NEPS
National Educational Panel Study

Research Data

Information on Competence Testing

NEPS Starting Cohort 2 — Kindergarten

From Kindergarten to Elementary School

Wave 6: Grade 4

LIfBi
LEIBNIZ INSTITUTE FOR
EDUCATIONAL TRAJECTORIES

Information on testing		
Study	Assessment in schools (Main Study A97), students of fourth grade in general schools including students who repeated or skipped a grade level	Assessment at the study participant's home for children in the individual field (Main Study B103), students of fourth grade including students who repeated or skipped a grade level
Test situation	Paper-based group testing (N ≤ 20) at schools, 1 test instructor and a supervising teacher	Paper-based testing , personal interview held at the study participant's home, 1 test instructor
Test sequence	The tests were conducted on two test days. The sequence of the tests was identical for all study participants. Test day 1: Mathematical competence + procedural metacognition, reading competence + procedural metacognition Test day 2: Orthography (+ questions on orthography + student questionnaire)	The tests were conducted on one test day. The sequence of the tests was identical for all study participants. Testtag 1: Mathematical competence + procedural metacognition, Reading competence + procedural metacognition (optionally: student questionnaire)
Test duration (net processing time)	Test day 1: 60 minutes Test day 2: 19 minutes (+ 7 minutes questions on orthography + 25 minutes student questionnaire)	Testtag 1: 60 minutes (+ 25 minutes student questionnaire)
Breaks	Test day 1: 15-minute break between mathematical competence and reading competence Test day 2: 15-minute break before the student questionnaire	Testtag 1: 5-minute break between mathematical competence and reading competence

Information on the individual tests				
Construct	Number of items	Allowed processing time	Survey mode	Next measurement
1. Test day				
Mathematical competence	24	28 min	paper-pencil	grade 7
Domain-specific procedural metacognition				
Regarding the domain mathematical competence	1	1 min	paper-pencil	grade 7

Reading competence	33	28 min	paper-pencil	grade 7
Domain-specific procedural metacognition				
Regarding the domain reading competence	6	3 min	paper-pencil	grade 7
2. Test day[1]				
Orthography	37	17 min	paper-pencil; dictation from CD	--
Domain-specific procedural metacognition				
Regarding the domain orthography	2	2 min	paper-pencil	--

[1] The second test day including the test on orthography was only realized when the assessment took place in schools (Main Study A97).

Preliminary note

The development of the individual tests is based on framework concepts. They constitute overarching concepts on the basis of which education-relevant competences are to be shown consistently and coherently over the entire personal history. Therefore, the following framework concepts that served as a basis for the development of the test tools to measure the above-mentioned constructs are identical in the different studies.

Mathematical competence

In the National Education Panel Study, the construct of mathematical competence is based on the idea of mathematical literacy as was defined, for example, in PISA. Thus, the construct describes "[…] an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen." (OECD, 2003, 24). Regarding younger children, this idea refers to competent handling of mathematical problems in age-specific contexts.

Accordingly, mathematical competence in NEPS is operationalized by items assessing more than pure mathematical knowledge; instead, solving the items requires recognizing and flexibly applying mathematics in realistic, mainly extra-mathematical situations.

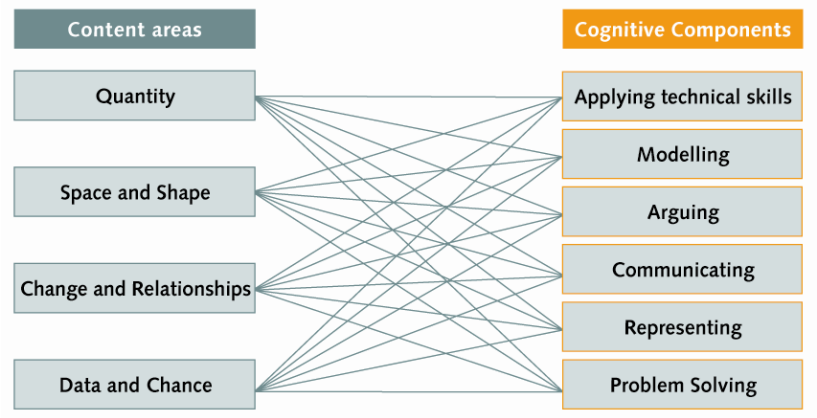

Fig. 1: Framework of mathematical competence in NEPS

The NEPS framework of mathematical competence distinguishes between content-related and process-related components (cf. Fig. 1). In detail, the content areas are characterized as follows:

- Quantity comprises all kinds of quantifications when numbers are used to organize and describe situations.
  Examples from the elementary sector: comparisons of sets, counting (ordinal/cardinal aspects of numbers), simple operations (e.g., adding)
  Examples from the adult sector: calculations of percentages and interests, calculations of area and volume, use of different units, simple equation systems
- Space and Shape includes all types of planar and spatial configurations, shapes or patterns.
  Examples from the elementary sector: recognizing geometric shapes, simple properties of shapes, perspective
  Examples from the adult sector: three-dimensional mathematical objects, geometric mappings, elementary geometric theorems
- Change and Relationships includes all kinds of (functional) relationships and patterns.
  Examples from the elementary sector: recognizing and continuing patterns, relationships among numbers, proportionality

Examples from the adult sector: interpreting curves or function graphs, properties of linear, quadratic, and exponential functions, extremum problems

- Data and Chance comprises all situations involving statistical data or chance.
  Examples from the elementary sector: intuitively assessing probabilities, collecting and structuring data
  Examples from the adult sector: interpreting statistics, basic statistical methods, calculating probabilities

The cognitive components of mathematical thinking processes are distinguished as follows:

- Applying technical skills includes using known algorithms and remembering mathematical knowledge or calculation methods.
- Modelling includes the representation in a situation model and in a mathematical model as well as interpreting and validating results in real-life situations.
- Arguing includes assessing explanations and proofs, but also developing own explanations or proofs.
- Communicating requires communication on mathematical contents and includes, among other things, the correct and adequate use of mathematical technical terms.
- Representing comprises the use and interpretation of mathematical representations such as tables, charts or graphs.
- Problem Solving takes place, when there is no obvious approach, and, therefore, includes systematic trying, generalizing or examining special cases.

The test items used in NEPS refer to one content area that is mainly addressed by the item, but may well contain several cognitive components (further description of the framework in Neumann et al., 2013). This differentiation renders the framework concept of mathematical competence in NEPS compatible with both the PISA studies and the German National Mathematics Education Standards. Some literature also show a high correlation between NEPS, the PISA studies and federal states comparisons from the Institute of Educational Quality Improvement (IQB): r = .89 for NEPS-PISA and r = .91 for NEPS-IQB (van den Ham, 2016).

Bibliography

Neumann, I., Duchhardt, C., Grüßing, M., Heinze, A., Knopp, E., & Ehmke, T. (2013). Modeling and assessing mathematical competence over the lifespan. Journal for Educational Research Online, 5(2), 80–109. Retrieved http://journal-for-educational-research-online.com/index.php/jero/article/view/362.

Organisation for Economic Co-Operation and Development [OECD] (2003). The PISA 2003 assessment framework – mathematics, reading, science and problem solving knowledge and skills. Paris: OECD.

Van den Ham, A.-K. (2016). Ein Validitätsargument für den Mathematiktest der National Educational Panel Study für die neunte Klassenstufe. Unpublished doctoral dissertation, Leuphana University Lüneburg, Lüneburg.

Reading competence

The ability to understand and use written texts is an important precondition for further developing personal knowledge and personal skills and a prerequisite for participating in cultural and social life. Manifold areas of knowledge and life are made accessible through reading. The range of reading occasions is very wide, and reading fulfills many different functions (cf. Groeben & Hurrelmann, 2004). They range from reading for expanding knowledge, which is crucial for further education, to lifelong learning as well as literary-esthetic reading. Not only do texts convey information and facts, but they also transfer ideas, moral concepts, and cultural contents. Accordingly, the concept of reading competence in the National Education Panel incorporates functional understanding as a basis for reading competence, as is also reflected in the Anglo-Saxon Literacy Concept (see also OECD, 2009), with a focus on competent handling of texts in different typical everyday situations.

In order to represent the concept of reading competence over the entire life span as coherently as possible, three characteristic features are specified in the framework concepts of the NEPS reading competence tests. They are considered in the following age- and stage-specific test forms:

1. text functions, text types,
2. comprehension requirements,
3. task formats.

