

# Zambia

LOCALISED VERSION

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# BANUCA

**Basic Numerical and Calculation Abilities**

## User's Guide

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Mrs A Nzala:	HQs/ Ministry of Education
Ms Beatrice Matafwali:	EPSSE, UNZA Assessment Centre
Mrs EM Sifunkwe:	CDC/ Ministry of Education
Ms H Alasuutari:	ESSP III North-Western Province, Associate Advisor
Mr P Siltakorpi:	ESSP III Western Province, Associate Advisor
Mr P Muhau:	ESSP III Western Province, Counterpart to the Associate Advisor

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Pekka Räsänen  
International Consultant  
ESSP III project  
- test development  
- data analysis  
- guide and test booklet

Michael M Chilala  
Local Consultant  
ESSP III project  
- data collection  
- assistant training  
- local language translations

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## Introduction

This test of **BA**sic **NU**merical and **CA**lculati**ON** Abilities (**BANUCA**) is test battery for assessing basic numerical and calculation abilities. Behind of the test development is years of work. Many of the ideas of the tasks owe to ideas of the researchers in the field and to the international co-operation done in the test development.

The test is developed for children at grades 1 to 4. It is developed for group assignment and for screening difficulties in basic numeracy. However, it can also be used for older persons with special needs. In these cases, it is recommended to do the assessment individually. At the moment there are no normative information about the performance levels of older subjects, thus the analysis has to be done more qualitatively than quantitatively.

The test battery does NOT give an estimate of the examinee's formal (school) mathematical skills. The tasks in the test battery give an estimate of the person's skills in number related abilities, which form the grounds for learning mathematics at school and as well grounds for mathematical skills needed in daily living.

The Banuca contains nine tasks. These nine tasks have been divided into two short-forms for children at different grade levels. See page 8 for detailed information.

When an examinee performance in the Banuca test is poor, then an individual, more detailed assessment is required. The Banuca alone is not enough for a reliable diagnosis. In this User's Guide some guidelines for further assessment and practice are given.

## General description

This test of **BA**sic **NU**merical and **CA**lculati**ON** Abilities (**BANUCA**) is constructed from nine different tasks. The tasks have been developed to cover as wide an area of basic numeracy as possible. It is meant to be used for assessment individually or in group settings.

### Languages

The Zambian localised version of Banuca User's Guide is written in English. Thus all information, including instructions, can be found in English. However, the instructions have been translated into seven local languages spoken in Zambia. These are the languages used officially at schools in Zambia:

- Chitonga
- Cinyanja
- Icibemba
- Kiikaonde
- Lunda
- Luvale
- Silozi

In the cover pages of the User's Guide you can find which local language version you have. The instructions in one local language are presented in the Appendix at the end of the User's Guide.

**Tools needed**

Each examinee is given his/her own test booklet and a pencil. The examiner needs this User's Guide and a stop-watch (or a clock) for timing the tasks.

**Timing**

The examiner controls how the examinees do the tasks. They are not allowed to proceed at their own speed from task to task; they have to wait for the next instructions before proceeding. Each task has a maximum time limit. The time limit is written in the instructions of each task.

In group assignment situations, the examiner should pay extra attention to the given time limits of each task.

If the examinee(s) is/are able to do a task faster than the maximum time limit, the examiner can finish the task before the maximum time limit and proceed to the next task.

**Time requirements**

The maximum time for doing the tasks makes a total of 40 minutes. Depending on the age of the examinees 20-40 minutes should be reserved for instructions and other guidance of the examinees.

**About the instructions**

Every task contains word-to-word instructions and in each task there are examples or a drawing to help to understand what is required in the task. The tasks are made as self-explanatory as they can be. However, a basic level of understanding of spoken language is required from the examinees to be able to follow the instructions.

Make sure that the examinees follow the instructions. If you notice that some of the examinees did not understand the instructions, repeat them slower and show carefully the purpose of the task using the example items. If you notice that an examinee has misunderstood the instructions or has not understood the instructions even though all others in the group start to solve the items in the task successfully, you should repeat the instructions to that examinee individually without disturbing the other examinees.

**Preparation**

As an examiner, please study the instructions carefully in advance, so that you can present them to the examinees correctly and fluently without sudden slow down or disruption. It is important to present the instructions word for word as they are in the Users' Guide to guarantee that each examinee has been given the same tasks with the same instructions.

Note that differences in instructions may cause differences in results, using other words or guiding the examinee differently, can make the results incomparable to the results of the normative sample presented here.

### The Examiners responsibilities

The examiner has two main responsibilities during the assessment:

1. S(he) is obligated to follow the instructions of the Test User's Guide to guarantee that the results between examinees are comparable.
2. S(he) is responsible to make sure that each examinee has circumstances and a possibility to perform as well as they can.

### General rules of using BANUCA

The steps to go through the whole assessment are presented here in this User's Guide. Before you go through them, it is important to learn the basic rules of standardised assessment by heart. These rules concern all tasks and are as follows:

1. Present the tasks exactly as introduced in this User's Guide.
2. If you need to repeat the instructions to ensure that each examinee has heard and understood what to do in the task, follow the instructions from the User's Guide carefully and if there is need, repeat the original instructions without any additions.
3. Never give any verbal or nonverbal indication to the examinees about the correctness or incorrectness of their responses.
4. Encourage the examinees to work hard and concentrate carefully to each task and each item. However, be aware not to give any feedback about the success in the tasks. E.g. "*You are doing good*" may give the examinee a wrong understanding that (s)he has done all items correctly.
5. The items in the tasks are ordered from easier to more difficult ones. Therefore, at some point, the examinee may reach the limit of their skills or understanding.
  - a. In multiple choice tasks encourage the examinee to continue working even though (s)he is not sure about the correctness of her/his answers. Do not advise the examinee to guess, but to "*mark the option which you think looks to you or you think it might be correct even though you are not absolutely certain*".
  - b. In the production tasks encourage the examinee to try the items which (s)he feels too hard for her/him. If the examinee does not want to continue even after encouragement, direct the examinee to "*recheck the items s(he) has already done*".

