NEPS
National Educational Panel Study

Research Data

Information on Competence Testing

NEPS Starting Cohort 3 — Grade 5

Paths Through Lower Secondary School — Educational Pathways of Students in Grade 5 and Higher

Wave 5: Grade 9

LIfBi
LEIBNIZ INSTITUTE FOR
EDUCATIONAL TRAJECTORIES

Leibniz Institute for Educational Trajectories (LIfBi)
Wilhelmsplatz 3, 96047 Bamberg
Director: Prof. Dr. Sabine Weinert
Executive Director of Research: Dr. Jutta von Maurice
Executive Director of Administration: Dr. Robert Polgar
Bamberg; July 11, 2018

Information on testing

Test situation	Group testing in schools, 1 test instructor, usually 1 supervisory teaching staff
Test sequence	The tests were administered on one day. The students were given tests in the domains scientific literacy, ICT literacy, reading speed, mathematical competencies and orthography. There were two different orders regarding the tests on scientific literacy and ICT-literacy (test booklets 1 and 2). Test booklet 3 included a test on reading speed and mathematical competencies. The tests in the domains mathematical competence, scientific literacy and ICT literacy were each presented in three different difficulty levels. The difficulty levels were assigned to the students based on their former performance in the respective domain. Test booklet 4 included tasks and questions regarding orthography. Furthermore, there were two different versions of a student questionnaire (first interviewed students and panel students) **Order of the test booklets:** **Test booklet 1:** Scientific literacy (3 versions) + procedural metacognition or ICT literacy (3 versions) + procedural metacognition **Test booklet 2:** ICT literacy (3 versions) + procedural metacognition or scientific literacy (3 versions) + procedural metacognition **Test booklet 3**: Reading speed, mathematical competence (3 versions) + procedural metacognition **Test booklet 4**: Orthography + procedural metacognition + questions regarding orthography **Student questionnaire** (Version A and B): Version A for panel students, Version B for first interviewed students.
Test duration (net processing time)	162 min (including student questionnaire)
Breaks	30 min (15 mins after 2; 15 mins after booklet 4)
Administration time	approx. 210 min

Information on the individual tests

Construct	Number of Items*	Allowed Processing Time	Survey Mode	Next Measurement (until 2017)
Scientific literacy	28	29 min	paper-pencil	after 2 years

ICT literacy	36	29 min	paper-pencil	after 3 years
Reading speed	51	2 min	paper-pencil	--
Mathematical competence	23	29 min	paper-pencil	after 3 years
Orthography	138	28 min	paper-pencil	--
Stage-specific procedural metacognition				
regarding scientific literacy	1	1 min	paper-pencil	see above
regarding ICT literacy	1	1 min	paper-pencil	see above
regarding mathematical competence	1	1 min	paper-pencil	see above
regarding orthography	2	1.5 min	paper-pencil	see above

*The number refers to the number of items each participant worked on. If difficulty tiered test booklets were used the total number of items per domain was higher.

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 development. 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.

Scientific literacy

Scientific literacy is the precondition for participating in world affairs marked 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. Many problems and issues we encounter in our daily life require an understanding of natural sciences and technology. Scientific topics and problems affect all people. Therefore, the current discussions of the goals of scientific education focus on the concept of scientific literacy for all people (Osborne & Dillon, 2008). Such literacy is the basis for lifelong learning, serves as a connection for further learning (OECD, 2006; Prenzel et al., 2007) and, thus, also influences professional careers.

Based on this, the NEPS definition of scientific literacy follows the Anglo-Saxon literacy concept (Bybee, 1997; Gräber, Nentwig, Koballa & Evans, 2002; OECD, 2006) that does not regard scientific competence as a simple reproduction but rather as flexible use of acquired knowledge in different situations and contexts of daily life.

In NEPS, scientific literacy is understood as the use of scientific knowledge in the environmental, technological and health contexts (Hahn et al., 2013). In addition, the concept distinguishes between content-related and process-related elements (see Fig. 1). In selecting its contexts as well as the content-related and process-related elements, NEPS uses the education standards of the Conference of Ministers of Education for the medium-level school-leaving qualification (KMK, 2005) and the *Benchmarks for Scientific Literacy* of the *American Association for the Advancement of Science* (AAAS, 1989, 2009) as a guideline. The selected contexts are of personal, social and global relevance. Considering the current scientific research and the general events of the day, it is assumed that they will remain important across the entire life span.

