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9th International Cognitive Load Theory Conference

Cognitive Load as Criterion for Item Difficulty in Case of Complex Problem Solving.

A Quantitative Approach with Standardized Test Items

Leading Question

Purpose:

- computer-based assessment to diagnose complex problem solving competency
- use of standardized items to enable computer-based analysis and scaling with low effort

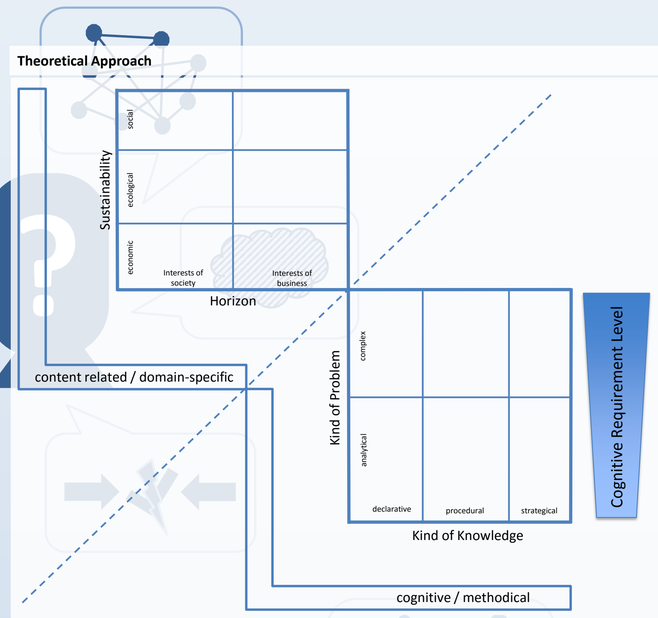
Leading Question:

How can item difficulty, and therefore the potential variance of test scores in the assessment, be calculated prior to a pre-test to reduce measurement inaccuracy and therefore post-processing of the items?

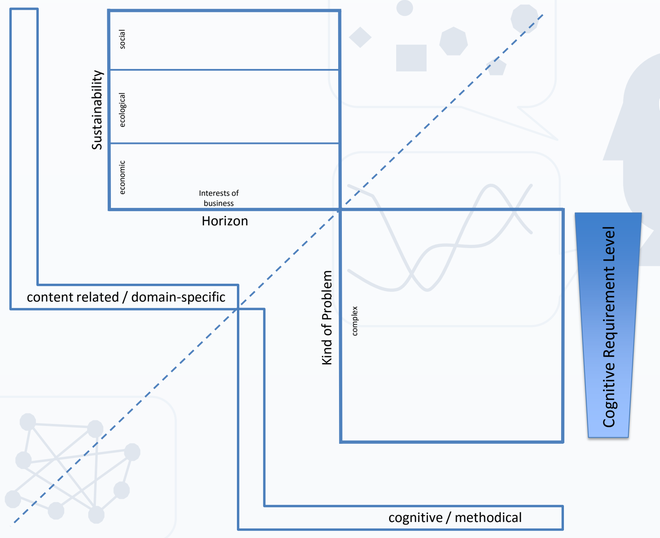
Idea:

Estimation of the cognitve requirement-level of the items → calculation of a complexity coefficient → esimation of cognitve load

Theoretical Approach



Model of problem solving competency in the domain of sustainable management



Test Construct of problem solving competency in the domain of sustainable management

Cognitive Load Theory (Sweller, 1988[1]; 1993[2])

Essence of Cognitive Load Theory

Working memory is limited and if the complexity of information offered to learners is not properly managed the result is lower performance because of **Cognitive Overload**[1]

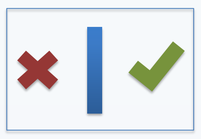
→ handling of complex problems forces the agent to „learn" the situation and to process information in the working memory

[But two theses on the limits of adaptability:

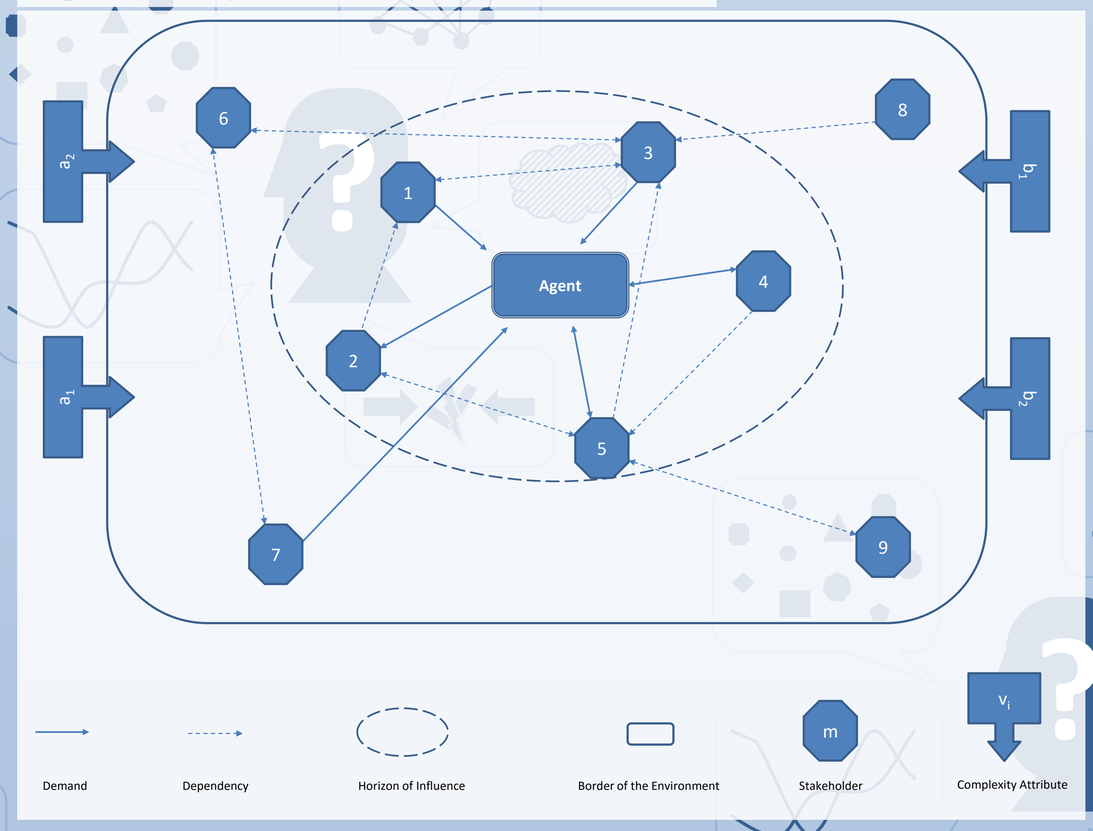
I. problem solving strategies may relieve the working memory → use of action schemata by the individuum provides structure for information processing
II. Test on Problem Solving demands handling of **intrinsic cognitive load**[2] → separation of relevant and irrelevant information and identification of the form of the problem]

The Cognitive Perspective – Components of a Problem (Dörner, 1987; Mayer, 1992)

1. Undesirerable initial state
2. Desireable target state
3. Barrier, preventing the transformation of the initial state into the target state (for the moment)



The Cognitive Perspective – Complex Problem Situation as a System



Attributes of Complex Problems (Funke, 1995; 2003)

Extent / Complexity

- determined by the number of features of the system and the number of interventions and their mutual influence
- high extent means high demands on the processing capacity of the agent
- an exceeding of the processing capacity of the agent results in the need to reduce information

Cognitive Load: quantity of relevant information and quantity of distracting information

Attributes of Complex Problems (Funke, 1995; 2003)

Interconnectedness

- influencing a variable does not work in isolation but has side and distant effects
- this produces effect relationships between different components of the problem
- agents must take consider these relationships and long-term effects which requires a mental model of the problem solving situation

Cognitive Load: quantity of effect relationships

Attributes of Complex Problems (Funke, 1995; 2003)

Polytelie

- simultaneously or sequentially given multiple, possibly conflicting sub-objectives (= contradictory target ratio)
- all sub-objectives have to be adressed by the agent
- agent has to evaluate information on several levels and has to build a differentiated target structure

Cognitive Load: quantity of sub-objectives

Attributes of Complex Problems (Funke, 1995; 2003)

Dynamics

- situation develops independently from the intervention of the agent
- agent is forced to adapt and to estimate tendencies of the development of the situation

no matter of ***Cognitive Load*** but of cognitive closure (?)