## Doing the assessment

The Banuca can be presented either individually or to a group. When presented to a group guarantee that each examinee has time enough to show their competence within the given time limits.

The group assignment may cause some practical problems. First, in group assignment it is more difficult to make sure that each examinee has understood the instructions. Follow carefully what the examinees are doing. If you notice that an examinee has misunderstood the instructions or has not understood the instructions at all, you should repeat the instructions to that examinee individually without disturbing the other examinees.

Secondly, in very heterogeneous groups, some examinees get through the items in a task much faster than others. In these situations those who have already done all items in the task may become frustrated and start disturbing those who are still trying to solve the questions. There are several solutions for this kind of situations:

- If possible, make sure in advance that the group is more homogeneous, i.e. using your “best guess”, organize the assessment to be done in smaller groups.
- Even though it is not recommended that the examinees do other things during the assessment, the examiner can use his/her own judgement in cases, where giving extra work for those who wait till others have solved the questions, causes less disturbance than continuous ordering them to be quiet. If extra activity is used, it has to be something which can be quickly given and starting or doing it does not disturb other examinees. For example simple drawing tasks to a clean paper suitable. Make sure that also these examinees continue with the assessment when you proceed to the next task.

### ***Tasks and the skills required in them***

The tasks in the Banuca require different number skills. In Table 1 the central skills required are shortly summarised.

Table 1. The tasks of the Banuca battery

<b>NR</b>	<b>TASK</b>	<b>SKILLS</b>
1	Comparison: dots	<ul style="list-style-type: none"> <li>• Concept of more</li> <li>• perceptual estimation</li> </ul>
3	Correspondence	<ul style="list-style-type: none"> <li>• Counting</li> <li>• One-to-one correspondence</li> <li>• Arabic numbers</li> </ul>
2	Single-digit addition	<ul style="list-style-type: none"> <li>• Counting 0-20</li> <li>• Arabic numbers</li> <li>• Addition</li> </ul>
4	Single-digit subtraction	<ul style="list-style-type: none"> <li>• Counting 0-20</li> <li>• Arabic numbers</li> <li>• Subtraction</li> </ul>
5	Writing numbers: number line	<ul style="list-style-type: none"> <li>• Arabic numbers</li> <li>• Counting with numbers above 20</li> <li>• Number system (10-base system)</li> <li>• Fine-motor skills</li> </ul>
6	Comparison: numbers	<ul style="list-style-type: none"> <li>• Arabic numbers</li> <li>• Number system</li> <li>• Visual attention and memory</li> </ul>

7	Matching spoken and written numbers	<ul style="list-style-type: none"> <li>• Verbal memory</li> <li>• Number system</li> </ul>
8	Calculation: multi-digit numbers	<ul style="list-style-type: none"> <li>• Fluent skills in single-digit calculations</li> <li>• Number system</li> <li>• Calculation algorithms</li> </ul>
9	Arithmetic reasoning	<ul style="list-style-type: none"> <li>• Reasoning</li> <li>• Fluent calculation skills</li> </ul>

### ***The three test batteries of Banuca***

The Banuca test battery contains nine different tasks. The tasks differ in how much skills and knowledge they require. The very first tasks (task 1 and 3) require understanding the very basic number related skills, particularly understanding the concepts of more and same, and the skills of counting and written Arabic numbers. In contrast, the most complex tasks (tasks 8 and 9) involve multi-digit calculations and the concept of additive relations. Consequently some of the tasks are very simple for older children, and almost all older children do them correctly, and some tasks contain items which are too difficult for younger children.

Therefore the Banuca consist of three different batteries which are meant for children at different ages and for children at different intellectual levels. There is a full battery, which contains all tasks and then there are two short-forms: A short-form for assessing basic number skills and a short-form for assessing arithmetic skills. If you do the full battery, you can also calculate the scores for short-forms. In Table 2 there are guidelines when to use the different batteries.

There are norms for each individual task, the two short-forms and for the full battery. When you get more experience in using Banuca, you can use different combinations of the tasks more freely and you learn which of the tasks to use in different situations and with different needs of children.

Table 2. The different batteries of the Banuca.

TASK	Full battery	Short-forms	
		Number skills	Arithmetic skills
Comparison: dots	X	X	
Single-digit addition	X	X	X
Correspondence	X	X	
Single-digit subtraction	X	X	X
Writing numbers: number line	X	X	
Comparison: numbers	X		X
Matching spoken and written numbers	X		
Calculation: multi-digit numbers	X		X
Arithmetic reasoning	X		



Table 3. When to use the different batteries of the Banuca.

<b>Battery</b>	<b>Use when</b>
Short-form Number skills	<ul style="list-style-type: none"> <li>• the examinee has less than two years of formal schooling (e.g. student of 1<sup>st</sup> or 2<sup>nd</sup> grade)</li> <li>• older children, when the examinee's intellectual level is low</li> <li>• older children, when the examinee has neurological disorders or impairments of perception (vision, hearing), which may have delayed cognitive development</li> </ul>
Short-form Arithmetic skills	<ul style="list-style-type: none"> <li>• the examinee has more than two years of formal schooling (e.g. student of 3<sup>rd</sup> grade or above)</li> <li>• the examinee's intellectual level is normal</li> <li>• time for the assessment is limited</li> </ul>
Full battery	<ul style="list-style-type: none"> <li>• the examinee has more than two years of formal schooling (e.g. student of 3<sup>rd</sup> grade or above)</li> <li>• the examinee's intellectual level is normal</li> <li>• you have time enough for a more comprehensive assessment</li> </ul>

In an individual assessment you have a lot of possibilities to personalise the assessment. If you are not certain, which battery or tasks to use in the assessment, you can start with the tasks in the Short-form for Number skills (tasks 1-5). If the examinee's performance in these tasks is average or above average compared to the normative samples results, continue with the rest of the tasks in Short-form for Arithmetic skills (Tasks 6 and 8) and if you have time enough, do the last two tasks (Tasks 7 and 9) for a comprehensive assessment.