1. Text functions/text types

The NEPS distinguishes between five text functions and associated text types, which are represented in each version of the test: a) factual texts, b) commenting texts, c) literary texts, d) instructions, and e) advertising texts (Gehrer, Zimmermann, Artelt, & Weinert, 2013). This selection is based on the assumption that these five text functions have practical relevance for the various age backgrounds of the participants. The text functions and/or text types (see Gehrer & Artelt, 2013) can be characterized as follows:

Texts conveying factual information represent basic texts for learning, fundamental acquisition of knowledge, and extraction of information; examples of these are: articles, reports, reportages, and announcements. Texts with a commenting function are texts in which a stand is taken or contradictive arguments are discussed and in which reflection is integrated. Examples of such texts are cleverly worded essays or humorous comments, which are implemented in tests for college students and adult cohorts. In school cohorts, a text with a discussion about the pleasures and disadvantages of smoking may be used, for example. The literary-esthetic function of texts is included in the third category, which encompasses short stories and extracts from novels or stories. Specific literary text types such as stage plays, satires, or poems are excluded as a result of their specific reception, which is presumably strongly dependent on educational track and curriculum. The fourth category comprises text types that are product inserts such as building and assembly instructions, package inserts for medication, work instructions, and cooking recipes. The fifth category (appeals, advertisements, notifications) includes text types such as job advertisements and recreation programs.

The five selected text functions and their associated text types are implemented in each test booklet over the life span as a longitudinal concept, which means that each test/each test booklet for measuring reading competence contains five texts corresponding to the five text functions. Unlike the PISA studies, the NEPS does not include discontinuous texts such as graphs, tables, and road maps. Discontinuous texts are excluded from the NEPS concept as they place special demands on readers, which are not always meaningful for each age group in which reading competence is measured.

Age-specific selection (text complexity, topic selection/task requirements):

For each age cohort, texts are selected according to their thematic orientation as well as their lexical, semantic, and grammatical properties which have to be appropriate for the respective group of readers.

The growth of reading competence from childhood to early adulthood is taken into account by increasing the text complexity (larger vocabulary, longer words, foreign words, higher complexity of sentence structures) and the basic length of texts. In addition, texts are selected on topics that correspond to and are appropriate for the environment of the respective age group. They cover a wide spectrum of topics ranging from animals (for children) to social and philosophical questions related to the meaning of life for adults. Additionally, the test material is adjusted to the respective age group through age-adapted phrasing of the questions, the answer options, and the comprehension requirements of the tasks.

2. Comprehension requirements / task types

From the literature on reading competence and text comprehension (e.g., Kintsch, 1998; Richter & Christmann, 2002), it is possible to derive different types of comprehension requirement which are reflected in the NEPS concept in three specific requirement types of tasks (task types). The variants are called types as there is no explicit assumption that the tasks of one type are necessarily more difficult or easier than tasks of another type (Gehrer, Zimmermann, Artelt, & Weinert, 2013).

For tasks of the first type ("finding information in the text"), detailed information must be identified at sentence level; in other words, the reader is required to decipher words and recognize statements or propositions. For tasks on this requirement cluster, the wording of the information needed to solve the respective tasks is either contained in the text and identical with the task itself, or the phrasing varies slightly.

In the case of the second task type ("drawing text-related conclusions"), conclusions have to be drawn from several sentences that have to be related to each other in order to extract local or global coherence. In some cases, the relevant sentences are located closely together. In others, several sentences are spread over entire sections. In another form of this task type, the reader has to understand the thoughts expressed in the entire text, which requires the comprehension and integration of larger and more complex text portions.

For the third type, the main requirement involves "reflecting and assessing", which is often linked to the mental representation of the text in a situation model in literature. In one version of this task type, the task is to understand the central idea, the main events, or the core message of text,

whereas in another version the purpose and intention of a text have to be recognized or the readers are asked to assess the credibility of a text.

The different comprehension requirements can be found in all text functions and are considered in the respective test versions in a well-proportioned ratio. (cf. Fig. 1.).

