NEPS
National Educational Panel Study

Research Data

Information on Competence Testing

NEPS Starting Cohort 4 — Grade 9

School and Vocational Training — Educational Pathways of Students in Grade 9 and Higher

Wave 10: 21 years

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Information on testing			
Sample	Sub-sample 1: basic sample (school-leavers from regular schools) Young adults, Starting Cohort 4, wave 10, year 2016	Sub-sample 2: school-leavers from secondary school (as a comparison group to sub sample 3) Young adults, Starting Cohort 4, wave 10, year 2017	Sub-sample 3: school-leavers from special schools Young adults, Starting Cohort 4, wave 10, year 2017
Test situation	Computer-assisted face-to-face interviews (CAPI), normally held at the study participant's home		
Test sequence	Sub-sample 1 and 2: For the first time, the study participants worked on computer-based tasks in the module for technology-based testing (TBT). The tests were administrated in different rotations and difficulties. The level of difficulty of the math tasks was adaptive, i.e. the difficulty of the tasks was automatically varied according to previous answers so that the respective difficulty of the task corresponds as closely as possible to the abilities of the target person. The assignment to the easy or difficult booklet in the domain "reading" was based on the results of competence measurements from previous waves. The tests used in reading and mathematics are identical in sub-samples 1 and 2. Sub-sample 3: The study participants worked on a paper-pencil booklet with reading tasks and - as in sub-sample 2 - basic cognitive skills in the module for technology-based testing (TBT). The tests were all administrated in the same order.		
	Constructs		
	Reading competence 1: Reading easy (TBT) Reading competence 2: Reading difficult (TBT) Mathematical competence: adaptive (TBT)	Reading competence 1: Reading easy (TBT) Reading competence 2: Reading difficult (TBT) Mathematical competence: adaptive (TBT) Cognitive basic skills (non-verbal) (TBT)	Reading competence 3: Reading (paper-pencil) Cognitive basic skills (non-verbal) (TBT)

	Rotations		
	1. Reading easy + proc. metacognition – Mathematical competence + proc. metacognition 2. Reading difficult + proc. metacognition – Mathematical competence + proc. metacognition 3. Mathematical competence + proc. metacognition – Reading easy + proc. metacognition 4. Mathematical competence + proc. metacognition – Reading difficult + proc. metacognition	1. Reading easy + proc. metacognition – Cognitive basic skills 2. Reading difficult + proc. metacognition – Cognitive basic skills 3. Mathematical competence + proc. metacognition – Cognitive basic skills	1. Reading + proc. metacognition – Cognitive basic skills
Test duration (net test time)	58 minutes	40 minutes	42 minutes
Administration time (incl. survey)	94 minutes	80 minutes	94 minutes

Information on constructs				
Constructs	Number of Items	Allowed Processing Time	Survey Mode	Next Measurement (expected)
Reading competence 1 or	27	28 min	CAPI (TBT)	2024
Reading competence 2	25	28 min	CAPI (TBT)	
Reading competence 3	33	28 min	CAPI (paper-pencil)	-
Mathematical competence	21	28 min	CAPI (TBT)	2024
Domain specific procedural metacognition regarding the domain reading competence 1 or 2 regarding the domain reading competence 3	 1 6	 1 min 3 min	 CAPI (TBT) CAPI (paper-pencil)	2024 -
Domain specific procedural metacognition regarding the domain mathematical competence	1	1 min	CAPI (TBT)	2024
Cognitive basic skills (non-verbal)				-
Perceptual speed and speed of information processing	3 x 31 = 93	3 x 30 sec	CAPI (TBT)	
Reasoning	3 x 4 = 12	3 x 3 min	CAPI (TBT)	

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.

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.).

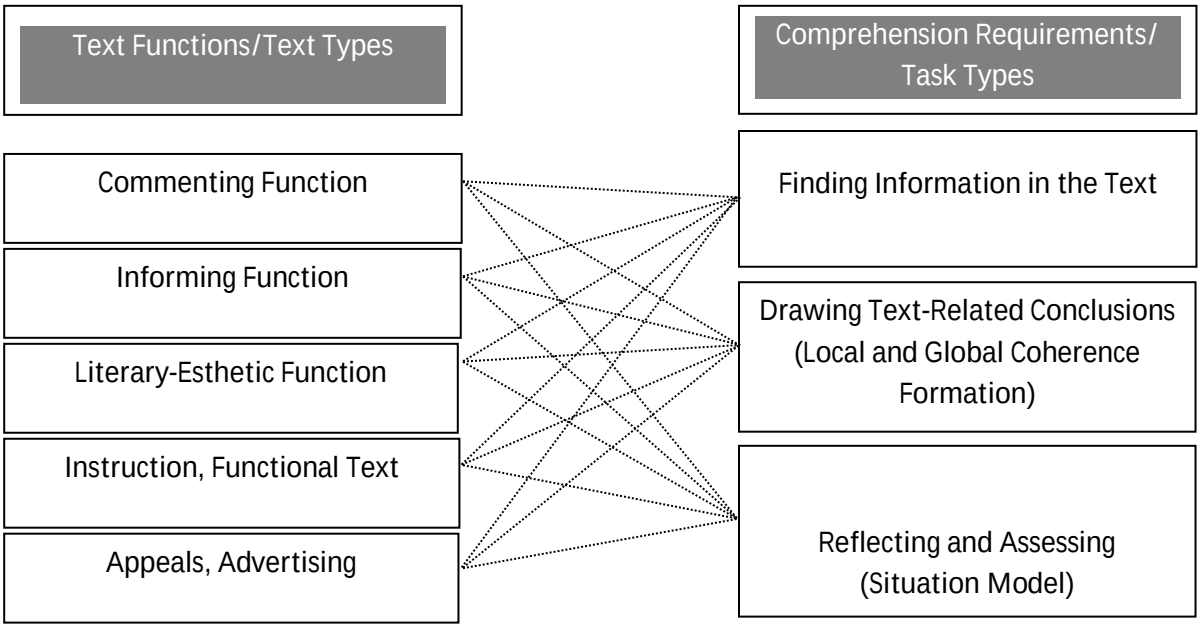

Fig. 1: Text functions and comprehension requirements (cf. Gehrer, Zimmermann, Artelt, & Weinert, 2013, p. 63)

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.