The Banuca has been developed for group assignment. Thus no tasks which require verbal response are included in the battery. In an individual assessment, use also other tasks which you give only verbally and tasks where you require the examinee to respond verbally.

## INSTRUCTIONS

### Page 1. Personal information

Personal information has been divided into two sections. The first section, indicated with a solid square and capital letters will be filled by the examinee and the second by the examiner.

Lead the examinees in completing the following details on the front cover of the test booklet:

- Name,
- Sex,
- Grade,
- Age in years

The examiner fills the rest of the information

- Date of Birth of the examinee,
- Date of the assessment,
- Examiner's name
- Name of the School or other institution,
- The location of the school (place, city)
- District

Hint 1:	You should write the common information on the blackboard
Hint 2:	If the examinee(s) does / do not know how to write, ask him/her/them to write the as many letters of his/her/their name (s) as they know.

When the examinees have completed filling in their personal information,

1. Tell them to put the pencils on the table.
2. Tell them to open the test booklets and show them how to turn over the cover page in a way that only page 2 is visible.
3. Check that everyone has only page 2 open.

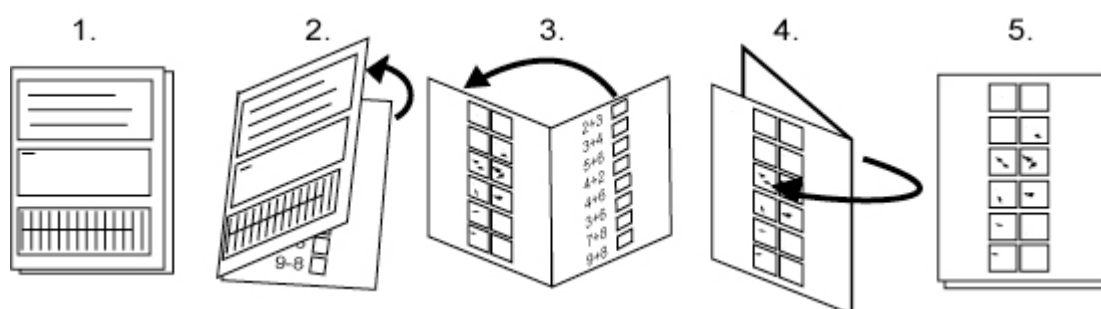


Figure 1. How to turn the test booklet pages.

**Page 2 - Task 1: Dot Comparison**

Reminder:	Make sure everyone has page 2 ready.
-----------	--------------------------------------

Each page contains a picture which you can use with younger examinees to ensure that they have found the right page.

Page hint:	 a bird
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Examiner says to the examinees:

“Do not touch your pencil before I say so. Listen carefully!  
Here, in the shaded area, (*Show the place with your finger to the examinees’ from your own booklet*) you see two examples where there are two boxes with a different number of dots. The box with more dots has been crossed. (*Show*) Similarly, from the following pairs of boxes, cross the box which has more dots. Do not count the dots, cross the box which looks like having more dots. You can take your pencil, and start.”

**Timing: max 3 minutes** (if everyone is ready earlier, continue to the next task)

After exactly 3 minutes Examiner says to the examinees:

Very good, now put your pencil on the table and turn next page.

**Page 3 - Task 2: Single Digit Addition**

Reminder:	Make sure everyone has page 3 ready.
-----------	--------------------------------------

Page hint:	 a mouse
------------	---

Examiner says to the examinees:


“Do not take your pencil before I say so. Listen carefully!  
Here you see (*Show the place with your finger to the examinees from your own booklet*) two numbers and a plus sign (+), which means you have to add these numbers together. When you have 2 and you add 1, it makes 3 (*Show*). Write the answer into the answer box. Try to solve as many tasks as you can. Now you can get your pencil and start working the tasks.”

**Timing: max 4 minutes**

After exactly 4 minutes Examiner says to the examinees:

Very good, now put your pencil on the table and turn next page.

**Page 4 - Task 3: Correspondence**

Reminder:	Make sure everyone has page 4 ready.
Page hint:	 a ball

Examiner says to the examinees:


“Do not get your pencil before I tell you to do so. Listen carefully!  
In this task your job is to cross the number that matches with the amount of dots. Look at the first example here. (*Show the example from your own booklet*). Here, there are two dots and from the numbers, the number “two” has been crossed. Now you can take your pencil and start crossing from the rest of the tasks the number which is the same as the amount of dots.

**Timing: max 4 minutes**

After exactly 4 minutes Examiner says to the examinees:

Very good, now put your pencil on the table and turn next page.

**Page 5 - Task 4: Single Digit Subtraction**

Reminder:	Make sure everyone has page 5 ready.
Page hint:	 a flower

Examiner says to the examinees:


“Do not get your pencil before I say so. Listen carefully!  
Here you see (*Show the place with your finger to the examinees from your own booklet*) two numbers and a sign minus (-) which means you have to subtract the last number from the earlier. When you have 2 and you take a way 1, it makes 1 (*Show*). Write your answers into the answer boxes (*Show*).  
Now you can take your pencil. Try to solve as many tasks as you can.

**Timing: max 4 minutes**

After exactly 4 minutes Examiner says to the examinees:

Very good, now put your pencil on the table and turn next page.

**Page 6 - Task 5: Writing numbers: Number Line**

Reminder:	Make sure everyone has page 6 ready.
Page hint:	 an ant

Examiner says to the examinees:


“Do not get your pencil before I say so. Listen carefully!  
Here you see two successive numbers: two and three. (*Show the place from your own booklet*). After two and three comes four. Similarly, write down the number which comes next in the number line. Start from the first task. Five, six, write down, what comes next. Now you can get your pencil and start.

**Timing: max 4 minutes**

After exactly 4 minutes Examiner says to the examinees:

Very good, now put your pencil on the table and turn next page.

