

Multi-Item Scale for Project:

PIAAC-Longitudinal (PIAAC-L) 2014 (English Version)

Introduction:

Now it's about how you assess your ability to use and understand numbers.

[Jetzt geht es darum, wie Sie Ihre Fähigkeit einschätzen, Zahlen zu verwenden und zu verstehen.]

Question Text:

I will now read you various everyday mathematical activities. For each of these activities, please tell me how well you can perform them. Think about your experiences from your job and everyday life.

Please give me your answers again using this list.

[Ich lese Ihnen jetzt verschiedene alltagsmathematische Tätigkeiten vor. Bitte sagen Sie mir für jede dieser Tätigkeiten, wie gut Sie diese durchführen können. Denken Sie dabei an Ihre Erfahrungen aus Beruf und Alltag.]

Bitte geben Sie mir Ihre Antworten wieder anhand dieser Liste.]

Instruction:

(CI: List 1 is already there!) [(TL: Liste 1 liegt bereits vor!)]

Answer Categories:

I cannot *[Kann ich nicht]*

I can, but with great difficulties *[Kann ich, aber mit großen Schwierigkeiten]*

I can, but with certain difficulties *[Kann ich, aber mit gewissen Schwierigkeiten]*

I can without problems *[Kann ich problemlos]*

Findings for Multi-Item Scale:

There were no noteworthy comments on the introductory text as a whole from the test persons or the cognitive interviewers. All test persons were able to provide information on each individual item. However, the term "everyday mathematics" is generally uncommon and could be deleted in favor of a simplification of the question.

Recommendations for Multi-Item Scale:

Response options: For this question there was no indication that the default answer categories did not work. However, if the same scale is to be used for question 1 and question 2, the alternative answers suggested in question 1 are of course also applicable.

Cognitive Techniques:

General Probing, Specific Probing, Comprehension Probing.

All Items for Question(Question Text):

I will now read you various everyday mathematical activities. For each of these activities, please tell me how well you can perform them. Think about your experiences from your job and everyday life.

Please give me your answers again using this list.

[Ich lese Ihnen jetzt verschiedene alltagsmathematische Tätigkeiten vor. Bitte sagen Sie mir für jede dieser Tätigkeiten, wie gut Sie diese durchführen können. Denken Sie dabei an Ihre Erfahrungen aus Beruf und Alltag.]

Bitte geben Sie mir Ihre Antworten wieder anhand dieser Liste.]

-> Tested Items:

Item Text:

a. Calculate percentages like e.g. calculating the value added tax. *[Prozente berechnen wie z.B. die Mehrwertsteuer ausrechnen.]*

Recommendations:

The variance in response behavior is largely due to the use of technical aids. Therefore, it should be specified whether only mental arithmetic or also the use of tools such as paper or calculators is allowed.

Findings:

14 test persons stated that they could calculate percentages without any problems, four test persons could do so with certain difficulties and two test persons stated that they could do so only with great difficulties.

Two test persons asked the cognitive interviewer whether the calculation should be done in the head or with the help of a pocket calculator, whereby test person 06 (answer: with great difficulty) assumes mental arithmetic when answering and test person 20 (answer: I can do it without any problems) decides to use a pocket calculator as an aid when classifying their everyday mathematical competence.

With the help of the questionnaire it becomes clear that 14 test persons (TP 01, 04, 06, 07, 08, 09, 10, 11, 13, 15, 16, 17, 18, 19) thought of mental arithmetic when assessing their abilities, two test persons (TP 03, 20) thought of using a calculator or cell phone and four thought of both (TP 02, 05, 12, 14).

When asked whether they would have answered differently if they had thought about using a calculator, five of the 14 test persons who thought about mental arithmetic said that they could do this without any problems.

