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 7: Grade 12

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	Information on testing		
Test setting	Assessment in schools (Main Study A50), students attending Grade 12 in general schools including students who repeated or skipped a grade level.		Assessment at the study participant´s home for students in the individual field (Main Study B41); including students who changed or left school after Grade 9, 10 and 11 (without students formerly attending schools for students with special educational needs (SEN)[1]).
Test situation	Paper based group testing in classrooms of the regular school, normally with 1 test instructor and 1 supervisory teacher. In schools with NEPS-students -N ≤ 30 the groups were clubbed together.		Paper based testing, personal interview held at the study participant´s home, 1 test instructor
Tests	Paper based tests in the domains reading competence, mathematical competence , ICT literacy, English und scientific thinking (+ procedural metacognition, one or more judgements after each test)		Paper based tests in the domains reading competence, mathematical competence and ICT literacy (+ procedural metacognition, one or more judgements after each test)
Test sequence	The tests were administered on one day. All five tests were presented to all participants. The tests were predetermined in four different sequences. The sequence of the domains ICT literacy - reading competence was the same as in Grade 9. The order of the domains English - scientific thinking was random. After the tests, all students filled out a questionnaire. **Sequence 1**: ICT literacy, reading competence, mathematical competence, English, scientific thinking **Sequence 2**: reading competence, ICT literacy, mathematical competence, scientific thinking , English **Sequence 3**: ICT literacy, reading competence, mathematical competence, scientific thinking , English **Sequence 4**: reading competence, ICT literacy, mathematical competence, English, scientific thinking		The tests were administered on one day. Half of the participants received two tests, the other half received only one test (ICT literacy or mathematical competence). After the test, all participants filled out a questionnaire. Students of the school type Grammar school („Gymnasium“) were asked to participate in a follow-up questionnaire a week later. **Test day 1**: ICT literacy or/and reading competence or/and mathematical competence The difficulty levels of the test on mathematic were assigned to the students depending on the school type (1 = Grammar school , 2 = all other schools). The difficulty levels of the test on reading competence (“reading competence 1 easy” or “reading competence 2

	The difficulty levels of the test on reading competence ("reading competence 1 easy" or "reading competence 2 difficult") were assigned to the students depending on their performance in the previous reading test in Grade 9. Persons who missed the test in Grade 9 received the easy booklet. The test on mathematical competence was assigned to the students depending on the school type (see individual testing, study B41). All in all, there were eight rotations regarding difficulty and sequences.		difficult") were assigned to the students depending on their performance in the previous reading test in Grade 9. Persons who missed the test in Grade 9 received the easy booklet. All in all, there were fifteen rotations/booklets regarding difficulty and sequences.
Test duration (net processing time)	**Test day 1:** 150 min + 40 min questionnaire		**Test day 1:** 60 min test + 30 min questionnaire OR **Test day 1:** 30 min test + 30 min questionnaire
Breaks	**Test day 1:** 10 min break between first and second test; 15 min break after third test and 15 min break before the questionnaire		**Test day 1:** between two tests maximum 10 min breaks possible

Information on the individual tests

Construct	**Number of items**	**Allowed processing time**	**Survey method**	**Next Measurement**
1. Test day				
Mathematical competence	22	28 min	paper pencil	age of 21
Domain specific procedural metacognition regarding mathematical competence	1	1 min	paper pencil	age of 21
Reading competence	29	28 min	paper pencil	age of 21
Domain specific procedural metacognition regarding reading competence	6	3 min	paper pencil	age of 21
ICT literacy	32	28 min	paper pencil	age of 21
Domain specific procedural metacognition	1	1 min	paper pencil	age of 21

regarding ICT literacy				
English reading competence	30	29 min	paper pencil	
Domain specific procedural metacognition regarding English reading competence	1	1 min	paper pencil	
Scientific thinking	32	29 min	paper pencil	
Domain specific procedural metacognition regarding scientific thinking	1	1 min	paper pencil	

[1] Former participants in schools for students with special educational needs (SEN) did receive get the tests, but did the questionnaire by telephone interview (CATI).

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.

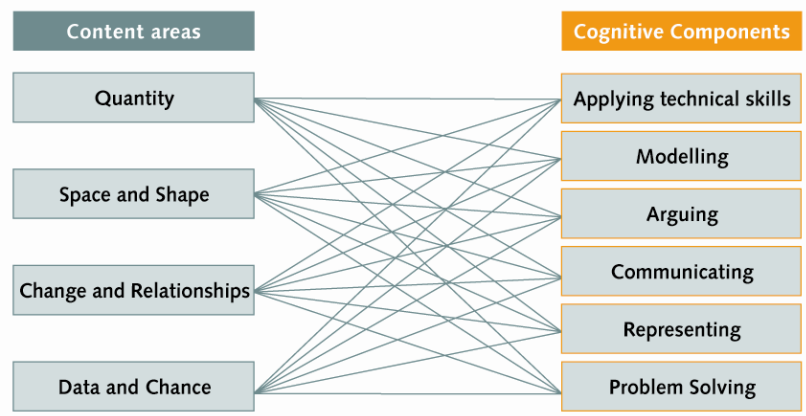

Fig. 1: Framework of mathematical competence in NEPS

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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ICT Literacy