**Page 7 - Task 6: Number Comparisons**

Reminder:	Make sure everyone has page 7 ready.
Page hint:	 an elephant

Examiner says to the examinees:


“Do not get your pencil before I say so. Listen carefully!  
Here are lines with numbers. (*Show the place from your own booklet*). Find the biggest number from each line and cross it. Look at the example. (*Show the place from your own booklet*) Here, there are numbers 2, 4, 1 and 3. Four is the biggest number, so it is crossed. Now you can get your pencil and start the task.”

**Timing: max 4 minutes**

After exactly 4 minutes Examiner says to the examinees:

Very good, now put your pencil on the table and turn next page.

**Page 8 - Task 7: Matching Spoken and Written Numbers**

Reminder:	Make sure everyone has page 8 ready.
Page hint:	 a dog

Examiner says to the examinees:

“Do not get your pencil before I tell you to do so. Listen carefully! Here there are lines with numbers. (*Show the place from your own booklet*). I will call out one of the numbers from each line. Your job is to find and cross the number that I call out. I will give you time to cross the number before I call out the number from the next line. Look at the example in the first line. I call out “four”. Find number four. Four has been crossed. Are you ready? Take your pencils. From the next line cross number “nine”. nine.”

**The numbers to call out are:**

Reminder:	Remember to say the numbers slowly and clearly and repeat each number once). You say “From the next line cross number XX, XX”.
-----------	--

Hint:	If the examinees seem confused from which line to search, you can use the letter in front of the line as a guide: “From the line which starts with letter Y ( <i>you can write the letter on the blackboard</i> ), cross number XX.
-------	--


**Timing: Give examinees 20 seconds time for each item.**

9	nine
18	eighteen
25	twenty five
73	seventy three
102	one hundred and two
504	five hundred and four
4 012	four thousand twelve
10 004	ten thousand four

After presenting the last number and 20 seconds answer time, Examiner says:

Very good, now put your pencil on the table and turn next page.

**Page 9 - Task 8: Multi-Digit Calculations**

Reminder:	Make sure everyone has page 9 ready.
Page hint:	 a bike

Examiner says to the examinees:


“Do not get your pencil before I say so. Listen carefully!  
Here you see calculations with smaller and bigger numbers (*show the place with your finger to the examinees from your own booklet*) Try to solve as many tasks as you can. Look carefully whether the task is an addition or a subtraction. Write your answers into the answer boxes.  
Now you can take your pencil and do the calculations.

**Timing: max 6 minutes**

After exactly 6 minutes Examiner says to the examinees:

Very good, now put your pencil on the table and turn next page.

**Page 10 - Task 9: Arithmetic Reasoning**

Reminder:	Make sure everyone has page 10 ready.
Page hint:	 a cat

Examiner says to the examinees:

“Do not get your pencil before I say so. Listen carefully!  
In the left side, (*show the place with your finger to the examinees from your own booklet*), there are three numbers, which form a series. On the other side, (*show the place with your finger*) there are options from which only one is the right one to continue that series.  
Look at the first line. The first line starts one, two, three. From the options, number four is the best one to follow one, two, three.  
Cross the number, which you think fits best to continue the series. Now you can get your pencil and start working.”

**Timing: max 8 minutes**

After 8 minutes, examiner says to the examinees:

“Put your pencil on the table. This exam has ended. Thank you for your work and effort.”

# Calculating the scores

## Basic rules for scoring

Calculating the scores has been made simple.

1. Give the examinee one point from each correct answer.
2. Calculate together the points for each task.
3. Mark the total number of points from each task to the scoring key presented in the test booklets cover page.
4. The scoring key indicates the level of performance with a three level scale which is indicated with shades of grey:

Dark grey	<i>average or above average performance</i>
Light grey	<i>satisfactory performance</i>
White	<i>of concern: further analysis recommended</i>

5. There is a separate scale for each grade level.
6. In addition to the scores of each task there are three summary scores for short-forms and the total score from the whole test battery which you can calculate.

If the examinees scores are at the lowest level (white: of concern), it indicates that the examinee may have difficulties understanding basic numerical information or his/her calculation skills are beyond the expected at that age or grade level. A detailed analysis of his/her mathematical skills is required. Guidelines for such an assessment are given in the section “Guidelines for interpretation and individual assessment”.

	Points	Mark scores			
		1	2	3	4
Dot Comparison	5	0-3	4	5-6	
Addition	8	0-3	4	5-6	
		3-4	5	6	
		4-4	5	6	
		0-2	3-4	5-8	
Correspondence	6	0-4	5	6	
		0-4	5	6	
		0-4	5	6	
		0-1	2-3	4-6	
Subtraction	4	0-4	5	6	
		0-4	5	6	
		0-1	2-3	4-8	
		0-2	3-4	5-8	
Number-line	5	0-3	4	5-8	
		0-4	5	6	
		0-1	2-3	4-10	
		0-2	3-4	5-10	
Number Comparison		0-3	4-6	7-10	
		0-4	5-6	7-10	
		0-1	2	3-8	
		0-1	2-3	4-8	
Spoken Numbers		0-2	3-4	5-8	
		0-3	4	5-8	
		0-1	2	3-10	
		0-1	2-3	4-10	
Calculations		0-2	3-4	5-10	
		0-3	4-5	6-10	
		0-1	2	3-15	
		0-1	2-3	4-15	
Arithmetic Reasoning		0-2	3-4	5-15	
		0-3	4-5	6-15	
		0-5	6-14	15-36	
		0-15	16-25	26-36	
Number Skills		0-23	24-30	31-36	
		0-26	27-31	32-36	
		0-3	4-9	10-36	
		0-12	13-19	20-36	
Arithmetic Skills		0-18	19-24	25-36	
		0-22	23-27	28-36	
		0-9	10-20	21-79	
		0-23	24-36	37-79	
Total Score		0-36	37-46	47-79	
		0-42	43-51	52-79	
		G	OF CONCERN	SATISFACTORY	GOOD

	Summary scores		
	Number Skills	Arithmetic Skills	Total Score
Dot Comparison	5		
Addition	8		
Correspondence	6		
Subtraction	4		
Number-line	5		
Number Comparison			
Spoken Numbers			
Calculations			
Arithmetic Reasoning			
Sum	28		

Notes: Calculate summary scores



### Calculating the summary scores

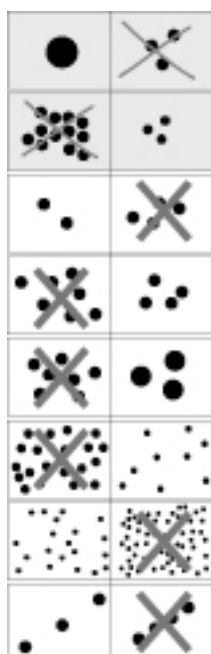
To calculate the summary scores you simply add together the number of correct items from each task which belongs to the battery.