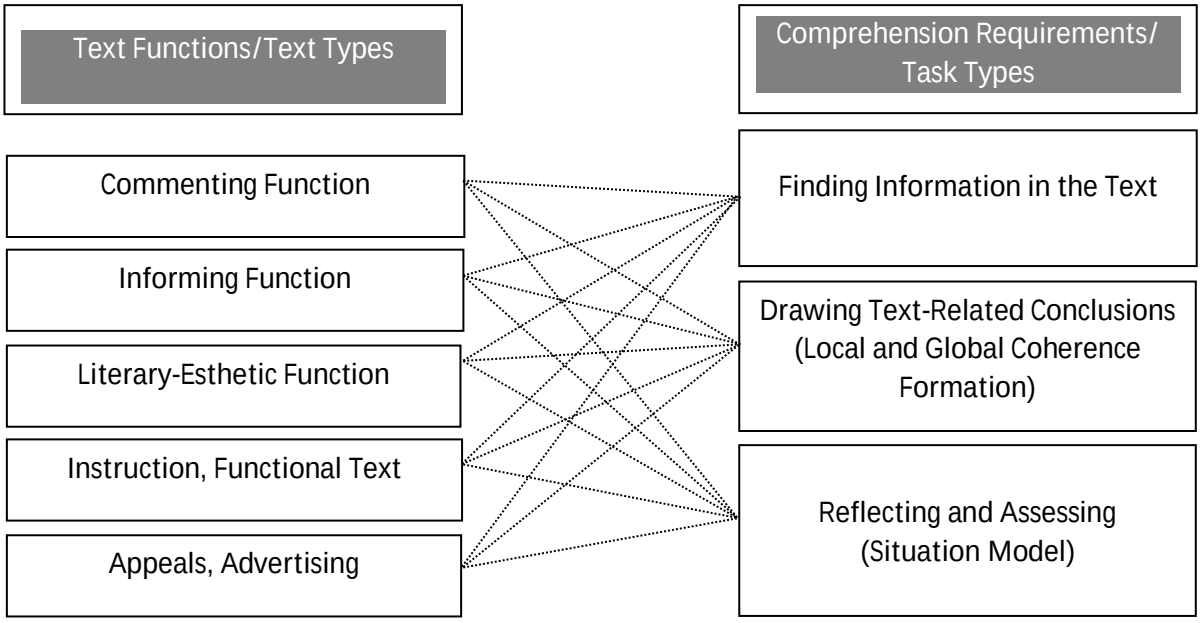

Fig. 1: Text functions and comprehension requirements (cf. Gehrer, Zimmermann, Artelt, & Weinert, 2013)

3. Task formats

The majority of tasks have a multiple-choice format. This tasks format consists of a question/assignment about a text for which four answers are offered, one of which is the correct answer. As another task format, decision-making tasks are used, which require readers to judge individual statements and state whether they are right or wrong according to the text. So-called matching tasks represent a third format in which, for example, a subtitle must be chosen and assigned to different sections of a text. For tasks of the second and third formats, summaries are made, if necessary, thus creating answers with partly correct solutions (partial-credit items).

By systematically considering different text functions which are implemented in different age groups in realistic and age-adapted texts with appropriate text themes and different comprehension requirements, it is possible to operationalize reading competence as a comprehensive ability construct.

4. Scaling of items

Items of several task formats have been Rasch-scaled and longitudinally linked (Fischer, Rohm, Gnambs, & Carstensen, 2016). In addition, partial-credit items have been calculated based on the answers on decision-making tasks and matching tasks. Therefore, subjects´ answers to the tasks are aggregated in one score and are not used as single items. The quality criteria and psychometric

characteristics of the items are presented in the technical reports of the different starting cohorts (for SC2: Rohm, Krohmer & Gnambs, 2017).

Bibliography

Fischer, L., Rohm, T., Gnambs, T., & Carstensen, C. H. (2016). Linking the data of the competence tests (NEPS Survey Paper No. 1). Bamberg, Germany: Leibniz Institute for Educational Trajectories, National Educational Panel Study.

Gehrer, K. & Artelt, C. (2013). Literalität und Bildungslaufbahn: Das Bildungspanel NEPS. In A. Bertschi-Kaufmann, & C. Rosebrock (Hrsg.). Literalität erfassen: bildungspolitisch, kulturell, individuell. S. 168-187. Weinheim, Germany: Juventa.

Gehrer, K., Zimmermann, S., Artelt, C. & Weinert, S. (2012). The assessment of reading competence (including sample items for grade 5 and 9). Scientific Use File 2012, Version 1.0.0. Bamberg: University of Bamberg, National Educational Panel Study.

Gehrer, K., Zimmermann, S., Artelt, C. & Weinert, S. (2013). NEPS framework for assessing reading competence and results from an adult pilot study. Journal for Educational Research Online 5(2), 50-79.

Groeben, N. & Hurrelmann, B. (Hrsg.) (2004). Lesesozialisation in der Mediengesellschaft: Ein Forschungsüberblick. Weinheim: Juventa.

Kintsch, W. (1998). Comprehension. A paradigm for cognition. Cambridge: University Press.

