

The logo for NEPS (National Educational Panel Study) features the acronym 'NEPS' in a bold, blue, sans-serif font. To the left of the text is a vertical orange bar with a white bracket-like shape at the top and bottom, framing the text.

National Educational Panel Study

Information on Competence Testing

NEPS Starting Cohort 2 — Kindergarten
From Kindergarten to Elementary School

Wave 9: Grade 7

Research Data

The logo for LifBi (Leibniz Institute for Educational Trajectories) consists of the letters 'LifBi' in a bold, black, sans-serif font. A vertical blue bar is positioned to the left of the 'i', and a vertical pink bar is positioned to the left of the 'B'.

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Bamberg; December 14, 2020

Information on testing				
Study	Assessment at the study participant's home for students in grade 7.			
Test situation	Paper-based testing, personal interview held at the study participant's home, one test instructor.			
Test sequence	<p>Two tests out of three areas of competencies were conducted on one day. The sequence of the tests was randomly assigned for all study participants.</p> <p>There are two different tests with a varying degree of difficulty for the competence areas Mathematics and Reading. These two tests were assigned according to the competence level in the last test (grade 4; wave 6). There was only one test of competencies in Science without differentiation in the level of difficulty.</p> <p>Exercise 1: Mathematical competence Exercise 1 or 2 + procedural Metacognition or Scientific literacy + procedural Metacognition</p> <p>Exercise 2: Reading competence Exercise 1 or 2 + procedural Metacognition or Scientific literacy + procedural Metacognition</p> <p>Delivery of a student questionnaire with an envelope and farewell.</p>			
Test duration (net processing time)	<p>28 minutes (Exercise 1) + approx. 1 minute <i>procedural</i> Metacognition</p> <p>28 minutes (Exercise 2) + approx. 1 - 2 minutes <i>procedural</i> Metacognition</p> <p>In total: approx. 60 minutes</p>			
Breaks	3 – 5 minutes break between Exercise 1 and Exercise 2.			
Hint	The two difficulty-graded tests of reading competence correspond to the version of starting cohort 3, also grade 7.			
Information on the individual tests				
Construct	Number of items	Allowed processing time	Survey mode	Next measurement
<i>Mathematical competence 1 or</i>	21	28 min	paper-pencil	2021
<i>Mathematical competence 2</i>	21	28 min	paper-pencil	2021
<i>Reading competence 1 or</i>	29	28 min	paper-pencil	
<i>Reading competence 2</i>	30	28 min	paper-pencil	
<i>Scientific literacy</i>	26	28 min	paper-pencil	
<i>Domain-specific procedural metacognition</i>				
Regarding the domain mathematical competence	1	1 min	paper-pencil	2021
Regarding the domain reading competence	6	2 min	paper-pencil	
Regarding the domain scientific literacy	1	1 min	paper-pencil	

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.

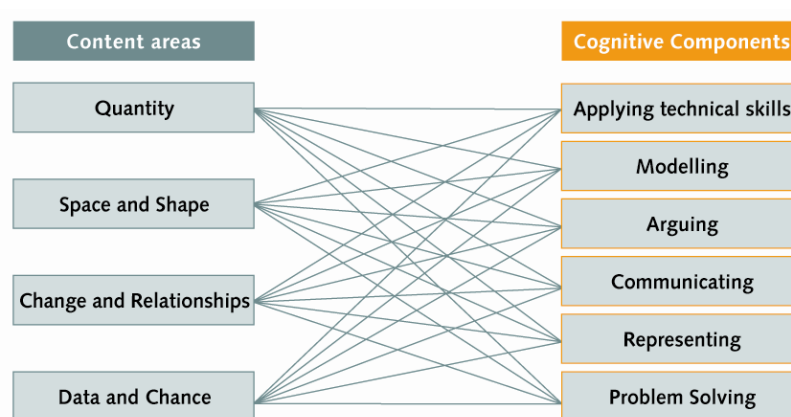


Fig. 1: Framework of mathematical competence in NEPS

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).

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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.).