The table below illustrates how you do it

TASK	Full battery	Short-forms	
		Number skills	Arithmetic skills
Comparison: dots	6	6	-
Single-digit addition	8	8	8
Correspondence	6	6	-
Single-digit subtraction	8	8	8
Writing numbers: number line	8	8	-
Comparison: numbers	10	-	10
Matching spoken and written numbers	8	-	-
Calculation: multi-digit numbers	10	-	10
Arithmetic reasoning	15	-	-
<b>Sum of above figures</b>	<b>79 / 79</b>	<b>36 / 36</b>	<b>36 / 36</b>

## Correct answers for the tasks

### Task 1 - Comparison: dots



### Task 3 - Correspondence

	4	<del>2</del>
	11	1
	7	212
	23	<del>5</del>
	5	<del>X</del>
	22	14
	55	9
	<del>X</del>	46
	<del>X</del>	232
	52	6
	352	82
	13	<del>X</del>
	351	80
	<del>X</del>	53
	42	<del>X</del>
	204	31

### Task 2 – Single-digit addition

$2 + 1 = 3$
$1 + 9 = 10$
$2 + 3 = \mathbf{5}$
$3 + 4 = \mathbf{7}$
$2 + 7 = \mathbf{9}$
$5 + 3 = \mathbf{8}$
$6 + 5 = \mathbf{11}$
$2 + 9 = \mathbf{11}$
$7 + 6 = \mathbf{13}$
$9 + 7 = \mathbf{16}$

### Task 4 – Single-digit subtraction

$2 - 1 = 1$
$5 - 1 = 4$
$3 - 2 = \mathbf{1}$
$7 - 4 = \mathbf{3}$
$9 - 2 = \mathbf{7}$
$8 - 5 = \mathbf{3}$
$14 - 4 = \mathbf{10}$
$11 - 8 = \mathbf{3}$
$15 - 6 = \mathbf{9}$
$13 - 7 = \mathbf{6}$

**Task 5 - Writing numbers: number line**

2	3	4
5	6	7
9	10	<b>11</b>
18	19	<b>20</b>
38	39	<b>40</b>
53	54	<b>55</b>
98	99	<b>100</b>
258	259	<b>260</b>
1470	1471	<b>1472</b>

**Task 6 - Comparison: numbers**

2	3	<b>7</b>	6
<b>11</b>	9	6	3
14	<b>17</b>	11	9
19	27	<b>31</b>	22
46	<b>60</b>	57	18
24	<b>114</b>	96	78
<b>411</b>	297	108	87
536	<b>546</b>	456	365
<b>1202</b>	1021	1089	1119
6789	<b>12345</b>	6708	10067

**Task 7 - Matching spoken and written numbers**

25	<b>9</b>	8	12	21
28	88	180	<b>18</b>	16
22	19	61	<b>25</b>	35
703	713	37	307	<b>73</b>
200	1200	1002	<b>102</b>	2100
5004	54	405	0540	<b>504</b>
40012	<b>4012</b>	4120	400012	412000
<b>10004</b>	100004	104	104004	104000

**Task 8 - Calculation: multi digit numbers**

10	+	15	=	<b>25</b>
18	-	10	=	<b>8</b>
28	-	20	=	<b>8</b>
37	+	20	=	<b>57</b>
100	-	10	=	<b>90</b>
<b>6</b>	-	4	=	2
100	+	104	=	<b>204</b>
502	-	498	=	<b>4</b>
6608	-	<b>6008</b>	=	600
<b>2825</b>	-	805	=	2020

Task 9 - Arithmetic reasoning						
5	4	3	1	10	<b>2</b>	0
7	8	9	6	<b>10</b>	12	13
5	10	15	1	25	<b>20</b>	18
3	4	5	8	<b>6</b>	4	7
18	17	16	11	51	5	<b>15</b>
30	45	60	85	66	<b>75</b>	70
27	28	29	21	13	210	<b>30</b>
62	51	40	31	20	73	<b>29</b>
3	6	9	10	<b>12</b>	15	7
97	98	99	<b>100</b>	101	110	109
3	5	7	14	10	8	<b>9</b>
20	16	12	<b>8</b>	4	2	1
28	21	14	0	<b>7</b>	10	8
8	11	14	35	22	<b>17</b>	16
9	7	5	2	1	<b>3</b>	4

## Guidelines for interpretation and individual assessment

These guidelines present ideas, how to proceed from a standardised assessment with the BANUCA to an individual non-standardised assessment. A detailed non-standardised assessment put emphasis on each individual's unique personality, skills, abilities and disabilities. There is no constant way of doing a clinically oriented non-standardised assessment. The only basic rule is: *to aspire after objective information for understanding the difficulties the examinee has in learning, so that there would be more possibilities to meet the examinee's special needs.*

It is always important to analyse in detail examinees that have performed poorly in the standardised assessment. Best way to do this further analysis of number skills is to do it individually, or with a group of two or utmost three examinees at a same time. If you use larger groups of examinees, you can not do the tasks properly for each examinee and your possibilities to do reliable observations are decline.

These guidelines contain a check list of questions for each task in the Banuca and illustrations how you can search for the causes for poor performance in the number skills measured.

The questions are ordered in a sequence for each task to help you to rule out one-by-one different factors which may have caused the examinees difficulties with the Banuca task. Thus it is recommended that you go through questions in the order they are presented. However, the more experienced you become, the more flexible with the individual assessment you can be.