- *"If I had to do it, I would already know how to do the math. But when I'm standing in the store, I have a hard time doing it."* (TP 06, answer: with great difficulty)
- *"If it is odd, it gets complicated, straight in the head. For example, if it's 27%, I need technical help."* (TP 07, answer: with certain difficulties)
- *"At 50 %, 20 % or 10 % this is still possible, but as soon as 3 % of an odd number [should be calculated], it becomes more difficult. If I would calculate more often with a calculator and I would know how to do it in the calculator, it would be no problem. But I hardly ever do that."* (TP 10, answer: with great difficulties)
- *"If you can write it down and calculate it with a calculator, then it works, but in your head like this."* (TP 12, answer: with certain difficulties)

Consequently, the variance of the scale results from the different ways in which technical aids are considered or not considered. In other words, those who claim to have some or great difficulties with the calculation of percentages, e.g. VAT, do so because they assume that the data should be calculated in their head. Only test person 05, who thinks of both mental arithmetic and the use of a calculator, sticks to her assessment that this task causes her certain difficulties: *"I would have to think about it first and if I were to make a few mistakes, I would be fine. I would have to reach into certain areas of my brain that I otherwise never use. Nothing will change with a calculator, I think."*

Question Topic:

Job and career/ Job situation & professional activity

Construct:

Self-assessment of everyday mathematical competence

Item Text:

b. Calculate simple areas such as the area of a wall to buy tiles. [*Einfache Flächen berechnen wie z.B. die Fläche einer Wand, um Fliesen zu kaufen.*]

Recommendations:

No changes recommended.

Findings:

In terms of simple area calculation, e.g. the area of a wall to buy tiles, 15 test persons state that they can do this without any problems, four test persons are of the opinion that they can do this task with certain difficulties and one test person with great difficulties.

All test persons have a more or less comprehensive idea of what is meant by the term "simple surface". Apart from test person 12, who thinks of calculating the area of a circle, all test persons think of a rectangle when using this term or name the example wall. Furthermore, seven persons (TP 01, 04, 08, 10, 13, 15, 16) state that the term "simple surface" is used to connect a square and two test persons (TP 01, 04) triangles.

13 of the 15 test persons who state that they can easily calculate a simple area think of calculating a wall, i.e. a rectangle:

- *"Length times width." (TP 02)*
- *"I also laid laminate myself in my apartment. You take length times width, how many square meters you need." (TP 09)*
- *"I can definitely calculate the area of a wall. Length times width. A two-dimensional surface." (TP 16)*
- *"2.5 meters by 4 meters, that's relatively easy." (TP 19)*

Test persons 08 and 11, who also report no problems with the calculation, think of somewhat more complex area calculations:

- *"Multiply in your head, estimate and measure. That is no problem to calculate an area. Most of the time you have the formulas in your head and then you can easily calculate the area." (TP 08)*
- *"I have to know how many square meters. First in meters and then in square meters, then I have to add it up. Of course I can't calculate the number of plates, you have to tell the man where I buy [the plates]." (TP 11)*

Of the five test persons who would have certain (TP 05, 06, 12, 17) or great (TP 03) difficulties with this task, four think of more extensive calculations of areas:

- *"There I add up the 4 walls, so 3.5 x 4 m for wallpaper, for example."* (TP 03)
- *"Length times width would be easy, but as soon as a part has to be moved e.g. away from the heating, then I don't know how to subtract something from what."* (TP 05)
- *"Calculate a barrel or a circle."* (TP 12)
- *"I have the problem, I need the formula. There are people who can get it out of their heads, but I always need a formula."* (TP 17)

Test person 06, who also has certain difficulties, however, thinks of simple calculations.

Again, the variance of the scale is largely due to the presumed complexity of the computational operations to be performed and not exclusively to the assessment of the underlying computational competence.

Question Topic:

Job and career/ Job situation & professional activity

Construct:

Self-assessment of everyday mathematical competence

Item Text:

c. Convert units such as milliliters to liters or miles to kilometers. [*Einheiten umrechnen wie z.B. Milliliter in Liter oder Meilen in Kilometer.*]

Recommendations:

Only two test persons consider both examples when answering. If the conversion between metric and American systems is of central importance, this should be recorded explicitly and above all individually:

"Convert units of different measurement systems, e.g. miles to kilometers."

[*"Einheiten unterschiedlicher Messsysteme umrechnen, z. B. Meilen in Kilometer."*]

If this is not desired or irrelevant in terms of the construct, only examples within a system should be used:

"Convert units such as milliliters into liters or meters into kilometers"

[*"Einheiten umrechnen wie z.B. Milliliter in Liter oder Meter in Kilometer."*]

Findings:

Twelve test persons state that they manage to convert units without any problems, five test persons find this task somewhat difficult and three test persons even find it very difficult.

