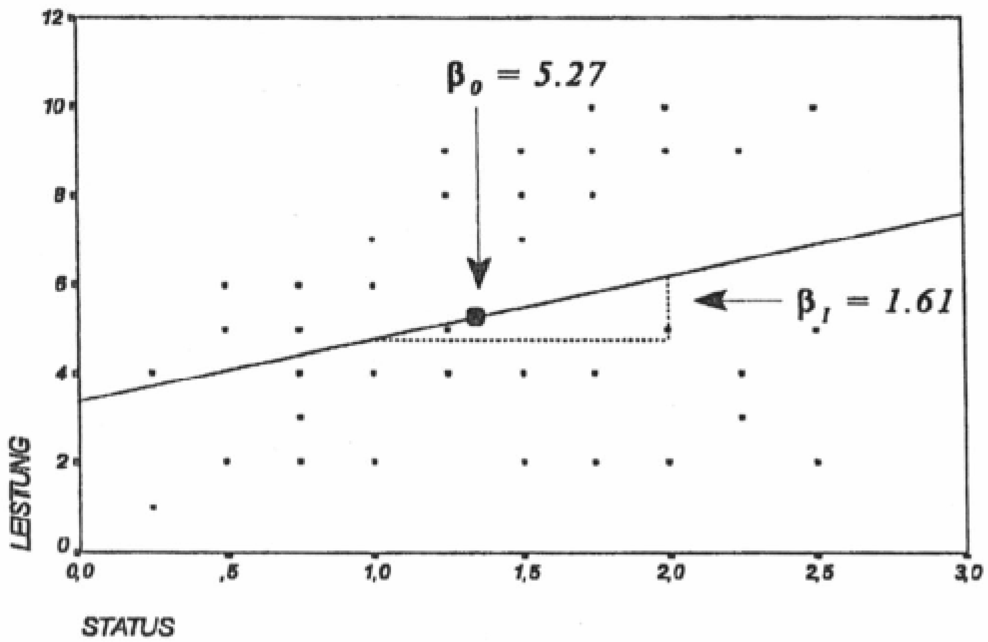


Abbildung 1-1: Beziehung zwischen sozialer Herkunft und Schulleistung in der Gesamtgruppe