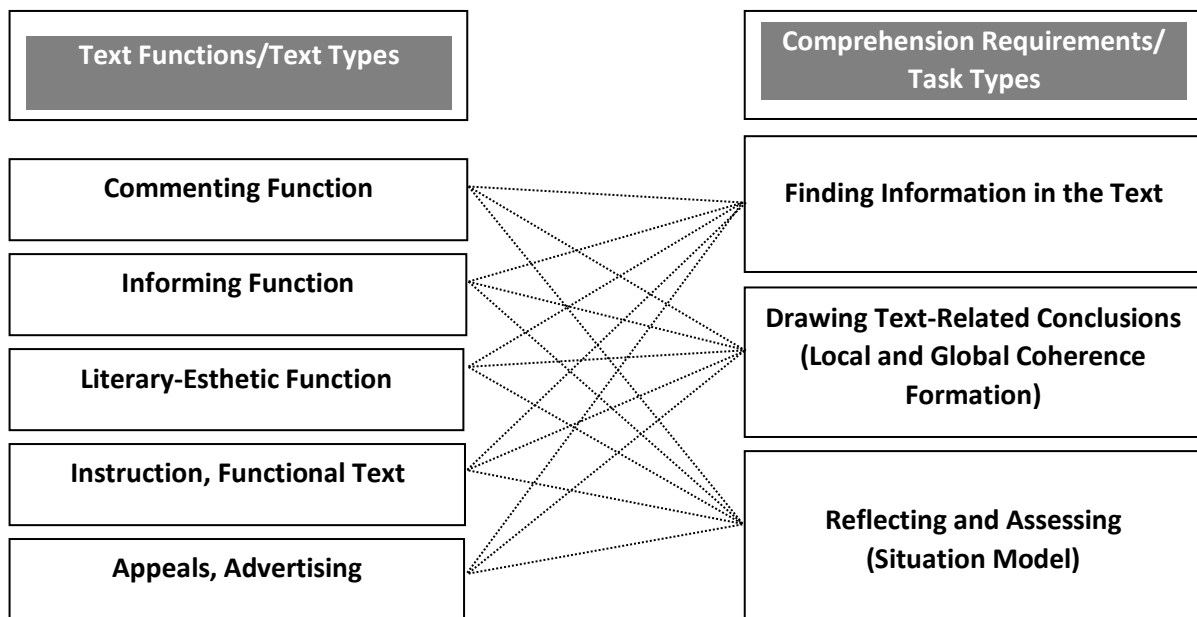


Fig. 1: Text functions and comprehension requirements (cf. Gehrer, Zimmermann, Artelt, & Weinert, 2013)

3. Task formats

The majority of tasks have a multiple-choice format. This task 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, Gnams, & 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 & Gnams, 2017; Rohm et al. (in prep.); *for grade 7 in SC3*: Krannich, Jost, Rohm, Koller, Carstensen, Fischer & Gnams, 2017).

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Scientific literacy

NEPS's definition of scientific literacy derives from the Anglo-Saxon concept of literacy (Bybee, 1997; Gräber, Nentwig, Koballa & Evans, 2002; OECD, 2006), viewing scientific competence not solely as the reproduction but rather as the application of knowledge in different situations and contexts of everyday life. Scientific literacy is the prerequisite to participate in a world driven by science and technology (Prenzel, 2000; Prenzel et al., 2001; Rost et al., 2004) and is viewed as a predictor for an economically, socially, and culturally successful life. Scientific literacy is one part of the foundation for lifelong learning (OECD, 2006; Prenzel et al. 2007) thus influencing career choices and career developments.

NEPS defines scientific literacy as the application of science knowledge within the contexts of environment, technology, and health. Additionally, the NEPS framework distinguishes between content-related and process-related components (figure 1). It follows the PISA-framework (OECD, 2006), the German Educational Standards for biology, chemistry, and physics at the end of Grade 10 (KMK, 2005a,b,c), and the Benchmarks for Scientific Literacy of the American Association for the Advancement of Science (AAAS, 2009) thus fulfilling the requirement that the NEPS framework can be linked to international large scale assessments in the field of competence assessment.

The chosen contexts of health, environment, and technology are of personal, social, and global significance. New research and the events of the day show that they continue to be relevant throughout a person's life span. The content-related and process-related components cover the central concepts of all of the science disciplines. In the area of knowledge of science this includes matter, development, interactions, and systems. The knowledge about science contains scientific inquiry and reasoning such as to test hypotheses, interpret findings, and the principles of measurement and measurement errors.

The test results of the content-related and process-related components lead to a composite value assessing scientific literacy.

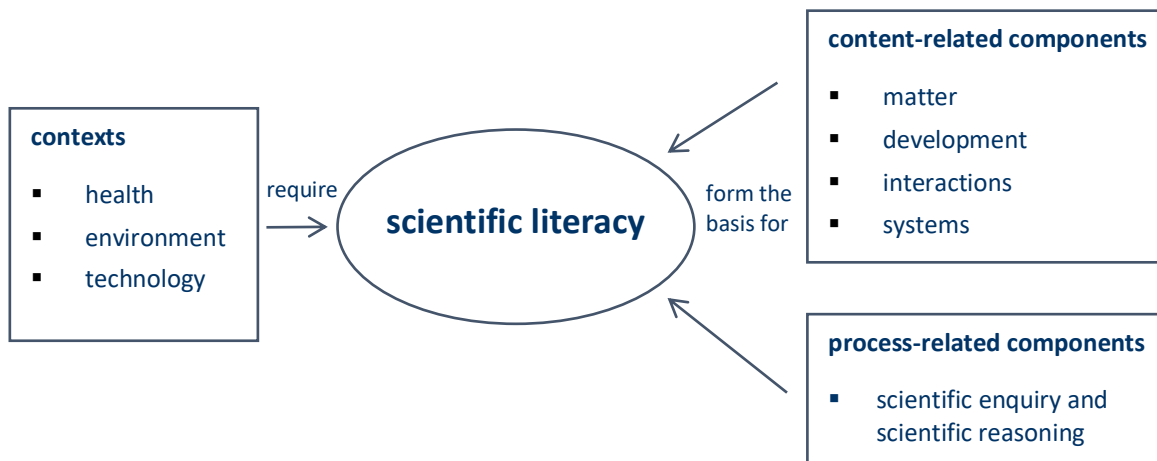


Figure 1: Implementation contexts as well as the content-related and process-related components scientific competence test of the NEPS-science tests

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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.

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