Republic of Zambia

Project Research for "Analysis of Challenges and Solutions for Improving Numeracy Competence in Zambia"

Project Completion Report

November 2021

Japan International Cooperation Agency

Hiroshima University

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Acknowledgement

This research is joint work in mathematics education between Hiroshima University and University of Zambia. Hiroshima University, Japan, had been sending its graduate students as mathematics and science volunteer teachers to basic schools in Zambia in collaboration with Japan International Cooperation Agency (JICA), and has been working together with the University of Zambia since 2002. Early in the collaboration, we noticed a serious problem of low performance of students in mathematics education. Learners consistently recorded extremely low performance in national and international assessments. Thus, many graduate students have been dealing with this problem. We had identified the root of the problem as counting-all strategy, but did not identify an intervention strategy to address this issue.

We got an opportunity to address the counting-all strategy in 2017. The JICA research project was initiated to tackle this challenge through development of the diagnostic assessment of students' numerical competence. We conducted a field research at schools twice, both in 2018 and 2019. As a result of this field research, we developed assessment and intervention tools, and conducted an intervention between pre and post surveys from March to June in 2021, due to one-year postponement of the final stage caused by the COVID-19 pandemic.

This research project was funded by JICA and its implementation was supported by JICA Zambia Office. We are grateful for their financial support and managerial guidance to enable this research.

We explained and asked permission from the Ministry of General Education to conduct a field research in ten schools in the Lusaka district, Lusaka province. Their understanding and arrangement enabled us to implement the field research efficiently. Ten schools, in which we conducted the research, realized the significance of this research and accommodated our activities flexibly considering the situation of the COVID-19 pandemic. We are grateful for their support.

We are very grateful to professors Joanne Mulligan and Michael Michelmore, Macquarie University, Sydney, Australia, who have developed a distinctive assessment approach called Patterns and Structure Assessment (PASA). We visited them in Australia in 2018 and 2019 to seek their comments on our approach and assessment tools. Professor Michelmore even visited us in Hiroshima. They understood the importance of this research and extended their professional support. We appreciate their professionalism and friendship.

We would like to express our gratitude to Prof. Norio Matsumi and Prof. Tsukasa Hirashima, our colleagues in Hiroshima University for their professional advices. Prof. Matsumi counselled us especially during the early stage of development of the assessment tools from a psychological perspective and advised to introduce a gadget and software to capture students' difficulties. Prof. Hirashima, an expert on artificial intelligence and CAI, introduced a computer software for automating the assessment procedure. This opened a new method for collecting data systematically.
Finally, I would like to convey my heartfelt gratitude to all members of the Zambian and Japanese teams. Their dedication to the research enabled us to execute this research despite of many difficulties.
We would also like to thank all who are related to implementation of this project. I hope that our effort opens a new possibility for this important and fundamental issue. We would like to continue our focus on how to develop "Evidence-based and Endogenous Curriculum Development" approach in mathematics education.

Takuya Baba
As a representative of JICA Zambia Research Project
November 30th, 2021

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Abbreviation

CDC	Curriculum Development Center
JICA	Japan International Cooperation Agency
MoGE	Ministry of General Education
PASA	The Pattern and Structure Assessment
SACMEQ	The Southern and Eastern Africa Consortium for Monitoring Educational Quality
TIMSS	Trends in International Mathematics and Science Study
ZSEP	Zambia Special Education Program

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Chapter 1 Project summary

（1）Country name

Republic of Zambia

（2）Project name

Analysis of Challenges and Solutions for Improving Numeracy Competence in Zambia

（3）Project duration

November, 2017 till November, 2021

（4）Background of the research project[1]

Since this is the final report on the research project (2018-2021), the description of research background in this section is based on the previous document (Baba et al., 2019). In 2015, the international community reached an agreement on "Sustainable Development Goals" to be achieved by 2030. These new international goals cover issues of conservation of environment and energy, and inclusive pre-primary, primary, secondary, tertiary, and vocational education. Quality improvement in these areas was part of the goals. This research project focuses on the efforts of the Republic of Zambia in improving the quality of education.

Zambia has participated in the Southern and Eastern Africa Consortium for Monitoring Educational Quality (hereafter, SACMEQ) since 1999 and has consistently recorded poor performance. For example, in SACMEQ II it was found that 67.3% of the Zambian Grade 6 pupils did not even meet the "Basic Numeracy" category (Hungi et al., 2010). Basic calculation ability is the foundation for further

[1] Chapter 1 (4) Background of the research project and Chapter 2 Section 2.2 Literature review are largely dependent on Baba et al. (2019).

mathematics and science, and an essential component of the human resources needed for the middle- and long-term development of society. Hence, in 1996 the Ministry of General Education (MoGE) of Zambia established the "Educating our Future," an educational policy that prioritized numeracy and literacy (Ministry of Education, 1996; Ministry of Education, Science, Vocational Training and Early Education, 2013; Ministry of National Development Planning, 2017).

Since 2002, Hiroshima University has sent graduate students as volunteers to Zambia in cooperation with the Japan International Cooperation Agency (JICA) as part of a unique educational program, which is explained in the section 2.1. Mr. Uchida was among the first batch of students of this program, and collected information on the context and issues of mathematics education in Zambia since there was no information at all. He studied the calculation abilities of primary pupils and identified the widespread use of a "counting-all" strategy without the use of grouping by tens (Uchida 2012). Furthermore, he developed a diagnostic evaluation method to investigate their calculation strategies using a Newman approach (Newman 1977; Clements 1980) that combined the use of concrete materials with oral questioning in the local language, Chinyanja. His most significant finding was that even poor performers showed some understanding of basic mathematics.