None of the 20 test persons express any difficulties in understanding the term "mile". However, eight test persons (TP 03, 08, 09, 10, 13, 15, 16, 17) do not think of the conversion of miles into kilometers when answering, but of something else:

- *"I immediately think of cooking or baking with American recipes, where everything is given in "cups"."* (TP 05)
- *"First of all I think of measures of length, cm in dm and m etc."* (TP 10)
- *"If I measure something in the measuring cup, e.g. half a liter, then that is 50 cl and 500 ml. Or meters in kilometers."* (TP 12)
- *"Convert one pound of coffee. I prefer grams."* (TP 13)

Another ten test persons (TP 01, 05, 06, 07, 11, 12, 14, 18, 19, 20) can understand the term "mile", but they do not know the conversion factor:

- *"All those simple units from milli to micro or no idea what, yes, but from miles to kilometers that's something else. I'd have to look up, what is a mile."* (TP 01)
- *"Well, there are certain difficulties with miles and kilometers, because I would have to look it up first because I don't know. I'd have to know how long a mile is first."* (TP 14)
- *"I don't know now how to express miles in kilometers."* (TP 19)

This leaves two test persons (TP 02, 04) who know the conversion factor from miles to kilometers and take this into account in their answers. Test person 04 explicitly deals with the conversion of both mentioned examples: *"Milliliter in liter is a decimal shift and miles in kilometer is 1.6 and this has to be converted."* (TP 04)

Except for test persons 02 and 04 (conversion of miles to kilometers) and 05 (conversion of "cups" to grams), the majority of respondents only consider the conversion of units within the metric system when answering.

When asked how easy or difficult it was for them to answer this statement about the conversion of units, only four test persons (TP 06, 07, 08, 14) classified this as "rather difficult", mainly because they did not know the conversion factor from miles to kilometers.

Question Topic:

Job and career/ Job situation & professional activity

Construct:

Self-assessment of everyday mathematical competence

Item Text:

d. Perform calculations that require several steps or arithmetic operations, such as calculating the cheapest cell phone contract for specific needs. [*Berechnungen durchführen, die mehrere Schritte oder Rechenoperationen erfordern, wie z.B. den günstigsten Handyvertrag für bestimmte Bedürfnisse ausrechnen.*]

Recommendations:

It is not clear, what is meant by the abstract notion "arithmetic operations". To make clear, what shall be considered at this item, either the formulation "arithmetic operations like plus, minus, multiply or divided" or the term "basic arithmetic operations" could be used.

In addition, the example with the cheapest cell phone contract does not work, since mainly a comparison of monthly costs for flat rates is considered. In contrast to this probably rather a multi-level computation procedure (basic and consumption costs, possible bonus payments, etc.) might find consideration with the determination of the most favorable current offerer:

"Perform calculations that require multiple steps or arithmetic operations such as addition, subtraction, multiplication or division, such as calculating the cheapest electricity provider for specific needs".

[*"Berechnungen durchführen, die mehrere Schritte oder Rechenoperationen wie Plus, Minus, Mal oder Geteilt erfordern, wie z.B. den günstigsten Stromanbieter für bestimmte Bedürfnisse ausrechnen."*]

Findings:

Also in this everyday mathematical activity almost three quarters of the test persons (n=14) state that they can do this without any problems, two test persons can do this with certain difficulties and three with great difficulties. One test person does not make any statement because he says of himself that he never calculates cell phone contracts for certain needs.