The ability to effectively use information and communication technologies (ICT) not only plays an important role in many workplace settings, but is also becoming increasingly important in people's everyday lives (ETS, 2002; Wittwer & Senkbeil, 2008). Because of the rapidly changing technological environment, self-regulated and continuous life-long learning is a key or meta competence for successfully keeping pace with recent developments in the area of ICT (e.g., Blossfeld, Doll, & Schneider, 2008).

More recent conceptualizations are not exclusively confined to technological literacy, that is, knowledge of hardware and software applications and understanding technological concepts. Instead, information literacy, that is, the ability to use digital media to access, create, manage and critically evaluate information and to use it effectively for one's own purposes, also plays an important role (ETS, 2002). Thus, ICT literacy is to be understood as a functional literacy that helps people to acquire other important competencies and skills for professional success (educational and work settings) and to achieve private goals across the lifespan. One widely used definition of ICT literacy to which we also refer was formulated by the *ICT Literacy Panel*:

„ICT literacy is the ability to appropriately use digital technology, communication tools, and/or networks to solve information problems in order to function in an information society. This includes having the ability to use technology as a tool to research, organize, and communicate information" (Katz, 2007, p. 6).

In the context of NEPS, *ICT Literacy* is conceptualized as a unidimensional construct comprising the facets of process components and software applications (see Figure 1; Senkbeil, Ihme & Wittwer, 2013a,b). As a basis for constructing the instrument assessing computer literacy in NEPS, we use a framework that identifies four process components of computer literacy representing the knowledge and skills needed for a problem-oriented use of modern information and communication technology. Each process component integrates technological and cognitive aspects of the construct. The process components are defined as follows:

Access: knowledge of basic operations used to retrieve information (e.g., entering a search term in an internet browser, opening and saving a document);

Create: the ability to create and edit documents and files (e.g., setting up tables, creating formulas);

Manage: the ability to find information within a program (e.g., retrieving information from tables, processing the hits returned by a search engine);

Evaluate: the ability to assess information and to use it as the basis for informed decisions (e.g., assessing the credibility of the information retrieved).

Apart from the process components, the construction of the NEPS tests for ICT Literacy is guided by a categorization of software applications that are used to locate, process, present, and communicate information: (a) word processing and operating systems, (b) spreadsheet and presentation software, (c) e-mail and other communication applications, and (d) internet and internet-based search engines. Each item in the test refers to one process component and one software application.

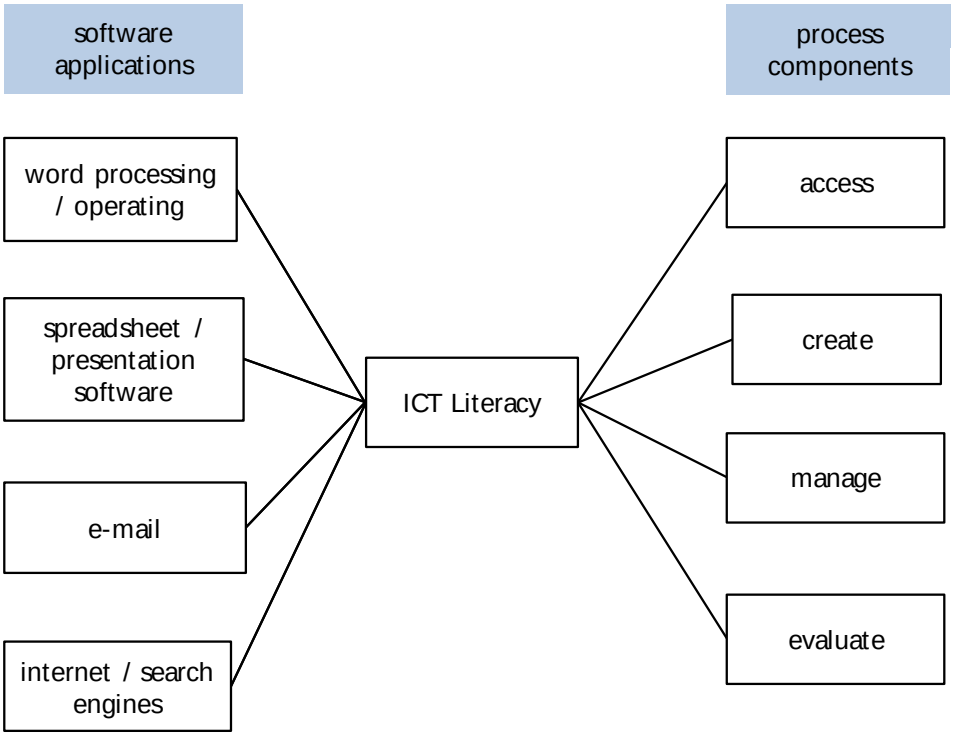

Figure. 1: Assessment framework for ICT Literacy in the German National Educational Panel Study

Item format

In the first stage of NEPS (2017 – 2017) the measurement of ICT literacy was based on multiple-choice tests (from 2018: computer-based and interactive items are additionally used).