For the calculation ability, other researches (Nakawa, 2016; Uchida, 2009) found grades 5 and 6 pupils used counting strategies to solve problems, and it was not recognized as a major issue. In South Africa, Roberts (2015) conducted a similar investigation and identified three modes of representation–iconic, indexical, and symbolic–in the responses to word problems solved by Grade 2 pupils. He also found that the most common strategy was counting-all.

These studies have recognized that pupils acquire competence related to calculations by generally low but different degrees. However, they did not develop a tool to measure pupils' numeracy competence and analyze their competence.

Therefore, in this project, we aimed at developing an assessment tool to identify Zambian pupils' numeracy competence. Definition of numeracy competence will be provided later. Our target group were pupils from lower and intermediate grades (grades 1 to 4). This study was done to identify valuable information on the causes for low level of competence in numeracy and suggest a more effective teaching strategy to improve it.

（5） Research area

Lusaka Province, Lusaka District was selected for this research project due to some criterion.

（6） Target schools

- Chipata Primary School
- New Kabanana Primary School.
- Muchiniga Primary School
- George Central Primary School.
- Chamba Valley Primary School
- Kaunda Square Primary School.
- Twashuka Primary School
- John Laing Primary School.
- New Kamulanga Primary School.
- Chimwemwe Primary School

Chapter 2 Research objective and method

2.1 Mutual exchange between University of Zambia (UNZA) and Hiroshima University prior to the research

Hiroshima University started a special education program called the "Zambia Special Education Program (ZSEP)" in collaboration with JICA and UNZA in 2002. In this program, master students are

dispatched as a volunteer teacher for a newly established basic school (now either primary or junior secondary) in Zambia. The selected graduate students are expected to engage in both teaching as a volunteer teacher and research as a graduate student. The volunteer program helps graduates develop their professional abilities and their awareness about various social issues. The mutual agreement between Hiroshima University and UNZA concluded in 2004 and lecturers were asked to function as local tutors to facilitate students' understanding of Zambia.

Since that conclusion, staff from both universities annually visit each other's country to acquire knowledge about education in each country. Since 2007, a joint UNZA-HU research dissemination workshop has been held when the professors of Hiroshima University visit Zambia and University of Zambia once a year to monitor students who participate in the ZSEP. Utilizing these opportunities, both universities have developed a common understanding and awareness regarding educational issues in Zambia. One of the representatives of mathematics education in UNZA is Dr. Bentry Nkhata, Senior Lecturer, Dean of the Faculty of Education. He also leads the Zambian team in this research project. It is important to have a reliable relationship and common understanding of issues among team members for this kind of research.

2.2 Previous studies

As in the Chapter 1 (4) research background, the description of previous studies in this section is based on the previous writing (Baba et al., 2019). To identify the numeracy competence taken up in the background, this research has been engaged with development of assessment tool. Previous studies have mostly explored the cause of poor performance and its improvement, especially in early years (pre-primary to lower grades) mathematics education but, we believe it is also necessary to focus on ways to develop mathematical competence. To better understand learning and teaching of mathematical competence in young children, we review the existing literature around three key concepts.

First are the studies on children's use of learning trajectories to understand the development of mathematical understanding. Clements are the initiators of learning trajectory in the early mathematics education. For example, Clements and Sarama (2013) described children's development of understanding by employing the idea of learning trajectories. They stated that "the learning trajectory has a goal, developmental progression, and instructional activities. To attain a certain mathematical competence within a given domain (goal), children typically learn each successive level of thinking (the developmental progression), aided by activities (instructional tasks)" (Clements & Sarama, 2013, p.122). The development does not occur in the same way for all pupils, so teaching needs to pay attention to pupils' present condition and the development of each pupil. The value of a learning trajectory is in "structuring the activities in accordance with theoretically and empirically based methods models of children's thinking" (Clements & Sarama, 2013, p.137).

Second ones are about patterns and structure in children's understanding of mathematical concepts. Mulligan has led the research project on early mathematics education, and developed assessment tools focusing on pattern and structure, Mulligan and Mitchelmore (2009; 2013) studied early mathematical development from the perspective of pattern and structure. They developed the Pattern and Structure Assessment (PASA) to investigate the mathematical awareness of primary school pupils. They found that pupils' representations showed various levels of structural understanding (see Figure 1). They stated

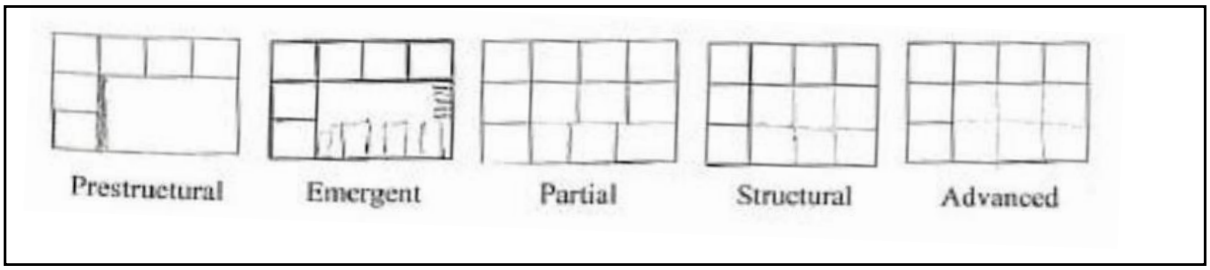


Figure 1 Levels of Structure (Mulligan et al., 2013)

that pupils' awareness of the structure was closely related to their mathematical abilities. In other words, the degree of mathematical ability can be understood in terms of the degree of structuralization of representation.