**Note.** Remember to compare the task requirements to the schooling history of the examinee. Do not ask questions which are more difficult than the items the examinee has been introduced at school or has had other opportunities to master them.

### Materials recommended for the individual assessment:

- a pencil, paper,
- wooden sticks, (about 50, 2-3 about 20 cm, 2-3 about 15 cm and the rest about 10 cm long).
- small stones, with a diameter about 2-3 cm (about 50, about the same size, preferable different colours or some of them painted) + 2-3 larger stones with a diameter 5-6 cm
- 8 common objects from the examinee's environment or school class (piece of chalk, pencil, scissors, button, notebook, wrist watch, bracelet, etc.)
- if available, wooden beads with holes and pieces of string: (thread the beads on a string to make chains of 2 to 10 beads). Make two chains of each amount and two additional chains with 10 beads and one with 20 beads. Use colour to indicate groups of fives. (o-o-o-o-o-**o-o-o-o-o**-o-o-o-o-o-**o-o-o-o-o**-o-o-o-o-o-**o-o-o-o-o**)

## 1. Task 1- Comparison: dots

- 1.1. *Does the examinee understand the instructions of the task?*
  - 1.1.1. Repeat the instructions and show clearly with your finger where to attend.
  - 1.1.2. Explain the instruction with your own words. Analyse the examples together with the examinee.
- 1.2. *Does the examinee understand concepts “more”, “less”, etc.?*
  - 1.2.1. Ask the examinee to do comparisons (show options)
    - which is longer/shorter (two sticks, trees)
    - who is taller (he/she vs. you)
    - which is bigger/smaller (two stones, )
    - who is older (he/she or you; he/she or his/her mother/grandmother)
    - who has more/less (share sticks or stones between you and the examinee, use only small quantities 1-3, 2-4)
- 1.3. *Does the examinee have difficulties with vision?*
  - 1.3.1. Check, how far the examinee can see letters/numbers you write on the blackboard
  - 1.3.2. Check, how well the examinee can recognise numbers or letters from a book. Ask the examinee to point to a certain letter or number in a word or string of numbers.
  - 1.3.3. Check, can the examinee recognise common pictures he/she knows from a book
- 1.4. *Does the examinee have visual-perceptual difficulties or difficulties with visual attention?*
  - 1.4.1. Put common objects (objects the examinee knows) on the table, ask the examinee to point one of objects, start with five objects, add up to 8 if he/she is successful, and remove if the examinee fails. Change the position of the objects after each question.
  - 1.4.2. Put a group of stones or sticks on the table, ask the examinee to point an object of certain colour he/she knows or the one that is bigger/longer than the others.
  - 1.4.3. If the examinee has passed question 1.2., ask who has more/less with large quantities. Use large differences between the quantities, 2-10, 5-10, 10-20, and 15-30. Share the sticks or stones of a same size between you and the examinee. Do not count the sticks or stones in front of the examinee: The idea of the task is to make perceptual estimation, not to calculate.
- 1.5. **Note:** Be careful in assessing and making interpretations about difficulties with vision, visual-perceptual difficulties and difficulties in naming common objects (i.e. word finding problems). If you suspect that any of these difficulties could be the reason for poor performance, always when possible, consult a specialist.

## 2. Task 3 - Correspondence: matching quantity to Arabic numbers

- 2.1. *Does the examinee understand the instructions of the task?*
  - 2.1.1. Repeat the instructions and show clearly with your finger where to attend.
  - 2.1.2. Explain the instruction with your own words. Analyse the examples together with the examinee.
- 2.2. *Does the examinee know the counting sequence*
  - 2.2.1. Ask the examinee to count aloud (stop if reaches 32)
  - 2.2.2. Ask the examinee which number comes after 3, 5, 10, 15, 19, and 22
  - 2.2.3. Ask the examinee to count with tens (10-20-..., stop if reaches 90)
- 2.3. *Does the examinee know the one-to-one correspondence and cardinal value*
  - 2.3.1. Ask the examinee to show 3, 5, 8 and 10 with fingers
  - 2.3.2. Ask the examinee to count the amount of stones or sticks (use 3, 6, 9 and 12). After the examinee has counted, confirm his/her understanding with a question “how many there were all together” with each amount)
- 2.4. *Does the examinee know Arabic numbers*
  - 2.4.1. Show the examinee numbers and ask him/her to name them (3, 7, 10, 12, 16, 25)
  - 2.4.2. Ask the examinee to write numbers (2, 4, 8, 15, 21, 35) from dictation
- 2.5. *Does the examinee understand the correspondence between quantity and Arabic numbers*
  - 2.5.1. Show the examinee written Arabic numbers without reading them aloud and ask he/she to indicate the quantity with fingers (2, 5, 8, 10)
  - 2.5.2. Show the examinee groups of stones, bunches of sticks or strings of beads. Tell that one group, bunch or string contains 10 stones, sticks or beads depending on the material.
    - show 20, and ask how many stones, sticks or beads there are altogether
    - if correct, ask the examinee to write the number
    - continue with 30, 50 and 70
  - 2.5.3. Add ones to the task 2.5.2. and repeat the questions with 21 (always use groups of tens, e.g.  $21=10+10+1$ ), 25, 35, 42 and 57

## 3. Task 2- Calculations: single-digit addition

- 3.1. *Check, that the examinee performs well in the Task 1 (Comparison-Dots)*
- 3.2. *Check, that the examinee performs well in the Task 3 (Correspondence)*
- 3.3. *Does the examinee understand the instructions of the task?*
  - 3.3.1. Repeat the instructions and show clearly with your finger where to attend.
  - 3.3.2. Explain the instruction with your own words. Analyse the examples together with the examinee.
- 3.4. *Does the examinee understand the concept of addition?*
  - 3.4.1. Ask the examinee to calculate together small groups of sticks, stones or beads. (1+1, 2+3, 4+3)
    - “You have one, and then I give you one more. How many you have now/all together?”
  - 3.4.2. Ask the examinee to calculate verbally presented tasks (2+1, 3+3, 4+2)
    - “If you have two and I give you one more, how many you would you have all together?”