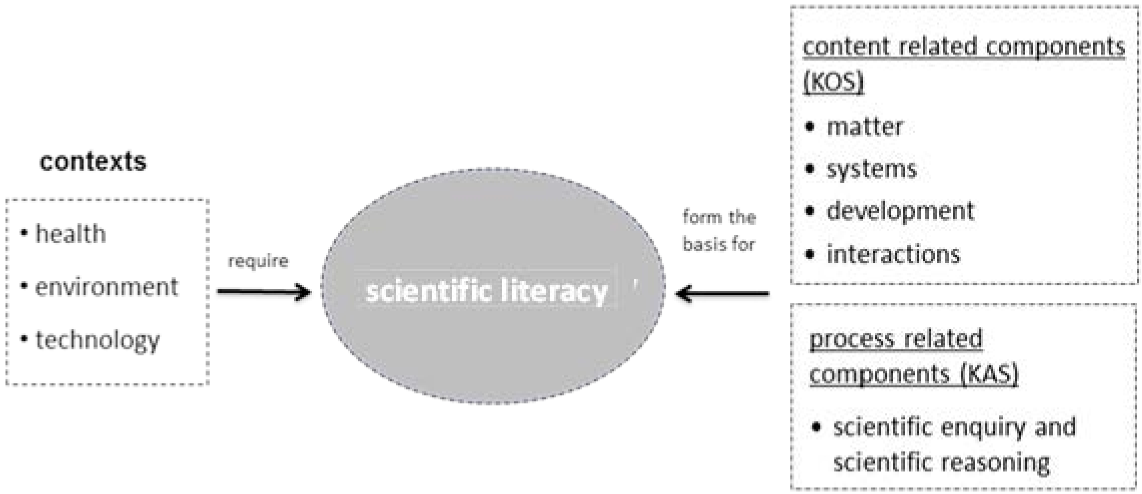

Fig.1: Application contexts as well as content-related and process-related elements of scientific literacy of the NEPS scientific test (Hahn et al., 2013).

The selected content-related and process-related elements cover central concepts of all scientific disciplines. The scientific knowledge domain comprises the content-related matter, *systems*, *development* and *interactions*. The knowledge of natural sciences includes *inquiry and scientific reasoning* that deal, among other things, with checking hypotheses, interpreting findings as well as measuring principles and measuring error control.

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ICT Literacy

New conceptions for computer literacy increasingly emphasize aspects of information literacy in addition to technological literacy (basic declarative and procedural functional knowledge about hardware and software applications). Computer literacy is the ability to create, access, manage, integrate, and evaluate information using digital media. It can thus be seen as a combination of technological and information literacy. Therefore, explicit technological and informational tasks in specific contexts are represented in the tests. Different process components and content areas are taken into account for a content valid test construction. The process components were either allocated to technological literacy (e.g. create) or information literacy (e.g. evaluate) (see Fig. 1). Various software applications (e.g. operating system, internet search engines) were included for the content areas. All test items were constructed in such a way that they could be allocated to either of the two subscales as well as to a process component and a field of content.