They hypothesized that the more a student's internal representational system develops structurally, the more coherent, well organized, and stable in its structural aspects will be their external representations and the more mathematically competent the student will be (Mulligan et al. 2011, p.555). Conversely, low achievers are characterized by low levels of structuralization. They were more likely to produce poorly organized representations and were only able to replicate models of grouped, arrays, or patterns that had been produced by others. They tended to use unitary counting exclusively and appeared unable to visualize part-whole relations. Moreover, they made little progress between Grades 2 and 5 (Mulligan & Mitchelmore, 2013, p.33). In other words, the low level of structuralization (including the use of the counting-all strategy) can hinder primary pupils from moving onto a higher level of mathematical competence.

Third are the studies that focus on the weakness of early mathematics learning in African context Roberts (2015) also pointed out the weakness of the counting-all strategy: "There is growing consensus in South Africa that one of the major factors inhibiting learners' mathematical progression is continued using counting-in-ones strategies for Mathematical calculation." (p.243). Adding concrete and symbolic representations into the three representations previously mentioned, he classified pupils' representations into five levels: concrete, iconic, indexical, symbolic, and syntactical. Figure 2 shows examples of some of these representations. Iconic representation shows diagrams of real objects (left), while indexical

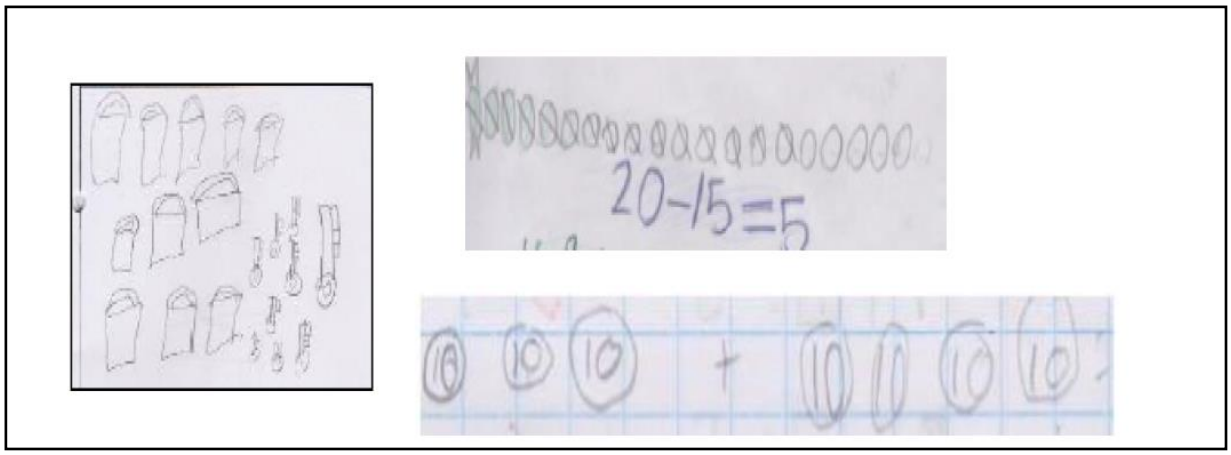


Figure 2 Iconic, indexical and syntactical representations (Roberts, 2015)

representations depict objects with semi-abstract diagrams of circles (right above). Both work are based on a one-to-one correspondence. Whereas, syntactical representation (right below) shows that numerical symbols are assigned to some group.

From these studies, learning trajectory, structuralization, and representation were identified as keywords.

2.3 Objective and method of Research

2.3.1 Objective of research

The objective of this research project was to develop an assessment tool to diagnose pupils' level of numeracy competence (Figure 3) and develop an intervention tool to improve the competence. The development of both these tools consider learning trajectories, the ability to see structurally, and the various types of representation that are essential for mathematical competence.

Composition and decomposition of number, count by groups, count forward and backward

Relative size of numbers, seeing in terms of unit

Decimal number system, Understanding of patterns and structure of numbers Expression of Number (blocks, counters, number line, etc.)

Significance, procedure and proficiency of calculation

Reading and expressing skills of mathematics sentence

Figure 3 Definition of numeracy competence

2.3.2 Formation and management of Research team

A common understanding and reliable relationship between the Hiroshima University and UNZA, which was previously described, is a very important prior condition for forming a reliable research team invested in developing a new research method. Baba and Nkhata, who have played a central role in the mutual exchange program between two universities, were also team leaders of the Japanese and

Zambian research project teams respectively. Baba was also the overall leader of this research project. The Japanese team had six members, including the leader. All the members have knowledge of Zambian education system, through their participation in ZSEP. In addition, four of them had a Ph.D. in mathematics education, and one was enrolled in a Ph.D. course in mathematics education. Thus, the team has sufficient ability to conduct this research. The Zambian team was made up of six members, excluding the leader, who were the master students at UNZA, and were recruited after consultation with Dr. Nkhata. The recruitment for the Zambian team members occurred twice, first in March 2018 when four members were selected, and the second time was in September 2019 for two more members. All the members had the capability and willingness in mathematics education and a deep understanding of the approach and significance of this research. After they had completed their master's course, we requested them to stay on as team members and with the permission of the Ministry of General Education, they were able to join the survey activity while being exempted from their original work at the time they were needed.

Moreover, to manage the international project effectively, we initially recruited one coordinator each for the Japanese and the Zambian teams and later two more coordinators were recruited in Zambia. They managed the logistical aspects of the project through the guidance of the Japanese coordinator. They were responsible for communication with various interested parties such as team members, UNZA, the Ministry of General Education, the ten research schools, and JICA Zambia, along with research activities, organizing accommodation, food, transportation and other miscellaneous tasks. Almost all team members stayed together till the end of the project, except for one coordinator who left the country for personal reasons. This "almost no change" in team members was an important factor in the successful implementation of the project.