- 3.5. *Does the examinee understand the +-sign?*
- 3.5.1. Ask the examinee what the +-sign means.
  - 3.5.2. Ask the examinee to give an example of a task where +-sign is used.
- 3.6. *Analyse the errors in calculations and the strategies the examinee uses*
- 3.6.1. Give the examinee the tasks in the Banuca without requirements to write down the answer and observe the errors and the strategies in each item.
  - 3.6.2. **Note.** There are four main strategies in single-digit addition. The more immature the strategy, the more error-prone it usually is
    - count all -strategy (the examinee counts everything with fingers:  $3+2=1,2,3+1,2$  equals  $1,2,3,4,5$ )
    - count on- strategies (the examinee starts from the first or the larger number and counts only the rest:  $3+2=3+4,5$ )
    - composition strategy ( $5+6=5+5+1=10+1=11$ )
    - direct retrieval from memory
    - instruction should support the examinee to develop stepwise from more immature strategy to a more developed
- 3.7. *Check, whether the examinee remembers all written Arabic numbers*
- 3.7.1. Ask the examinee to write numbers from 1 to 9
- 3.8. *Check, whether the examinee has difficulties in fine motor production?*
- 3.8.1. go to question 2.4.2., if very poor performance then
  - 3.8.2. Ask the examinee to write down the numbers in very large size (to a blackboard or on a paper). If that helps, ask the examinee to draw the same number again making it gradually smaller
- 3.9. *Check, if the examinee has difficulties in remembering the reading direction of written Arabic numbers (if reversal errors in the Banuca)*
- 3.9.1. Write the same numbers which were reversed in Banuca correctly and reversed side-by-side and ask which is correct.
  - 3.9.2. Write two-digit numbers and ask which is a certain number (12-21, which one is 12; 19-91, which one is 91; 35-53 which one is 35)

#### 4. **Task 4- Calculations: single-digit subtraction**

- 4.1. *Check, that the examinee performs well in the Task 1 (Comparison-Dots)*
- 4.2. *Check, that the examinee performs well in the Task 3 (Correspondence)*
- 4.3. *Check, that the examinee performs well in the Task 2 (Addition)*
- 4.4. *Does the examinee understand the instructions of the task?*
  - 4.4.1. Repeat the instructions and show clearly with your finger where to attend.
  - 4.4.2. Explain the instruction with your own words. Analyse the examples together with the examinee.
- 4.5. *Does the examinee understand the concept of subtraction?*
  - 4.5.1. Ask the examinee to calculate together small groups of sticks, stones or beads. (2-1, 3-2, 4-1)
    - “You have two, and then I take away one. How many you have now/all together?”
  - 4.5.2. Ask the examinee to calculate verbally presented tasks (3-1, 3-2, 4-2)
    - “If you have three and I take away one, how many you would you have left/all together?”
- 4.6. *Does the examinee understand the --sign?*
  - 4.6.1. Ask the examinee what the --sign means.
  - 4.6.2. Ask the examinee to give an example of a task where --sign is used.



- 4.7. *Analyse the errors in calculations and the strategies the examinee uses*
- 4.7.1. Give the examinee the tasks in the Banuca without requirements to write down the answer and observe the errors and the strategies in each item.
- 4.7.2. **Note.** There are more strategies in subtraction than in addition. However, the same basic rule as in addition is valid: the more the examinee is dependent on counting and using external aids (e.g. fingers) the more error-prone the solution strategy, at which level the examinee has developed, usually is.
- 4.8. *Check, whether the examinee has difficulties in producing written numbers*
- 4.8.1. Go to questions 3.7 to 3.9

## **5. Task 5- Writing numbers: number line**

- 5.1. *Check, that the examinee performs well in the Task 1 (Comparison-Dots)*
- 5.2. *Check, that the examinee performs well in the Task 3 (Correspondence)*
- 5.3. *Check, whether the examinee has motor difficulties in producing written numbers*
- 5.3.1. Go to questions 3.7 to 3.9
- 5.4. *Does the examinee understand the instructions of the task?*
- 5.4.1. Repeat the instructions and show clearly with your finger where to attend.
- 5.4.2. Explain the instruction with your own words. Analyse the example together with the examinee.
- 5.5. *Check, that the examinee knows the number syntax*
- 5.5.1. Ask the examinee to count verbally starting from certain number (stop when 3 successive numbers counted) (3, 11, 24, 100, 201, 18, 97).
- 5.5.2. Ask the examinee to point the ones, tens and hundreds from written numbers, “Which number indicates/shows ...” (Ask the one which is underlined 15, 28, 123, 358, 240, and 1024).
- 5.5.3. Ask the examinee to read written numbers (10, 1000, 100, 25, 321, and 405).
- 5.5.4. Ask the examinee to write numbers from dictation (12, 75, 100, 102, 1000, and 1205).

## **6. Task 6- Comparison: numbers**

- 6.1. *Check, that the examinee performs well in the Task 1 (Comparison-Dots)*
- 6.2. *Check, that the examinee performs well in the Task 3 (Correspondence)*
- 6.3. *Check, that the examinee performs well in the Task 5 (Number line)*
- 6.4. *Does the examinee understand the instructions of the task?*
- 6.4.1. Repeat the instructions and show clearly with your finger where to attend.
- 6.4.2. Explain the instruction with your own words. Analyse the examples together with the examinee.
- 6.5. *Check, if the examinee has difficulties in remembering the reading direction of written Arabic numbers*
- 6.5.1. Go to question 3.9.

