NEPS
National Educational Panel Study

Research Data

Information on Competence Testing

NEPS Starting Cohort 1 — Newborns

Education From the Very Beginning

Wave 11: Grade 4

LIfBi
LEIBNIZ INSTITUTE FOR
EDUCATIONAL TRAJECTORIES

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Information on testing	
Sample	Study B155, students in fourth grade (10 years), Starting Cohort 1, wave 11, year 2022. The survey started at the end of April 2022 as a CAPI-by-Phone[1] interview. The interviewer conducted the parent interview by phone from home. After arranging another appointment, the testing and subsequent interview with the target child was conducted via a CAPI[2] interview in the children's homes.
Test situation	**Computer-assisted telephone interview (CAPI-by-Phone) with technology based testing (TBT[3]) and a computer assisted self/web interview for the child (CASI[4])**
Test sequence	At the end of the parent telephone interview (part 1) with a parent or guardian of the target child, consent for testing and interviewing at home was requested. If consent was given, the target child was tested and interviewed at home on a tablet PC at a later date under agreed hygiene conditions (part 2). The target children completed the competence tests and answered the questions themselves on the tablet PC. The interviewer was responsible for administering the test transitions, and partly, for carrying out the instructions if these were not video-based.
	Rotations
	The testing took place in the following order: 1. Reading speed 2. Early reading competence + procedural metacognition 3. Mathematic competence (adaptive) + procedural metacognition 4. Basic cognitive skills (nonverbal) – perceptual speed
Test duration (net processing time)	Approx. 30 minutes
Administration time (incl. survey)	Approx. 70 minutes (approx. 43 minutes TBT-testing and instruction; approx. 12 minutes child questionnaire, approx. 15 minutes preparation test situation) The parent interview was conducted on a separate date before testing and interviewing the child.

[1] CAPI-by-Phone = Computer Assisted Telephone Interview by CAPI interviewer
[2] CAPI = Computer Assisted Personal Interview
[3] TBT = Technology Based Testing
[4] CASI = Computer Assisted Self Interview

Information on constructs				
Constructs	**Number of items**	**Allowed processing time**	**Survey mode**	**Next measurement (expected)**
Reading speed	100	3 min	CAPI (TBT)	tba
Early reading competence	26	7 min	CAPI (TBT)	tba
Mathematic competence	16 (26 in multistage test)	approx. 17 min	CAPI (TBT)	tba
Basic cognitive skills (nonverbal) – perceptual speed	2 x 21	2 x 30 sec	CAPI (TBT)	tba
Domain-specific procedural metacognition regarding vocabulary: Listening comprehension at word level	1	1 min	CAPI (TBT)	tba
Domain-specific procedural metacognition regarding mathematic competence	1	1 min	CAPI (TBT)	tba

Preliminary note

The development of the individual tests is based on framework concepts. These are overarching concepts that serve as a basis for measuring educationally relevant competencies consistently and coherently across the individual's life course. Therefore, the following framework concepts underlying the development of the test instruments for measuring the above-mentioned constructs are identical in the different studies.

Reading speed

In addition to the reading competence test which focuses on reading comprehension, an indicator of reading speed is collected, which primarily assesses basal reading processes and/or their automation. The Salzburg Reading Screening for grades 2-9 (Mayringer & Wimmer, 2014; courtesy of the publisher Hogrefe[5]) is used for Starting Cohort 1. The instrument is administered on a tablet or laptop in a NEPS computer implementation for individual testing. The child is presented with simple sentences that can usually be answered on the basis of general world knowledge alone, i.e., no specific prior knowledge of the content is required (e.g., "Mice can fly"). After each sentence, the children must indicate whether the content of the sentence is correct ("correct") or incorrect ("incorrect"). The input is done by touch on the field device (tablet PC). Instructions are given via video. The instrument contains a total of 100 sentences. When completing the test, children differ primarily in how many sentences they can complete correctly in the given time. Differences between subjects in the proportion of incorrectly completed sentences are negligible because the material is not very demanding in terms of content. As a measure of reading speed, the number of sentences completed correctly within the three-minute time limit is determined[6].

Bibliography

Auer, M., Gruber, G., Mayringer, H. & Wimmer, H. (2005). *Salzburger Lesescreening für die Klassenstufen 5-8.* Göttingen: Hogrefe.

Zimmermann, S., Artelt, C., & Weinert, S. (2014). The assessment of reading speed in adults and first-year students (NEPS Research Data Paper). Bamberg, Germany: Leibniz Institute for Educational Trajectories, National Educational Panel Study.