Table 1 Japanese team

Name	Affiliation	Expertise
BABA, Takuya	Hiroshima University	Overall and Japanese team leader
NAKAWA, Nagisa	Kanto Gakuin University	
KUSAKA, Satoshi	Naruto University of Education	
WATANABE, Koji	Miyazaki International College	
KOSAKA, Masato	University of Fukui	
MINAGOSHI, Kanae	Hiroshima University	Coordinator

Table 2 Zambian team

Name	Affiliation	Expertise
NKHATA, Bentry	University of Zambia	Zambian team leader
ARTHUR, Mungalu	Charles Lwanga College of Education	
BARBARA, Mudenda	New Nakonde Secondary School	
EMMANUEL, Kaabo	Canisius Secondary School	
MAMBWE, Bareford	Serenje Boma Secondary School	
CHIKOLA, Doye	St Mary's College of Education	
SPIWE, Tafeni	Mkushi Day Secondary School	
NKHALAMO, Chimwemwe Joy	JICA team	Project Coordinator
TAKUZWA, Jane Njovu	JICA team	Project Coordinator
MUGWAGWA, Himunza	JICA team	Project Coordinator
BANDA, Raphael	Ministry of General Education	Forcal Person

2.3.3 Research schools and pupils

During the first field survey in March 2018, the Japanese and Zambian teams presented the research plan to the Ministry of General Education (MoGE) and requested permission for this research. The Ministry provided a letter of approval, a list of ten schools in Lusaka District, Lusaka Province, and a focal person to liaise between the team and the Ministry. Mr. Raphael Banda, a curriculum specialist for mathematics at the Curriculum Development Centre of the Ministry of General Education was appointed the focal point person. The sample size was limited by logistic factors. The final sample consisted of pupils from ten schools in the Lusaka district, Lusaka Province. Those schools each consisting of two schools, from the five zones within Lusaka District, Lusaka Province were selected. Each school was designated as an experimental group and a control group. Since two schools were

selected from the same zone, we expected pupils from both the schools to belong to the same socioeconomic status.

During the developmental stage, which is explained later, four pupils were selected for each grade from Grade 1 to Grade 4. Two pupils out of the four were top performers in their class and the other two pupils were medium-level academic achievers. During the final stage, the number of pupils was reduced to two each due to logistical reasons. One was a high performer, and the other a medium performer. This systematic selection ensured feasibility, such as minimum movement within the country and validity, such as the similarity of socioeconomic status among the experimental and control groups.

2.3.4 Exploratory research method

The research implementation began in March 2018 after preparing for the necessary steps. While conducting the literature review, some internationally recognized assessment tools such as TIMSS and SACMEQ were judged unsuitable for Zambian pupils. Their previous experience with these assessments has taught us that most Zambian pupils perform very poorly. In other words, they cannot solve most of the test items. Hence, our exploration focused on what they can do to identify numeracy competence among Zambian pupils. This principle differs from the traditional approach, where the items in the assessment tool are determined from the curriculum. At the same time, our new instrument also needed a connection with the existing instruments so that the good performers can also be assessed according to the existing standards (Uchida, 2012)[2].

The chosen research method, therefore, is exploratory and the initial instrument was developed based on the literature review and later adjusted according to the field survey data analysis results. After each

[2] For example, PISA for development was connected to the PISA study. It was conducted between 2015 and 2018, to accommodate more diverse countries to participate PISA studies. It extends the original assessment criterion, proficiency level 1 to level 6, downwards to include levels 1a (original level 1), 1b and 1c. In the current cycle (2018-2022), the PISA for development is merged into the PISA study.

survey, the data were analyzed to confirm whether each interview item for the task and response categories adequately described pupils' level of understanding, and the tool was revised accordingly. By repeating this process, the assessment tool was revised and adjusted to ensure validity. Specifically, the tool has become more appropriate for assessing the status of pupils' understanding by probing the validity of tasks, the response levels and the reliability of its interpretation in the analysis of the collected data.

The first four times for our six field surveys (Table 3) are called the developmental stage. We developed a new instrument to assess the level of Zambian pupils' numeracy competence more appropriately through this process. We later conducted pre- and post-surveys to measure the effects of educational intervention using the developed intervention tools. This is referred to as the final stage. The last two surveys were the main surveys that measured the impact of education.

However, the implementation of the original plan was delayed by a year due to COVID-19. In fact, pre- and post-surveys were conducted in March 2021 and June 2021, respectively. Since we employed an experimental method to confirm the effectiveness of the developed tools, we conducted an intervention between post and pre-surveys, in April and May 2021.

Table 3 Survey plan (research schools, pupils and field surveys)

		Developmental stage				Final stage	
		2018		2019		2021	
		Mar.	Sep.	Mar.	Sep.	Mar.	Jun.
		1st Cycle	2nd Cycle	3rd Cycle	4th Cycle	Pre-	Post-
No. of Schools		2	2	4	4	10	10
No. of Students	Grade 1	8	8	16	16	20	20
	Grade 2	8	8	16	16	20	20
	Grade 3	8	8	16	16	20	20
	Grade 4	8	8	16	16	20	20

2.4 Implementation of the Developmental stage (The first cycle to fourth cycle)

2.4.1 Procedure during the developmental stage

In each field survey, we took the following steps and repeated them four times.

Step 1: Review the previous studies and improve the validity of the tool.