There are two questions of particular interest in this item. One is to find out if the test persons think of several arithmetical operations when answering the question and the other is to find out if the mentioned example of calculating the most favourable cell phone contract for certain needs is useful for answering the question. When asked which arithmetical operations the test persons thought of, the answers vary from basic arithmetical operations such as addition and multiplication to equations or trisentence calculation up to the calculation of functions e.g. a straight line. With a total of 14 test persons (TP 01, 02, 03, 04, 05, 06, 07, 09, 12, 13, 14, 16, 18, 19) it becomes clear that they thought of several arithmetical operations when answering, regardless of whether they were referring to cell phone contracts or not:

- *"Calculate three-sentence calculation in the same way as for fuel consumption. I do that occasionally in my head and it's easy for me."* (TP 04)
- *"I think that's something you do more often. The contract has this and the other has that. I might not use one of them. Or I have free SMS. [...] For a short time I thought of a formula where different things are used one after the other, but you can't calculate that directly with the contract. You have different steps."* (TP 06)
- *"I do also always make that, if I must decide between two offers, that does not have to be always a cell phone contract, then one goes also there and computes only times. For example also electricity providers. That I compare the fixed costs and also the variable costs and look at me, what I need and/or use. That can also be a multi-level comparison calculation."* (TP 09)
- *"I was thinking about some text tasks where you have to do several steps. First like this, then plus, minus and then a three-part sentence in the back."* (TP 16)

The remaining six test persons (TP 08, 10, 11, 15, 17, 20) refer to the example "cell phone contract", but in their explanations they only refer to comparing the costs of different flat rates:

- *"It is not a multiple bill. You compare who offers the cheapest Allnet flat rate and has a good net and all that. Well, I'll manage that, I'll have to find the right cell phone contract."* (TP 10)
- *"To the calculation from the telephone provider for me. 25€ and 9,95€ are a big difference for me."* (TP 11)
- *"I was thinking about the cell phone contract. Per month, with Internet flat rate without Internet flat rate, i.e. the services per month."* (TP 17)
- *"You read it through. So and so much Flatrate for so much euro etc. and compare that."* (TP 20)

There is no assessment of their everyday mathematical competence with regard to their ability to use a multi-stage calculation method. These six test persons all decide on the

answer category "I can without problems". This means that six of the 14 persons who claim to be able to do this without any problems, may be misplaced due to an incorrect understanding. Furthermore, it means that the example of calculating the cheapest cell phone contract no longer works today, since the costs for the widespread smart phones are based on flat rates and there is no longer any need for a multi-stage calculation method with basic arithmetic operations. In addition, there are also comparison computers on the Internet that can perform the actual computing power when the user enters the individual usage data.

Question Topic:

Job and career/ Job situation & professional activity

Construct:

Self-assessment of everyday mathematical competence

Item Text:

e. Understanding and interpreting statistical information or data, such as a graph showing the development of housing prices in different districts. *[Statistische Angaben oder Daten verstehen und interpretieren wie z.B. eine Abbildung mit der Entwicklung von Wohnungspreisen in verschiedenen Stadtteilen.]*

Recommendations:

No changes recommended

Findings:

This is the first item to use the full scale width. While eight test persons state that they can easily understand and interpret statistics and data using the example of housing price developments in different parts of the city, six test persons believe they can do so with some difficulty and one person with great difficulty. Three test persons state that they are not able to do so.

There are indications that two test persons (TP 03, 11) do not understand the statement in the intended sense:

- *"I know what it costs here, what it costs in Frankfurt, what it costs in Heidelberg. That is no problem. Frankfurt is expensive, Mannheim is cheaper, Heidelberg is in the middle."* (TP 03, answer: I can without problems)

- *"I have a house and know how many square meters that is, but the other one no. In the newspaper, I can understand that. Often there are certain square meters for apartment rentals. I understand that, but how much it should cost and how expensive the real estate agent is, I have never dealt with that."* (TP 11, answer: I cannot)

These two people think of costs that may be incurred for rental housing, but not of illustrations of price developments and their interpretation.

In contrast, the following test persons, for example, refer to concrete statistical information that may contain images. Here it becomes clear that persons have very different associations.

- *"We had this once in an Excel course with bar charts or something and I never knew what to get out of it, honestly."* (TP 05)
- *"This is again so that it is not commonplace. When you look at something like this, you first have to come in and understand what the axes mean and that's what I find the certain difficulties."* (TP 08)
- *"A coordinate system with an x and y axis and there you can see the development. I can also interpret it."* (TP 09)
- TP 12: *"I haven't done that yet. Maybe I could, I can't tell you."*
- CI: *"What if it was about a diagram in the newspaper?"*
- TP 12: *"I probably could. But I was thinking about big plans and calculations etc."*
- *"You'll have to get your head into it. Then there are circles. Then it says what costs what. But I don't deal with that in the same way."* (TP 13)
- *"I thought of a cake like this [pie chart]. I can read that."* (TP 16)

For the evaluation of this item it is of particular relevance whether the test persons perceive the activity in the sense of "understand and interpret" according to the actual wording. The above quotations show that they correctly refer to the reception and not to the active creation - as in item f).