OECD (2009). PISA 2009 assessment framework – Key competencies in reading, mathematics, and science. Paris: OECD

Richter, T. & Christmann, U. (2002). Lesekompetenz: Prozessebenen und interindividuelle Unterschiede. In N. Groeben, B. Hurrelmann (Hrsg.), Lesekompetenz: Bedingungen, Dimensionen, Funktionen (S. 25-58). Weinheim: Juventa.

Rohm, T., Krohmer, K., & Gnambs, T. (2017). NEPS technical report for reading: Scaling results of starting cohort 2 for grade 4 (NEPS Survey Paper No. 30). Bamberg: Leibniz Institute for Educational Trajectories, National Educational Panel Study.

Orthography

As empirical results at the end of elementary school reveal, fourth graders in part still show serious orthography problems (cf. Löffler & Meyer-Schepers, 2005). These problems verifiably extend across the entire secondary school period and increase even more (Schneider, 2008: 149). However, orthographic performance is seen as a reliable predictor for Students' educational path (Schneider, 2008). For these reasons, orthographic competence is tested as a stage-specific complement at secondary level in grade 5, 7 and 9.

In order to test orthographic competence in NEPS, a language-systematic test (SRT) was developed. It is based on a differential competence model which was empirically proved in the PIRLS-2006 complementary studies „Orthography" (International Elementary School Reading Survey) and tested and adapted for longitudinal measurement at secondary level in grades 5, 7 and 9 (cf., Blatt et al., 2011; Blatt et al. 2015; Blatt & Prosch 2016; Jarsinski 2014; Prosch 2016). This competence model is based on research in the linguistic field of graphemics (Eisenberg, 2006). According to the principles of German orthography shown by Eisenberg, five sub skills are differentiated (Table 1):

Table 1: Differential orthographic competence model according to the Eisenberg principles (2006)

Orientation Towards Principles	Sub skill
Phonographic and syllabic principle in the core area	Establish relationship between graphic and phonological structure with reference to the information on syllable structure (onset, coda, syllable cut)
Morphological principle in the core area	Derive inherited syllable-written information in inflected and derived forms, know and use inflectional morphemes
Peripheral area	Put irregular markings in open syllables, i.e. in inherited spellings; foreign word spelling
Principles of word formation	Know different parts of speech and word formation morphemes and productively use them in derivations and compounds
syntactic principle	Know syntax structures and apply to capitalization, writing as separate words or as one word, "dass" spelling and punctuation

The tests are evaluated both on a whole-word level and in terms of the included subskills, and are broken down into structural units according to the subskills. Table 2 shows the segmentation of the noun <Eisenbahnausstellung> (railway exhibition):

Table 2: Classification of structural units

subskills	Phonographic syllabic subskill	Morphological subskill	Peripheral subskill	Word formation subskill	Syntactic subskill
Example for structural units	#eisen	#stell	#bahn	#aus #ung #eisenbahnausstellung (compounding)	#E

The two-syllable structural unit #eisen has an open syllable and it has to be classified according to the phonographic syllabic subskill in the core area. The spelling of the double consonant in #stell is due to the morphological principle in the core area: #stell because of <stellen>. #bahn belongs because of the irregular marking of the long vowel to the peripheral subskill. Structural units in the word formation subskill are the prefix #aus, the suffix #ung and the compounding of the whole word. The majuscule #E is part of the syntactic subskill.

The test material is conform to the curriculum and provides an adequate number of structural units for testing all five subskills (Table 3) (cf., Blatt et al. 2018).

Table 3: Number of structural units used for the statistical analysis in grade four

	Phonographic syllabic subskill	Morphological subskill	Peripheral subskill	Word formation subskill	Syntactic subskill
Grade four	32	28	15	32	23

The test combines a cloze test and three full sentences. This ensures that capitalization can be measured reliably. In addition, this format is timesaving. The grade four test includes 22 words in the cloze test and 35 words in the full sentences. Prior to the analyses, words such as “and” that were correctly solved by a huge majority of the sample also were directly removed. During the estimation of student ability and item difficulty, some misfit items had to be removed, because they deviated from the PISA reference (Blatt et al. 2018, p. 4-5). For Grade 4 these were two out of 39 items at whole-word level and 23 out of 153 items at structural-unit level. 37 items remained at whole-word level and 130 items at structural-unit level.