Step 2: Develop an assessment tool with tasks and response levels, construct appropriate tasks, and examine its validity, the time required, and the influence of judgement errors.

Step 3: Shorten the time for assessment (approximately 30 to 40 minutes) by reducing the number of tasks and increasing the validity of the interview by adjusting the expressions.

Since it was important to collect detailed data on pupils' responses through our instrument, we expanded our exploratory method based on interviews. Pupils' responses were judged qualitatively by a team of observers and were simultaneously video-recorded for later confirmation if necessary. The team consisted of at least three people: interviewer, observer, and a camera person, the camera person also acted as the second observer. Japanese team members also participated through the observation and improve the validity of judgement through discussion. The interview was video recorded simultaneously and used for discussion and confirmation when necessary.

2.4.2 Refinement of assessment tool

The assessment tool comprised tasks that correspond with the sub-competences of numeracy competence and the collected data was used to analyze and assess the pupils' competence according to their response against the activities and utterances. Sub-competences, tasks, and interview methods, and response levels are defined as follows:

(A) Selecting an appropriate number of items included

- Deleting distinction of number categories "below ten," "between ten and twenty," and "more than twenty," in each number recognition, composition and decomposition of numbers, and complementary number tasks.
- Integrating sub-competences 3 and 4 due to similarities

- Deleting sub-competence "problem posing"

(B) Refinement of task questioning in local language

Table 4 Sub-competences and tasks

	After 2nd Cycle	After 3rd Cycle
No. of Sub-competencies	8	6
No. of Tasks	43	27

- Developing the assessment tool and the standard interviewing method by including keywords and questions to accommodate variation among researchers
- Showing the mathematical expression directly because the verbal expression of calculation problems connotes such expressions (e.g. 4-3=, 3x2=)

(C) Increasing validity of level judgement

- In the 2nd cycle, the criterion to use counting and/or grouping was determined. Judgement about this was unstable because it included various aspects of numbers, numerical expressions, and mental calculations. For example, mental calculations were sometimes judged as Level 5. After thorough discussion, the criterion for selecting process or product was standardized.
- After establishing the standardized criterion, it became clear that level 3 was counting all, level 4 was some kind of grouping, and level 5 was explanation of the grouping done at level 4.

2.4.3 Construction of Interview guide

After four cycles, the judgement errors became minimal. Even if observers made different judgements, they could refer to the criteria, discuss interpretation, and agree accordingly. Thus, the interview guide was finalized after four cycles.

The team finally adapted a six sub-competences instrument due to time limitations (approximately 30 minutes per pupil) and the fundamentality and extensibility of tasks (Table 5). Five response levels were organized across various tasks to assess pupils' responses diagnostically and consistently. Here, diagnostic assessment included: (1) identifying the level of pupils' numeracy competence and (2)

identifying the intervention point to deepen the pupils' numeracy competence. For example, if a student belongs to level 3, he/she can be facilitated to use the grouping method and then move to level 4. The followings are the construction of tasks and response levels.

Table 5 six sub-competences and tasks

Sub-competence	Task	Page No.
1. Counting objects one by one, by groups, count forward and backward	1.1 Counting objects	1
	1.2 Counting forward	2
	1.3 Counting backward	3
2. Recognizing patterns and structure of numbers	2.1 Creating patterns	4
	2.2 Recognizing structure of numbers within 10	5
	2.3 Recognizing structure of numbers more than 10	6
	2.4 Imaging frame of 10	7
3. Composing and decomposing numbers	3.1 Composing two 1-digit numbers	8
	3.2 Composing two 2-digit numbers	9
	3.3 Recognizing Complements of 10 (1)	10
	3.4 Recognizing Complements of 10 (2)	11
4. Seeing numbers in terms of unit and relative size of numbers	4.1 Seeing numbers in terms of unit and relative size of numbers	12
5. Understanding decimal system	5.1 Recognizing dots as groups (1)	13
	5.2a Recognizing numbers in a number line (1)	14
	5.2b Recognizing dots as groups (2)	15
	5.3a Recognizing numbers in a number line (2)	16
	5.3b Recognizing numbers in a number line (3)	17
	5.3c Recognizing dots as groups (3)	18
	5.3d Recognizing dots as groups (4)	19
6. Significance, procedure and proficiency of calculation	6.a1 Addition of "1-digit number + 1-digit number"	20
	6.a2 Addition of "2-digit number + 2-digit number"	21
	6.s1 Subtraction of "2-digit number − 1-digit number"	22
	6.s2 Subtraction of "2-digit number − 2-digit number"	23
	6.m1 Multiplication of "1-digit number × 1-digit number"	24
	6.m2 Multiplication of "2-digit number × 1-digit number"	25
	6.d1 Division of "1-digit number ÷ 1-digit number"	26
	6.d2 Division of "2-digit number ÷ 1-digit number"	27

Table 6 Five response levels and description example

Response levels	Description	Note
1 Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he tells the incorrect answers which are closed to the right answer, e.g. 10, 12	
3 Implicit	S/he can find an answer (12) by counting mentally or physically, not moving bottle tops.	Judge whether counting one by one or not from student's physical actions.
4 Structural	S/he can find an answer (12) by moving bottle tops.	Record the method in the individual observation sheet. [Level 4] In the case of counting one by one, after making 10 and 2 as a group by moving bottle tops.
5 Advanced structural	Besides level 4, s/he also can explain by words using group of 10.	(e.g.) Get one top from 3 and place it on the other frame so that we can get a group of 10.

2.5 Implementation of Final Stage

2.5.1 Correspondence among final tools

While finalizing the interview guides at the 3rd and 4th cycle, the team simultaneously developed the tests and intervention tools as the product of this research.