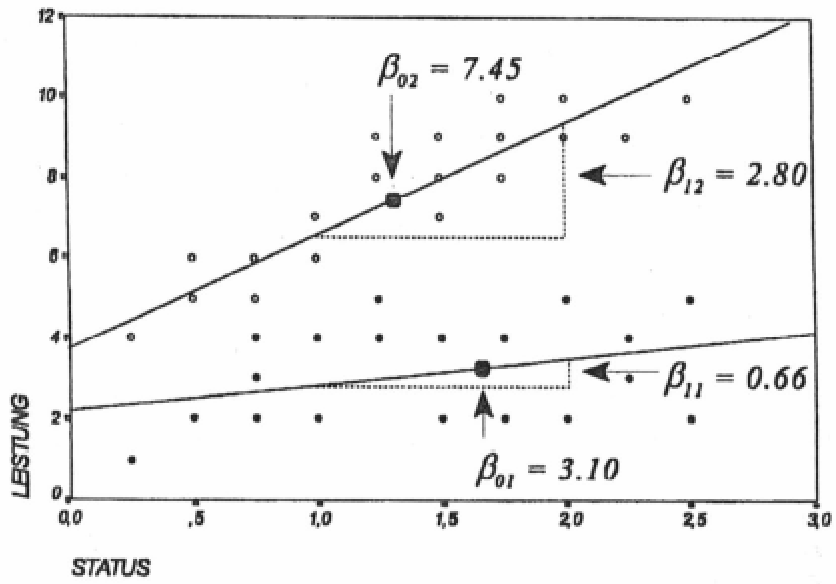
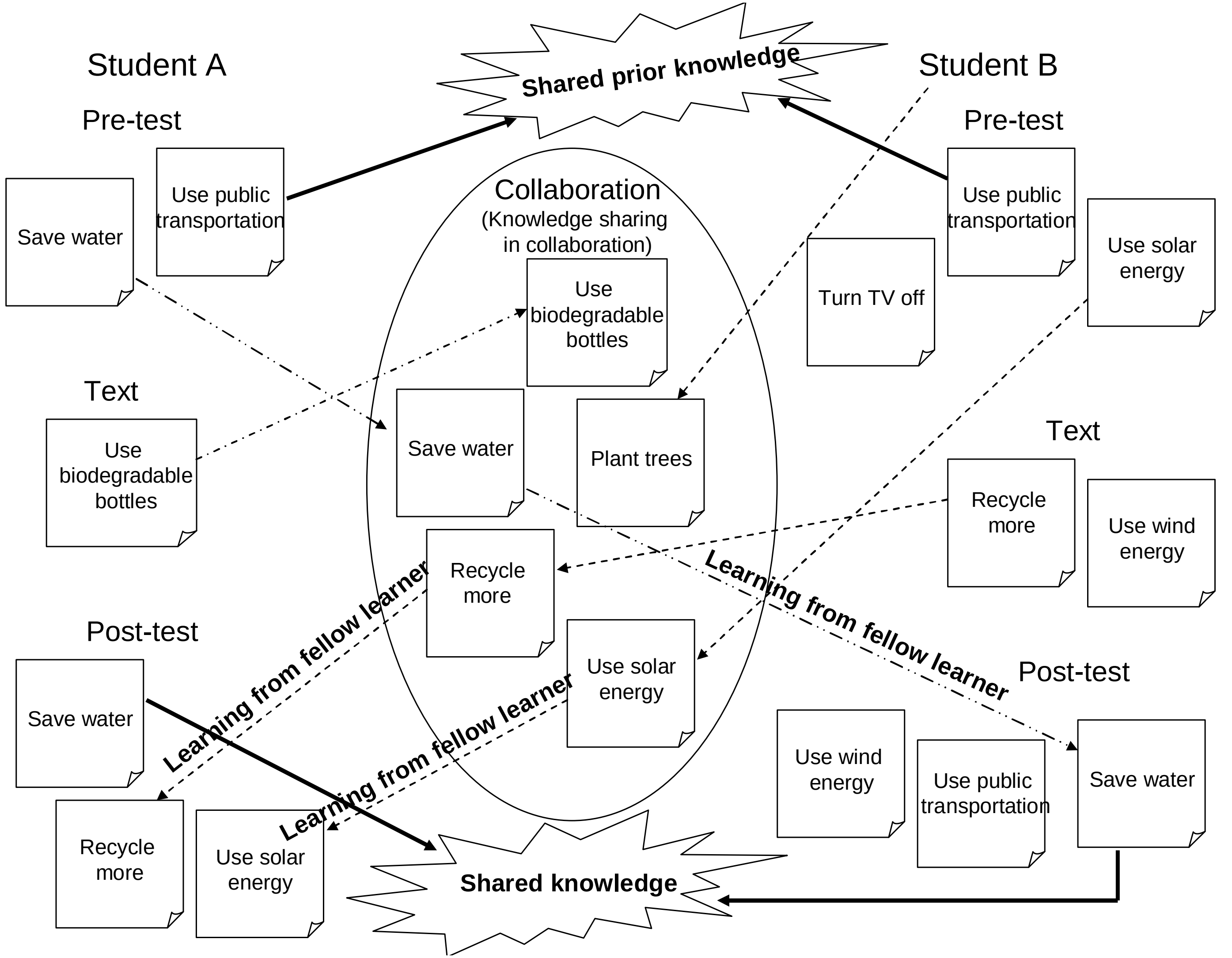
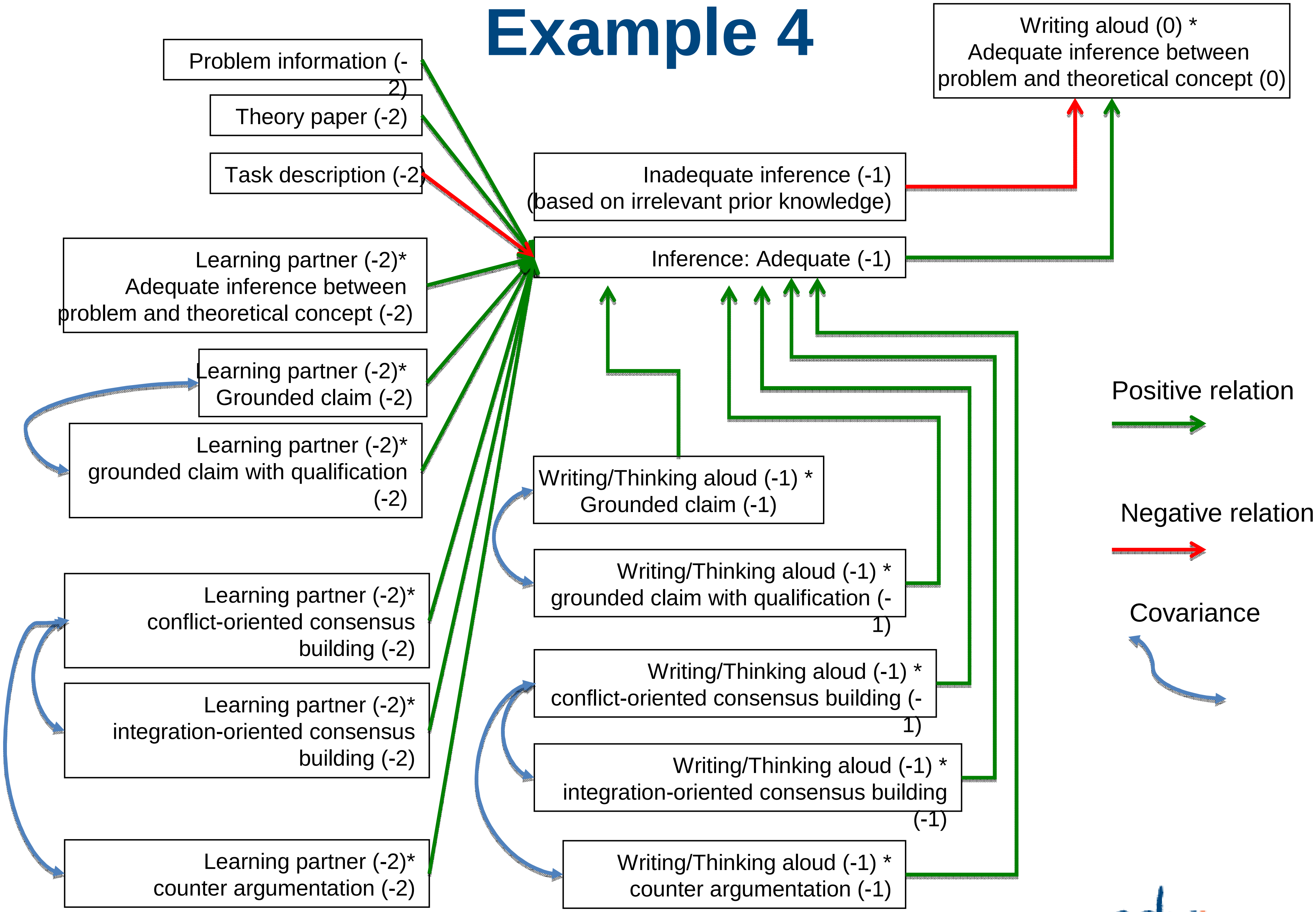