Bibliography

Blatt, I., Voss, A., Kowalski, K. & Jarsinski, S. (2011): Messung von Rechtschreibleistung und empirische Kompetenzmodellierung. In U. Bredel (Hrsg.), Weiterführender Orthographieunterricht (S. 226–256). Baltmannsweiler: Schneider Verlag Hohengehren.

Blatt, I., Frahm, S., Prosch, A., Jarsinski, S. & Voss, A. (2015). Kompetenzmodellierung im Kontext des Nationalen Bildungspanels (NEPS) am Beispiel der Rechtschreibkompetenz. In U. Riegel, S. Schubert, G. Siebert-Ott & K. Macha (Hrsg.), Kompetenzmodellierung und Kompetenzmessung in den Fachdidaktiken (S. 43-60). Münster: Waxmann.

Blatt, I., Prosch, A. & Lorenz, C. (2016). Erhebung der Rechtschreibkompetenz am Ende der Grundschulzeit: Ausgewählte Ergebnisse aus einer Großpilotstudie im Rahmen des Nationalen Bildungspanels. Zeitschrift für Grundschulforschung, 9(2), 125–138.

Blatt, I., Lorenz, C. & Prosch, A. (2018). Technical Report for Orthography: Scaling results of Starting Cohort 2 in Grade 4 (NEPS Survey Paper No. 36). Bamberg: Leibniz Institute for Educational Trajectories, National Educational Panel Study.

Eisenberg, P. (2006): Grundriss der deutschen Grammatik. Band 1: Das Wort (3. Auflage). Stuttgart und Weimar: Metzler.

Jarsinski, S. (2014). Quantitative Datenanalyse zur längsschnittlichen Erfassung der Rechtschreibkompetenz in NEPS unter besonderer Berücksichtigung der Kompetenzstruktur und der Einflussfaktoren. Dortmund: Technische Universität Dortmund.

Löffler, I. & Meyer-Schepers, U. (2005). Orthographische Kompetenzen: Ergebnisse qualitativer Fehleranalysen, insbesondere bei schwachen Rechtschreibern. In W. Bos, E.-M. Lankes, M. Prenzel, K. Schwippert, R. Valtin & G. Walther (Hrsg.), IGLU. Vertiefende Analysen zu Leseverständnis, Rahmenbedingungen und Zusatzstudien (S. 81–108). Münster: Waxmann.

Prosch, A. (2016). Entwicklung von Rechtschreibkompetenz. Differentielle Analysen mit NEPS-Daten der Haupterhebungen in den Klassenstufen fünf und sieben sowie der Entwicklungsstudien in den Klassenstufen sechs und sieben. Berlin: Logos.

Schneider, W. (2008). Entwicklung und Erfassung der Rechtschreibkompetenz im Jugend- und Erwachsenenalter. In W. Schneider, H. Marx & M. Hasselhorn (Hrsg.), Diagnostik von Rechtschreibleistungen und –kompetenzen (S. 145–157). Göttingen: Hogrefe.

Metacognition

Metacognition is the knowledge and control of the own cognitive system. According to Flavell (1979) und Brown (1987), declarative and procedural aspects of metacognition are differentiated which are both covered in the National Education Panel.

Procedural metacognition

Procedural metacognition includes the regulation of the learning process through activities of planning, monitoring and controlling. Within the framework of NEPS the procedural aspect of metacognition – in combination with the competence tests of individual domains – is not assessed as a direct measure of such planning, monitoring, and controlling activities but as a metacognitive judgement that refers to monitoring of learning performance during (and/or shortly after) the learning phase (also see Nelson & Narens, 1990). After participants have taken their competence tests, they are requested to rate their own performance. They are asked to state the number of questions presumably answered correctly. Kindergarten and elementary school children are shown a 5-point smiley scale to give their judgments.

Usually, one question is asked per domain. For competence domains that can be divided into coherent individual parts (e.g. reading competence referring to different texts), the inquiry of procedural metacognition is referred to these parts as well, which, of course, leads to a longer processing time.

Bibliography

Brown, A. L. (1987). Metacognition, executive control, self-regulation, and other more mysterious mechanisms. In F. E. Weinert and R. H. Kluwe (Eds.), Metacognition, motivation, and understanding (pp. 65-116). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist, 34, 906-911.

Nelson, T.O. & Narens, L. (1990). Metamemory: A theoretical framework and new findings. In G.H. Bower (Hrsg.), The psychology of learning and motivation (pp. 125-141). New York: Academic Press.