Zimmermann, S., Gehrer, K., Artelt, C., & Weinert, S. (2012). The assessment of reading speed in grade 5 and grade 9. Status: 2012 (NEPS Research Data Paper). Bamberg, Germany: University of Bamberg, National Educational Panel Study.

[5]https://www.testzentrale.de/shop/salzburger-lese-screening-fuer-die-schulstufen-2-9.html

[6] The test for the higher starting cohorts was redesigned for the purposes of the NEPS (Zimmermann, Artelt, & Weinert, 2014; Zimmermann, Gehrer, Artelt & Weinert, 2012), but it is also based on the test construction principles of the two Salzburg reading screenings (e.g. Auer, Gruber, Mayringer & Wimmer, 2005). It lasts two minutes.

Early reading competence

The operationalization of reading competence in the National Educational Panel Study (NEPS) during the early school years (i.e., elementary school) does not follow the overall NEPS framework regarding the measurement of reading competence (see Gehrer, Zimmermann, Artelt, & Weinert, 2013). Studies on the development of reading competence report that children first have to figure out how letters and written words map onto their phonological form and to master basic decoding processes before they can begin to read for meaning (Cain, 2010; Ebert & Weinert, 2013). At the end of elementary school, children exhibit a more complex reading comprehension, which exceeds basic reading ability (Klicpera & Gasteiger-Klicpera, 1993; McElvany, Kortenbruck, & Becker, 2008). As the reading tests based on the NEPS framework include longer texts and require more sophisticated text comprehension, they used from the end of elementary school at the earliest.In order to (a) conduct a reliable and valid measurement of reading comprehension in early elementary school and (b) enable a comparison of the construct with the following school years, a widespread standardized test is used in the NEPS: ELFE 1-6 A Reading Comprehension Test for First to Sixth Graders (Lenhard & Schneider, 2006)[7] in Starting Cohort 2 (grade 2), or the follow-up version ELFE II - A Reading Comprehension Test for First to Seventh Graders (Lenhard, Lenhard & Schneider, 2017)[8] in Starting Cohort 1 (grades 2 and 4). The main objective of the test is to measure early reading comprehension and not orthographic knowledge or articulation ability. The early reading comprehension is measured by ELFE 1-6[9] and ELFE II [10] using the following levels or subscales:

- Word comprehension (decoding and synthesizing)
- Reading speed (threshold of visual word recognition)
- Sentence comprehension (extracting meaning through reading and syntactic ability)
- Text comprehension from short stories (finding information, sentence comprehensive reading, deductive thinking)

In starting Cohort 2 of the NEPS, the **subscale text comprehension** of the ELFE 1-6 was used as a paper pencil test in the main study (2013) in grade 2. Children were asked to answer 20 questions that related to 13 short texts (2-7 sentences; maximum 56 words). Therefore, ca. 1-3 questions were asked about each of the texts. The children had to choose one out of four options by marking it. As with the original test, a completion time of 7 minutes was set for this subscale.In starting cohort 1 of the National Educational Panel Study, the ELFE II text comprehension subscale was used as a computer-based test in the main studies in grades 2 (2020) and 4 (2022). The instruction was given via video. The children were asked 26 questions about 17 short texts (2-7 sentences; maximum 74 words); that is, 1-3 questions were asked about each text. The children had to choose one of 4 possible answers by tapping (on the tablet) or clicking (with the mouse). As with the original test, a completion time of 7 minutes was set for this subscale.

[7] https://www.testzentrale.de/shop/ein-leseverstaendnistest-fuer-erst-bis-sechstklaessler.html
[8] https://www.testzentrale.de/shop/ein-leseverstaendnistest-fuer-erst-bis-siebtklaessler.html
[9] https://www.psychometrica.de/elfe1-6.html
[10] https://www.psychometrica.de/elfe2.html

Bibliography

Cain, K. (2010). Reading development and difficulties: An introduction. Oxford, UK: Wiley-Blackwell.

Ebert, S., & Weinert, S. (2013). Predicting reading literacy in primary school: The contribution of various language indicators in preschool. In M. Pfost, C. Artelt & S. Weinert (Eds.), The development of reading literacy from early childhood to adolescence (pp. 93-149). Bamberg, Germany: University of Bamberg Press.

Gehrer, K., Zimmermann, S., Artelt, C. & Weinert, S. (2013): NEPS Framework for Assessing Reading Competence and Results From an Adult Pilot Study. In: Artelt, C., S. Weinert & C. H. Carstensen (Hrsg.): Competence Assessment within the NEPS. JERO Journal for Educational Research Online/ Journal für Bildungsforschung Online, 5 (2). Waxmann, 50-79. http://www.j-e-r-o.com/index.php/jero/article/view/361/170 (11.06.2015).