Abbildung 1-2: Beziehung zwischen sozialer Herkunft und Schulleistung getrennt für beide Gruppen

Example 3


Shared prior knowledge
Student A
Pre-test
Save water
Use public transportation
Text
Use biodegradable bottles
Post-test
Save water
Recycle more
Use solar energy
Collaboration
(Knowledge sharing in collaboration)
Use biodegradable bottles
Save water
Plant trees
Recycle more
Use solar energy
Student B
Pre-test
Use public transportation
Use solar energy
Turn TV off
Text
Recycle more
Use wind energy
Post-test
Use wind energy
Use public transportation
Save water
Learning from fellow learner
Learning from fellow learner
Learning from fellow learner
Shared knowledge

Example 4


Writing aloud (0) * Adequate inference between problem and theoretical concept (0)
Problem information (-2)
Theory paper (-2)
Task description (-2)
Inadequate inference (-1) (based on irrelevant prior knowledge)
Inference: Adequate (-1)
Learning partner (-2)* Adequate inference between problem and theoretical concept (-2)
Learning partner (-2)* Grounded claim (-2)
Learning partner (-2)* grounded claim with qualification (-2)
Writing/Thinking aloud (-1) * Grounded claim (-1)
Writing/Thinking aloud (-1) * grounded claim with qualification (-1)
Learning partner (-2)* conflict-oriented consensus building (-2)
Learning partner (-2)* integration-oriented consensus building (-2)
Learning partner (-2)* counter argumentation (-2)
Writing/Thinking aloud (-1) * conflict-oriented consensus building (-1)
Writing/Thinking aloud (-1) * integration-oriented consensus building (-1)
Writing/Thinking aloud (-1) * counter argumentation (-1)
Positive relation
Negative relation
Covariance

Literature

- Chi, M. T. H. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *Journal of the Learning sciences, 6*(3), 271-315.
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