Question Topic:

Job and career/ Job situation & professional activity

Construct:

Self-assessment of everyday mathematical competence

Item Text:

f. Summarize or display information and data from different sources in tables or graphics.
[Informationen und Daten aus unterschiedlichen Quellen in Tabellen oder Grafiken übersichtlich zusammenfassen oder darstellen.]

Recommendations:

The item contains several stimuli and is complexly formulated. Many test persons have no concrete idea what it is all about. Therefore the formulation should be simplified, e.g. like this:

"Create your own tables or graphics to summarize or illustrate information from different sources"

["Eigene Tabellen oder Grafiken erstellen, um Informationen aus unterschiedlichen Quellen zusammenzufassen oder zu veranschaulichen"]

Findings:

The full scale width is also used for this item. A total of eight test persons state that they can summarize or display information and data in tables and graphics, six persons can do so with certain difficulties, three with great difficulties and three test persons state that they cannot do so.

When asked, twelve test persons (TP 01, 05, 06, 07, 08, 09, 14, 15, 16, 17, 19, 20) stated that they had thought of creating tables or graphics themselves when answering:

- *"Because I had to work with illustrations and statistics for my final papers in my student days, or I had to create one myself. Then this goes along with the fact that I have to present information in illustrations."* (TP 09)
- *"I always enjoy doing that. Take stock of who has come to me in practice and I also create graphics myself."* (TP 17)

The other eight test persons (TP 02, 03, 04, 10, 11, 12, 13, 18), on the other hand, refer to understanding tables and graphics, i.e. merely receiving them and not actively creating them. *"If you are busy reading something like this every day. General graphics and statistics."* (TP 13)

In general, it is noticeable that the test subjects rarely refer to concrete information or data that are to be summarized or presented, but rather mostly make generalized statements. A total of nine persons (TP 01, 02, 03, 10, 11, 12, 13, 14, 16) state that they have great or certain difficulties with it or are unable to do so because they are not concerned with it or are simply afraid of it:

- *"I would have to deal with everything first. Think about it for a moment, but then it should work out."* (TP 01, answer: certain difficulties)
- *"I am missing an example here. I cannot answer, because there is no example to take away my fear. Then the question wouldn't be so bad either."* (TP 10, Answer: great difficulties)
- *"Too many tables and graphics. So I assumed directly that I couldn't do it."* (TP 12, Answer: I cannot)
- *"That sounds so complicated and that's something I don't really like to do. It sounds complicated and you really have to think about what is meant by that."* (TP 16, Answer: certain difficulties)

Those test persons (N=8) who state that they can easily master this everyday mathematical activity think of graphics, illustrations or the presentation of statistics in tables:

- *"For example, surveys in the university, you also have to present them in tabular form."* (TP 08)
- *"For example, I was thinking about complex Excel spreadsheets."* (TP 19)

While in items a)-e) an example is given of what is meant by the everyday thematic activity described above, no specification is given here. Apart from test person 10, there is no indication that this omission leads to problems in answering. On the other hand, it is not always understandable why twelve test persons choose answers ranging from "I cannot" to "I can but with certain difficulties". This kind of answering behavior can be based on the fact that they do not deal with the subject matter in everyday life or have little practice, perhaps they do not even need it in everyday life or it is unclear to them what the item is aimed at.

The use of the term "or" in the phrase "tables or graphs" is not perceived as problematic here, rather it appears as a non-exclusive disjunction, i.e. an inclusive "or". This enables the test persons to refer to one of the two aspects or both together. No test person indicates to answer differently for the creation of tables than for graphics.

Question Topic:

Job and career/ Job situation & professional activity

Construct:

Self-assessment of everyday mathematical competence