Klicpera, C. & Gasteiger-Klicpera, B. (1993). Lesen und Schreiben - Entwicklung und Schwierigkeiten: Die Wiener Längsschnittuntersuchungen über die Entwicklung, den Verlauf und die Ursachen von Lese- und Schreibschwierigkeiten in der Pflichtschulzeit. Bern: Huber Verlag.

Lenhard, W., & Schneider, W. (2006). ELFE 1-6 Ein Leseverständnistest für Erst- bis Sechstklässler. Göttingen: Hogrefe.

McElvany, N., Kortenbruck, M., & Becker, M. (2008). Lesekompetenz und Lesemotivation: Entwicklung und Mediation des Zusammenhangs durch Leseverhalten. Zeitschrift für Pädagogische Psychologie, 22(3-4), 207-219. doi:10.1024/1010-0652.22.34.207.

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.

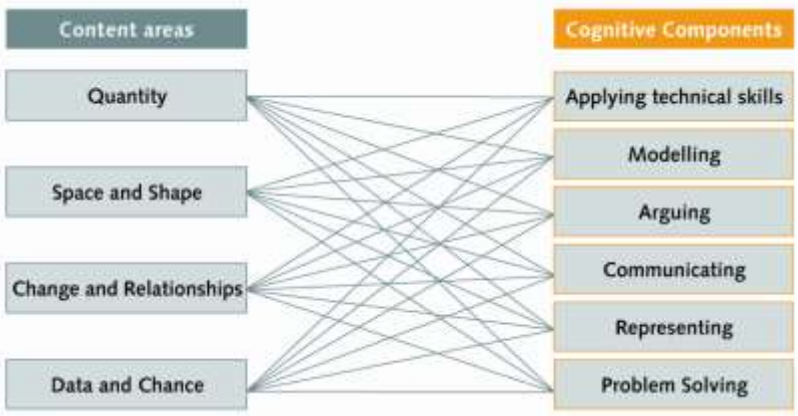

Fig. 1: Framework of mathematical competence in NEPS

The NEPS framework of mathematical competence distinguishes between content-related and process-related components (cf. Fig. 1). According German National Mathematics Education Standards for primary education, for content-related components are distinguished which are adapted for NEPS as follows (KMK, 2004).

- **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)
- **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
- **Change and Relationships** includes all kinds of (functional) relationships and patterns.
  Examples from the *elementary sector*: recognizing and continuing patterns, relationships among numbers, proportionality
- **Data and Chance** comprises all situations involving statistical data or chance.
  Examples from the *elementary sector*: intuitively assessing probabilities, collecting and structuring data
  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

KMK (Beschlüsse der Kultusministerkonferenz) (2004) Bildungsstandards im Fach Mathematik für den Primarbereich. Beschluss vom 15.10.2004. München: Luchterhand.

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.

Basic cognitive skills (nonverbal) – perceptual speed and reasoning

In the NEPS, basic cognitive skills are measured based on the differentiation between "cognitive mechanics" and "cognitive pragmatics" in accordance with Baltes, Staudinger, and Lindenberger (1999). While the former is measured using task contents with an approach that is 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 the NEPS may serve as indicators of pragmatics.

In contrast to this, the tests of basic cognitive skills aim at assessing individual differences in fluid cognitive abilities. While these abilities are subject to age-related changes, in comparison to education- and knowledge-related competences they have been proven to be less dependent on culture, experience and language. In this context, these tests provide an individual basis and a fundamental differentiating 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 reflects the basal speed of information processing (*"speed"*). In the NEPS, this is measured using the **Picture Symbol Test (NEPS-BZT)** which 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 test person to enter the correct figures for the preset symbols according to an answer key.

Reasoning serves as a key marker of mental performance (Baltes et al., 1999). The **NEPS reasoning test (NEPS-MAT)** is designed as a matrices test, in line with the tradition of 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 test person has to deduce the logical rules on which the pattern of the geometrical elements is based in order to be able to select the correct element for the free field from the solutions provided.

In this survey (wave 11 of starting cohort 1) only the Picture Symbol Test (NEPS-BZT) was used. The test was computer-based. The reasoning test (NEPS-MAT) was already part of the survey program in wave 10.

Both tests were designed in such a way that they can be effectively used without requiring changes to the item sets across as many age groups as possible and relatively independently from the subjects' mother tongue. The results of both tests provide an estimator of basic cognitive skills which, however, is not directly comparable to the overall result of a traditional intelligence test (IQ). It can be used to control for 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.

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. 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 (Ed.), *The psychology of learning and motivation* (pp. 125-141). New York: Academic Press.