The assessment tool includes tests for pre- and post-surveys and is based on the interview guide. This research mainly elicits detailed information from the pupils through interviews, but also collects complementarily data using the paper test by maneuvering the method. This is because the paper test can collect a large number of samples at one time, and it is necessary to seek future possibilities for tests. The planned sample sizes for the interviews and tests were 80 and 800 pupils, respectively.

Diagnostic assessment using interviews forms the core of assessment of numeracy competence. In addition, during the 3rd and 4th cycles, the tests were considered to have more data by adjusting the

modes of testing. The tests for the pre- and post-surveys were developed according to the interview guidelines.

The intervention tool was in a form of an exercise book, "Pupils' workbook." based on an interview guide Since we examined the effectiveness of this intervention by analyzing interview and test data for pre- and post-surveys, all tools corresponded to each other (Table 6). We also introduced more items such as the decomposition of numbers using the cherry diagram and number lines to explore future extensions. In addition, a Teachers' guide was also developed to explain the intention of sub-competences and tasks and how to use the workbook. We expected teachers to use this guide when they include the pupils' workbook in their teaching. With explanation and consultation from the team members, our observations found some teachers using the workbooks efficiently.

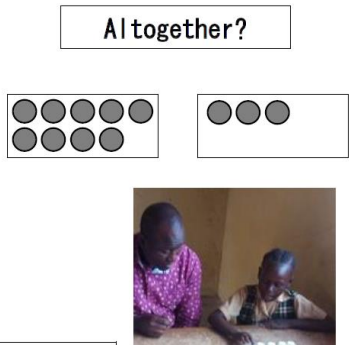
Table 7 Correspondence among interview guide, test and pupils' workbook

Sub-competence	Interview task	Test	Workbook
1. Counting objects one by one, by groups, count forward and backward	1.1 Counting objects		1-1
	1.2 Counting forward		1-2
	1.3 Counting backward		1-3
2. Recognizing patterns and structure of numbers	2.1 Creating patterns		2-1
	2.2 Recognizing structure of numbers within 10	Q3	2-2
	2.3 Recognizing structure of numbers more than 10	Q4	2-3
	2.4 Imaging frame of 10	Q1, 2	2-4, Extra activity1
3. Composing and decomposing numbers	3.1 Composing two 1-digit numbers	Q5	3-1
	3.2 Composing two 2-digit numbers		3-2
	3.3 Recognizing Complements of 10 (1)	Q6, 7	3-3
	3.4 Recognizing Complements of 10 (2)		3-4
4. Seeing numbers in terms of unit and relative size of numbers	4.1 Seeing numbers in terms of unit and relative size of numbers	Q8	4-1
5. Understanding decimal system	5.1 Recognizing dots as groups (1)		5-1
	5.2a Recognizing numbers in a number line (1)		5-2a
	5.2b Recognizing dots as groups (2)	Q9	5-2b
	5.3a Recognizing numbers in a number line		5-3a
	5.3b Recognizing numbers in a number line		5-3b
	5.3c Recognizing dots as groups		5-3c
	5.3d Recognizing dots as groups	Q10	5-3d
6. Significance, procedure and proficiency of calculation	6.a1 Addition of "1-digit number + 1-digit number"	Q11, 14a, 14b	Extra activity 2&3, 6-a, A, B & C
	6.a2 Addition of "2-digit number + 2-digit number"	Q14c	
	6.s1 Subtraction of "2-digit number − 1-digit number"	Q12, 13, 14d, 14e	6-s, A, B, C, D, E & F
	6.s2 Subtraction of "2-digit number − 2-digit number"	Q14f	
	6.m1 Multiplication of "1-digit number × 1-digit number"	Q14g	6-m1
	6.m2 Multiplication of "2-digit number × 1-digit number"	Q14h	6-m2
	6.d1 Division of "1-digit number ÷ 1-digit number"	Q14i	6-s1
	6.d2 Division of "2-digit number ÷ 1-digit number"	Q14j	6-s2

Excerpt of interview guide

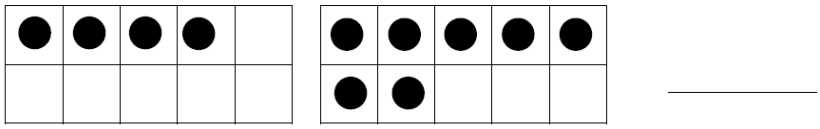
[3.1 Composing and decomposing numbers]

Prepares two frames of 10. On one side, place 9 bottle tops and on the other side, place 3 bottle tops.
Q. 'How many bottle tops are there altogether? You may move the bottle tops'
Local Language
Tuli tungati tupendelo utu pamodzi; ungatu tatike bwino kuti upendze bwino ansa?
Watantika bwanji?



Excerpt of test

(5) How many dots are there altogether? Show your working just here where the question is. (Tuli tungati tuma dot utu pamodzi? Onetsa mwamene wapezela pemene apa pali funso.) (1'00)



Excerpt of pupils' workbook

1. Prepare two 10-frames. On one frame, place 3 bottle tops and on the other frame, place 9 bottle tops.
   Think about how many bottle tops there are altogether using the idea of group of 10.

   Write the answer: _____ ☐ Done!

Figure 4 Excerpt of interview guide, test and pupils' workbook

2.5.2 Construction of final tools (Test)

A summary of the test developed is shown in Table 8. The intention of questions 1 and 2 is to identify the understanding of groups of 10 and 10-frames. Questions 3 through 10 are similar to the sub-competences 2 and 3. As shown in Table 8, the questions of the test generally correspond with the interview tasks, but they are not the same. The tests do not cover all the tasks due to their limitations. Questions 11, 12, and 13 are used to identify the underlying calculation process of using groups of 10

in adding one-digit numbers and subtracting them as its reverse. Question 14 was calculations that used two-digit numbers.