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. (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.

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.

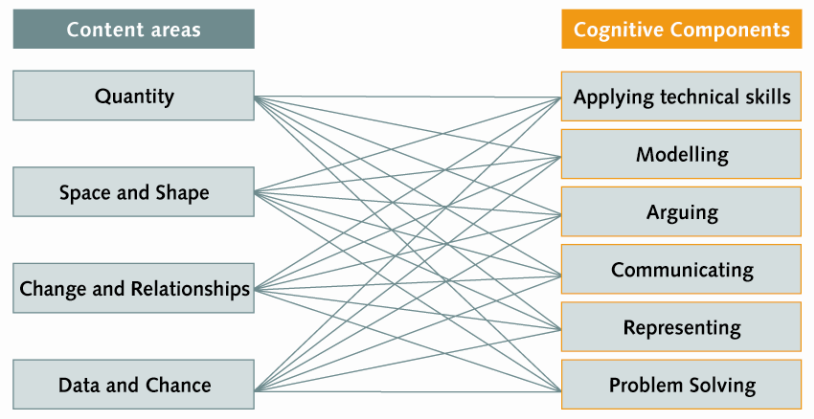

Fig. 1: Framework of mathematical competence in NEPS

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.

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.

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.

Cognitive basic skills (non-verbal) – Perceptual speed and reasoning

In NEPS, domain general cognitive functions (DGCF) are measured based on the differentiation between "cognitive mechanics" and "cognitive pragmatics" following Baltes, Staudinger and Lindenberger (1999). While the former is measured using task contents as education-independent, new and domain-unspecific as possible, the tasks for measuring cognitive pragmatics are based on acquired skills and knowledge (Ackerman, 1987). Consequently, some of the domain-specific performance tests used within the framework of NEPS may serve as indicators of cognitive pragmatics.

In contrast to this, the tests of DGCF aim at assessing individual differences of fluid cognitive abilities (cognitive mechanics). While these are subject to age-related changes, in comparison to the education- and knowledge-related competences they prove to be less culture-, experience- and language-dependent. In this context, these tests provide an individual basis and differentiating basic function for the acquisition of education-dependent competences.

Among the facets of cognitive mechanics, two common marker variables stand out: perceptual speed and reasoning.

Perceptual speed marks the basal speed of information processing ("speed"). In NEPS, this is measured by the Picture Symbol Test (NEPS-BZT). This is based on an improved version of the Digit-Symbol Test (DST) from the tests of the Wechsler family by Lang, Weiss, Stocker and von Rosenbladt (2007). Analogously to this improved version, the NEPS-BZT requires the performance to write the correct number for the given symbols according to an answer key.

Reasoning serves as key marker of mental performance (Baltes et al., 1999). The NEPS reasoning test (NEPS-MAT) is designed as a matrices test in the tradition of the typical reasoning tests. Each item of the matrices test consists of several horizontally and vertically arranged fields in which different geometrical elements are shown – with only one field remaining free. The logical rules on which the pattern of the geometrical elements is based have to be deduced in order to be able to select the right complement for the free field from the offered solutions.

Both tests have been designed in such a way that they can be effectively used without changes to the item sets across as many age groups as possible and relatively independent from the subjects' first language. Currently, they are administered as paper-and-pencil tests, while computer-assisted administration is generally possible.

The results of both tests provide an estimator of DGCF which, however, is not directly comparable to the overall result of a classical intelligence test (IQ). It rather serves as control of differential initial capacities in the competence acquisition process.

Bibliography

Ackerman, P. L. (1987). Individual differences in skill learning: An integration of psychometric and information processing perspectives. Psychological Bulletin, 102, 3-27.

Baltes, P. B., Staudinger, U. M. & Lindenberger, U. (1999). Lifespan psychology: Theory and application to intellectual functioning. Annual Review of Psychology, 50, 471-507.

Lang, F. R., Weiss, D., Stocker, A. & Rosenbladt, B. v. (2007). Assessing cognitive capacities in computer-assisted survey research: Two ultra-short tests of intellectual ability in the Germany Socio-Economic Panel (SOEP). Schmollers Jahrbuch. Journal of Applied Social Science Studies, 127, 183-192.

Technical report

Nusser, L. & Messingschlager, M. (2018). Erfassung kognitiver Grundfähigkeiten bei Schülerinnen und Schülern an Förderschulen in Startkohorte 4 (Klasse 9) (NEPS Survey Paper No. 33). Bamberg: Leibniz-Institut für Bildungsverläufe, Nationales Bildungspanel.

Further literature

Gnambs, T. & Nusser, L. (2019). The longitudinal measurement of reasoning abilities in students with special educational needs. Frontiers in Psychology, 10:232, 88-92. https://doi.org/10.3389/fpsyg.2019.00232.