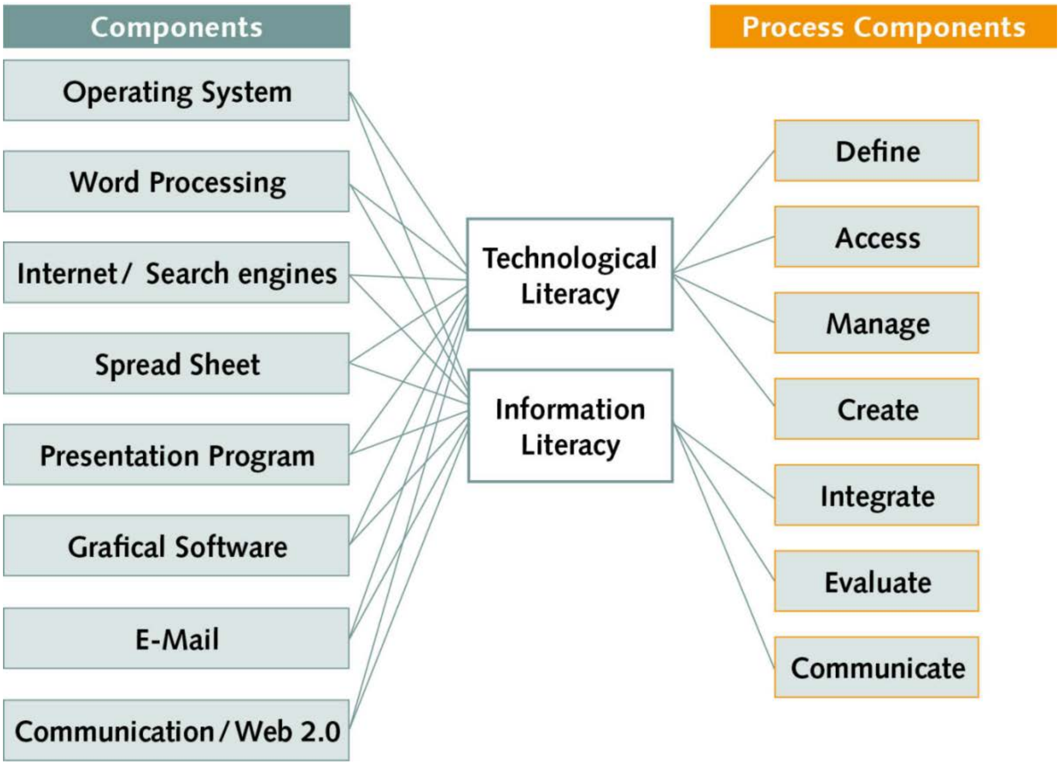

Fig. 1: ICT Literacy Outline Concept in NEPS

Reading speed

In addition to the reading competence test which focuses on reading comprehension, an indicator of the reading speed is collected where primarily basal reading processes and/or their automation are given priority. The test which is processed by the study participants within two minutes is based on the test design principles of the two Salzburg reading screenings (e.g. Auer, Gruber, Mayringer & Wimmer, 2005). The test material, however, was newly designed for use by the National Education Panel. The study participants are given a total of 51 sentences which can be answered with the aid of general world knowledge, in other words no specific content-related previous knowledge is required (e.g. ”mice can fly”). After each sentence, the participant has to check whether the sentence is correct in terms of content (“true“) or not (”false“). When taking the test, participants mainly differ from each other by the number of sentences they are able to process within the given time limit. As a result of the less demanding material in terms of content, differences between participants with proportionately falsely processed sentences are to be neglected. The measure of the reading speed is determined by the number of sentences correctly judged during the two-minute processing limit.

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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.

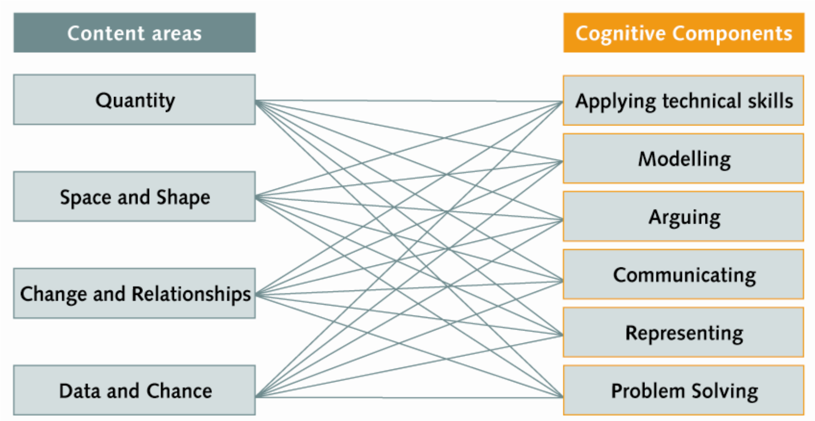

Fig. 1: Framework of mathematical competence in NEPS

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.

This differentiation renders the framework concept of mathematical competence in NEPS compatible with both the PISA studies and the German National Mathematics Education Standards. 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.

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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., Prosch 2016, 66).

Table 3: Number of structural units in grade nine

	Phonographic syllabic subskill	Morphological subskill	Peripheral subskill	Word formation subskill	Syntactic subskill
Grade nine	54	72	44	105	85

In grade seven the test combines a cloze test with six sentences and nine full sentences. This ensures that capitalization and punctuation can be measured reliably. In addition, this format is timesaving. The grade nine test includes 12 words in the cloze test and 126 words in the full sentences.

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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 in combination with the competence tests of the individual domains, the procedural aspect of metacognition is not assessed as a direct measure of such planning, monitoring and controlling activities but as a metacognitive judgement that refers to the control of the learning performance during (and/or shortly after) the learning phase (also see Nelson & Narens, 1990). After the study participants have taken their competence tests, they are requested to rate their own performance. They are asked to state the portion of questions presumably answered correctly.

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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