Table 8 Summary of test

No.	Description	No.	Description
1	Drawing 20 dots.	13(1)	Process of the minuend decomposition
2	Counting 20 discrete dots.	13(2)	
3	Counting the 14 dots in the frame of 10.	13(3)	
4	Drawing the 17 dots in the frame of 10.	14a	3+4
5	The sum of 7 and 8 dots in the frame of 10	14b	7+9
6	Number of dots needed for 20 (10 and 3)	14c	12+23
7	Number of dots needed for 20 (7 and 3)	14d	6-2
8	Number of dots in the frame of 10 (46)	14e	13-7
9	Circling the 12 dots in the frame of 10.	14f	24-12
10	Circling the 76 dots in the frame of 10.	14g	4×6
11(1)	Process of the single digit addtion using group of 10.	14h	12×3
11(2)		14i	$9 \div 3$
11(3)		14j	$26 \div 2$
12(1)	Process of the subtrahend decomposition		
12(2)			
12(3)			

2.5.3 Administrating the tests

A test was conducted to verify the effect of intervention in a large pupil sample. The test is a paper and pencil task, which makes it difficult to examine the process of calculation. However, the mode of question was maneuvered to clarify not only correct or wrong responses but also the calculation process and ways of thinking employed by the pupils. For example, it asks pupils to count semi-abstract objects (e.g., ●) drawn on the paper by groups and write the calculation process.

Many early grade pupils in Zambia have difficulty learning mathematics in English and most Grade 1 to Grade 3 pupils learn mathematics in a local language (e.g., Chinyanja at Lusaka). They, however,

have difficulty understanding the written sentences in the local language. Considering the influence of language on mathematics achievement, the following steps were taken.

- ✓ The examiner reads one question aloud and lets pupils solve it one by one.
- ✓ The examiner reads each question sentence twice.
- ✓ After the pre-determined time elapses, the examiner tells pupils to proceed to the next question.
- ✓ To prevent pupils from cheating, the pupils maintain a distance between them, and some examiners walk around and monitor the pupils.

2.5.4 Implementation of Workshops

In February 2020, a workshop was conducted to explain the purpose of the survey to the staff in all ten schools. Starting from 2018, we had explained our research purpose to two schools in the 1st and 2nd cycles, and four schools in the 3rd and 4th cycles. However, it was the first time to explain the objectives, contents, and methodology of the survey to all ten schools at the same time. This workshop was called the first session.

Five schools that were categorized as experimental schools were given a detailed explanation and demonstration of the intervention tool. The survey in these schools was originally planned in March 2020, immediately after the first session, but it was postponed to March 2021. This allowed the schools to understand the intentions and characteristics of the intervention approach more deeply. On the other hand, in the five schools categorized as control schools, the research method was explained during the first session, and another workshop on the intervention tool after the post-survey was promised. This was done to ensure that the control school would not be at a disadvantage.

2.5.5 Plan of Pre- and post-surveys

Pre- and post-surveys were originally planned to be conducted in March 2020. However, due to the

prevalence of COVID-19, we were forced to postpone by one year. During this period, we polished the tools further and discussed the method of the final stage. Two primary issues on timing and the research method were addressed.

With regards to timing, at the end of 2020, we carefully examined the implementation period. We had to consider various conditions such as the restrictions of due to COVID-19, the general elections to be held in August and the probable disturbance after the election, the occurrence of national examination between October and November, and the requirement for one-and-half months of intervention period between pre- and post-surveys. We frequently communicated with UNZA, Ministry of General Education, JICA Zambia office and finally decided on the survey schedule (Tables 9 and 10).

As for the method, we concluded that using an online platform for the survey was ideal. The Zambian team visited the schools and administered the interviews and tests, and the Japanese team participated the survey using on-line system. At the end of each day, the Zambian and the Japanese teams discussed the interpretation of the interview results until an agreement was reached about the interpretations. Since some basic ideas had already been shared within the teams during the process of developing the interview guide, it was easier to make final decisions for cases where there were differences in opinions. We also allowed the classroom teacher to stay in the same room during the interview and test to reduce the anxiety of the pupils, but they did not participate in any way.

The following is the schedule of pre- and post-surveys.

Table 9 Pre-survey Schedule March, 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7	8	9	10 School A (I) School B (T)	11 School C (I) School D (T)	12	13
14	15 School D (I) School C (T)	16 School E (I) School F (T)	17 School F (I) School E (T)	18 School G (I&T) School H (T)	19 School H (I) School G (I)	20

21	22 School B (I) School A (T)	23 School I (I) School J (T)	24 School J (I) School I (T)	25 School D (I&T)	26 School F (I)	27
28	29	30	31			

I: Interview, T: Test

Table 10 Post-survey schedule June, 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
May 30	31 School J (T)	1 School J (I) School I (T)	2 School H (I) School I (I)	3 School G (I) School H (I&T)	4 School B (I) School A (T)	5
6	7 School A (I&T) School B (T)	8 Cancelled	9 School D (I) School C (T)	10 School E (I) School F (T)	11 School F (I) School E (I&T)	12
13	14 School C (I) School D (T) School F (I)	15 School A (I) School G (I&T) School J (I)	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

I: Interview, T: Test

2.5.6 Correspondence between grades and interview tasks

To make full use of the limited time, we developed a plan for customizing interview tasks grade-wise. To make a comparison across different grades, the tasks were identical for all, but the range of tasks varied from one grade to another (Table 11). The Tasks, 3.1 to 3.4, were common to all grades.