6.6. Does the examinee understand how the number syntax of multi-digit numbers refers to the semantics of numbers

6.6.1. Go to questions 5.5.2-5.5.4.

6.6.2. Write down numbers on pieces of paper. Ask the examinee to put them in order from the smallest to the biggest.

- 2 – 4 – 6
- 6 – 8 – 9
- 2 – 9 – 11
- 11 – 9 – 17
- 15 – 17 – 28
- 28 – 123 – 100
- 123 – 240 – 321
- 240 – 358 – 1000
- 869 – 904 – 1024

## 7. Task 7- Matching spoken and written numbers

7.1. Check, that the examinee performs well in the Task 1 (Comparison-Dots)

7.2. Check, that the examinee performs well in the Task 3 (Correspondence)

7.3. Check, that the examinee performs well in the Task 5 (Number line)

7.4. Does the examinee understand the instructions of the task?

7.4.1. Repeat the instructions and show clearly with your finger where to attend.

7.4.2. Explain the instruction with your own words. Analyse the examples together with the examinee.

7.5. Check, that the examinee performs well in the Task 6 (Comparison-Numbers)

7.6. Check, if the examinee has difficulties in remembering the direction of written Arabic numbers (if reversal errors in the Banuca)

7.6.1. Go to question 3.9.

7.7. Check, that the examinee knows the number syntax

7.7.1. Go to questions 5.5. and 6.6

7.8. Check, that the examinee knows the transformation rules from spoken to Arabic numbers and vice versa.

7.8.1. **Note.** Zero: Everything which is written is not spoken: The zeros in Arabic numbers are not explicitly audible in spoken numbers (e.g. 102, zero is not said).

7.8.2. **Note.** The overwriting rule: Everything which is spoken is not written: “one hundred and two” is not written 100 and 2, or 1002, but 102. The Arabic numbers are written using overwriting the zeros.

7.9. Check, that the examinee does not have difficulties in hearing?

7.9.1. First make sure that the assessment environment is quiet. Place the examinee to a distance of 3-4 meters from you facing to right and then left from you (to compare the ears and to avoid lip reading). Ask the examinee to repeat the words you whisper. Use the examinee’s own language and only words he/she knows. Compare the loudness needed for hearing to the assessment situation.

- 7.10. *Check, that the examinee does not have auditory-perceptual difficulties or difficulties with auditory short-term memory?*
- 7.10.1. Say aloud words and sentences and ask the examinee repeat them aloud. Use the examinee's own language and only words which he/she knows and which are very common. Start with three short words, then ask three longer words, two short sentences and finally two longer sentences (e.g. "my dog is brown", "last week my neighbour's black dog chased my mother's white cat").
- 7.10.2. Ask the examinee to repeat number sequences with varying length. Use for example the digit span task in the BASAT (Ministry of Education, 2003).
- 7.10.3. Say aloud numbers and ask the examinee to repeat them (3, 9, 17, 26, 60, 114, 546, 1021, 2317, 10 264). Compare how long verbal strings the examinee can repeat with non-numerical words, number words and numbers.
- 7.11. **Note:** Be careful in assessing and making interpretations about difficulties with hearing, auditory-perceptual difficulties and examinee's difficulties in verbal short-term memory. If you suspect that any of these difficulties could be the reason for poor performance, always when possible, consult a specialist.

## **8. Task 8- Calculation: multi-digit numbers**

- 8.1. *Check, that the examinee performs well in the Task 2 (Addition)*
- 8.2. *Check, that the examinee performs well in the Task 4 (Subtraction)*
- 8.3. *Check, that the examinee performs well in the Task 6 (Comparison-Numbers)*
- 8.4. *Check, that the examinee performs well in the Task 7 (Spoken to Numbers)*
- 8.5. *Does the examinee understand the instructions of the task?*
- 8.5.1. Repeat the instructions and show clearly with your finger where to attend.
- 8.5.2. Explain the instruction with your own words. Analyse the examples together with the examinee.
- 8.6. *Has the examinee paid attention to the +- and –signs?*
- 8.6.1. If the examinee has incorrect answers which are correct answers to the other mathematical operation, ask the examinee to do the same items again.
- 8.7. *Does the examinee use immature calculation strategies, which often lead to errors?*
- 8.7.1. If the examinee solves multi-digit calculations with counting based strategies (see 3.6.2), especially with count-all strategy, it very often leads to errors which differ only with 1 or 2 from the correct answer. Besides, counting based strategies are very slow and demand a lot effort and work.
- 8.7.2. If the examinee uses vertically written calculation algorithms, analyse together with the examinee whether he/she remembers the carrying and borrowing rules.
- 8.7.3. Most of the items in the task can be solved, with the help of ten-base system and reasoning without doing multistage calculations. Using slower counting or algorithms for solving the tasks may take too much time and strength, that the examinee is able to solve only few items within the given time limit. To analyse this possibility, follow what kind of solution strategies the examinee uses and give more time than the six minutes of the standardised assessment.

- 8.8. *Does the examinee have specific problems with the three items where the missing information is not the answer?*
- 8.8.1. Check, whether the examinee understands the =-sign (equals, i.e. as much in both sides of the sign).
- 8.8.2. Check, whether the examinee understands the connections between addition and subtraction. Ask, how he/she can verify, if an addition or subtraction is calculated correctly.
- ( $3 - X = 1$  vs.  $3 - 1 = X$  vs.  $1 + X = 3$  vs.  $X + 1 = 3$ )

## 9. Task 9- Arithmetic reasoning

- 9.1. *Does the examinee understand the instructions of the task?*
- 9.1.1. Repeat the instructions and show clearly with your finger where to attend.
- 9.1.2. Explain the instruction with your own words. Analyse the examples together with the examinee.
- 9.2. The reasoning task requires many numerical skills. And because there are 15 tasks and only eight minutes time, these skills must be well learnt and effortless to perform. Therefore the task measures both the examinee's abilities to reason, and the examinee's basic numeracy and calculation fluency.
- 9.3. *Check, that the examinee performs well in the Task 2 (Addition)*
- 9.4. *Check, that the examinee performs well in the Task 4 (Subtraction)*
- 9.5. *Check, that the examinee performs well in the Task 5 (Number line)*
- 9.6. *Check, that the examinee performs well in the Task 6 (Comparison-Numbers)*
- 9.7. *Check, that the examinee performs well in the Task 7 (Spoken to Numbers)*
- 9.8. *Check, that the examinee performs well in the Task 8 (Calculations)*