The majority of the NEPS ICT literacy items are constructed as simple multiple choice (MC) items. These kinds of items display an item stem giving the test persons background information on the item topic. Most items contain a screenshot with given relations between text and screenshot. The test question is followed by four to eight different answer options. One of the response options is correct, whereas the other response options function as distractors (Senkbeil & Ihme, 2014). NEPS ICT literacy tests also use the multiple true false (MTF) format. Structurally similar to the MC format, they also feature an item stem containing background information and often a screenshot, a test question, and three to ten answers. Unlike the MC items, the test person here must decide whether

each MTF answer is either true or false. For MTF items, summaries are made, if necessary, thus creating answers with fully correct solutions (full credit) and partly correct solutions (partial credit).

Scaling of the tests

For estimating item and person parameters for ICT literacy a Rasch model is used. In order to compare competencies across different measurement occasions and examine competence development over time the different measurements are linked (Fischer, Rohm, Gnambs & Carstensen, 2016). The psychometric quality and the scaling results of the tests and items are described in the technical reports of each starting cohort.

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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.).

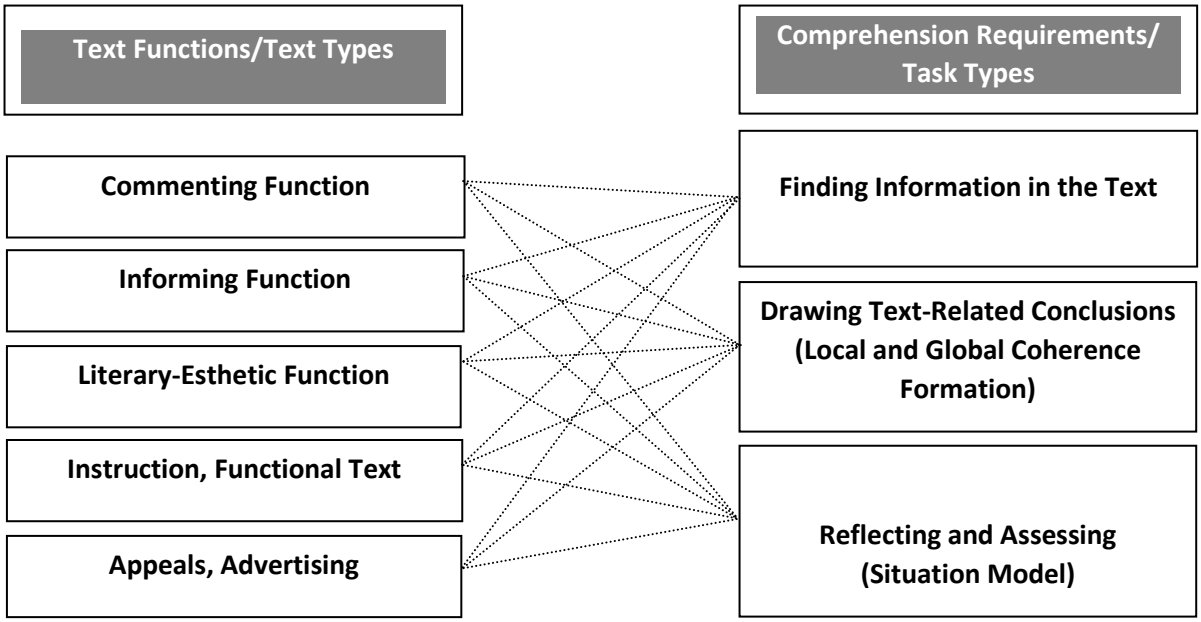

Fig. 1: Text functions and comprehension requirements (cf. Gehrer, Zimmermann, Artelt, & Weinert, 2013, p. 63)

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 (*for SC4*: Gnambs, Fischer & Rohm, 2017; Haberkorn, Pohl, Hardt & Wiegand, 2012).

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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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English Reading Competence

Further Informations to the construct will follow soon.

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Scientific Thinking

Short Version will follow soon.

Oschatz, K., Kramer, J. & Wagner, W. (2017). The assessment of Wissenschaftspropädeutik as metascientific reflection. Scientific Use File 2017, Version X.X.X. Bamberg: Leibniz Institute for Educational Trajectories, National Educational Panel Study.