Attributes of Complex Problems (Funke, 1995; 2003)

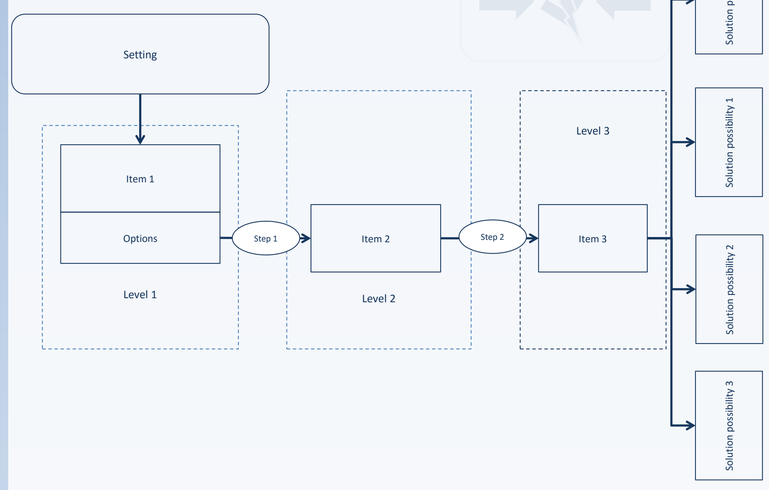
Non-transparency

- essential features of the situation are not accessible to the actor
- produced by imperfections of information about the situation, especially on variable links or consequences
- is an essential source of uncertainty of the planning and decision situation and requires active information gathering on the part of the actor

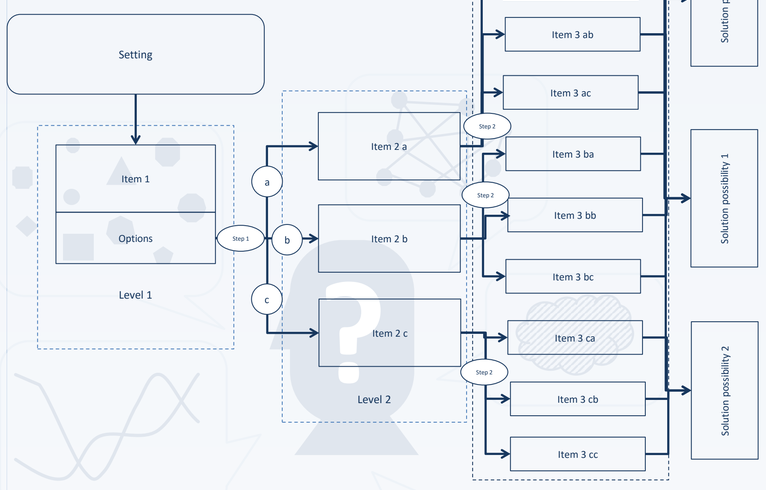
no matter of ***Cognitive Load*** but of the ability to handle uncertain situations

Realisation as Test Instrument

Complex Standardised Item-Sequence (KSI) – Linear Sequence



Complex Standardised Item-Sequence (KSI) – Non-linear Sequence



Solution – Definition of a Complexity-Coefficient

$$\gamma_s = \frac{\left(\frac{x_1}{k_1} * \beta_1\right) + \left(\frac{x_2}{k_2} * \beta_2\right) + \ldots + \left(\frac{x_j}{k_j} * \beta_j\right)}{n_s}$$

$$= \sum_{j=1}^{m} \frac{\left(\frac{x_j}{k_j} * \beta_j\right)}{n_s}$$

γ: Complexity-Coefficient of Item *i*
j: Complexity Attribute
x_j: manifestation of Complexity Attribute *j* in Item *i*
k_j: highest manifestation of Complexity Attribute *j* in Sequence *s*
β_j: regression parameter of Complexity Attribute *j* as predictor for RPME σ
n_s: quantity of Complexity Attributes Sequence *s*

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