Each task was assessed according to the five response levels, and thus the total score of the interview was five times the number of interview tasks.

Table 11 Correspondence between grades and interview tasks

	1			2				3				4	5							6							
	1	2	3	1	2	3	4	1	2	3	4	1	1	2a	2b	3a	3b	3c	3d	a1	a2	s1	s2	m1	m2	d1	d2
G1																											
G2																											
G3																											
G4																											

2.5.7 Educational intervention

As previously stated, educational intervention was planned between pre- and post-surveys. The educational intervention was conducted as follows. After the Zambian team arrived at the school, the team had a brief meeting with the class teacher. One workbook was distributed to each student and the teacher's guide to the teacher, and the teacher conducted an activity during the class. After class, the team received feedback from the teacher. Although most teachers had grasped the major points of the tool in the workshop, they were not quite sure about the key points and actual usage of the tool for a specific topic. The brief meetings, implementation, and feedbacks helped them learn the method more deeply with time.

To avoid incorrect usage of intervention tools the team stayed in the room observing when the class teacher conducted an educational intervention task. This was essential since educational intervention is effective when it is based on reliable relations between pupils and teachers. In the survey, we did not provide any hints but during the intervention, the team encouraged the class teacher to employ methods embedded within the developed intervention tools. In particular, they were requested to pay attention to the principles of the tools such as counting in groups with special attention to structure, representation types, and explanation for the answers.

The intervention was also conducted during holidays in consultation with the Ministry of General Education. The intervention was scheduled from March 29th to April 16th and from April 26th to May 7th after the school closure on April 23rd (Table 12). During the school period we were not able to have adequate time to complete our original plan, but with this special arrangement, we were able to cover the required contents. During the holidays. The teachers were able to exclusively concentrate on implementing our tool and thus gained a better understanding of the characteristics of our materials.

Table 12 Educational intervention April and May, 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Mar 28	29 School I	30 School G	31 School B	Apr 1 School D	2	3
4	5	6 School F	7 School I	8 School G	9 School G	10
11	12 School D	13 School I	14 School G	15 School G	16 School B	17
18	19 -	20 -	21 -	22 -	23 *Term 1* *Closing Day*	24
25	26 School D School B	27 School D School I	28 School G School I	29 School G School B	30 School I School B	May 1
2	3 School D School B	4 School D School I	5 School G School I	6 School G School B	7 School I School B	8
9	10 *Term 2* *Opening Day*	11 -	12 -	13 -	14 -	15
16	17 School I	18 School G	19 School B	20 School D	21 School F	22
23	24 School G	25	26 School I	27 School F	28 School D	29

Chapter 3 Results of Analysis

This chapter presents and analyzes the results of the pre- and post-surveys in the following order: Section 3.1 presents data processing methods, 3.2 interview results, 3.3 test data results and 3.4 summary.

3.1 Data processing methods

3.1.1 Data processing methods for interviews

The results of the interviews were reviewed several times to determine the final judgments based on the criteria. Although there was some difference among the first judgments during our observation of pupils' actions, a final judgement was made during the discussion after the interview.

3.1.2 Test data processing methods

We created the dataset for analysis, by typing all pupil answers on an Excel spreadsheet. In order to achieve the objective of this study, our analysis focused on seeing structurally, types of representation, and explanation. Besides, whether it was correct or wrong, we also examined calculation strategies and the use of grouping. The input codes are presented in Table 13.

In this section, we present our analysis of the correct and desirable answers. The answers to questions 1, 4. 9, and 10 are related to "groups of 10," and we classified their answers with the five codes shown in Table 13: 1 for answers that fall within these codes and 0 for others. For questions 2, 3, 5, 6, 7, and 8 that were for counting, we coded the answers according to Table 13 with a code of 1 and the other answers with a code of 0. These 11 codes were established and used for the analysis. For the 10 calculation problems in question 14, correct answers were coded as 1 and incorrect answers as 0, and the analysis was conducted focusing on the correct answers.

Table 13 Data processing criteria for the "number cohesion" problem

	Question	Solution to focus on	Code
Grouping	1	Drawing 20 dots in a group of 10.	q1m10
	4	5 dots in the lower left corner.	q4ld
		2 dots in the lower right corner.	q4rd
	9	Circling 12 dots.	q9m
	10	Circling 76 dots.	q10m
Counting	2	35	q2
	3	14	q3
	5	11	q5
	6	7	q6
	7	10	q7
	8	51	q8

3.2 Results of the interview survey

As shown in Table 14, 80 pupils were included for the interview in both the pre- and post-surveys. However, because some pupils were absent due to illness or other reasons on the day of the interview, the actual number of pupils who participated in both the interviews was 71. The total score for all interview tasks was 5.0 (equivalent to level 5), and the total score was "(number of tasks) × 5."

Table 14 Actual sample size for pre- and post-interviews

School	Group	pre	post	common	pre-only	post-only
A	control	8	8	7	1	1
B	experimental	8	8	7	1	1
C	control	8	8	8	0	0
D	experimental	8	8	5	3	3
E	control	8	8	6	2	2
F	experimental	8	8	8	0	0
G	experimental	8	8	7	1	1
H	control	8	8	8	0	0
I	experimental	8	8	7	1	1
J	control	8	8	8	0	0
	Total	80	80	71	9	9

3.2.1 Changes in interview scores for each grade

This section describes the changes in interview scores for each grade level. The results of the difference-in-differences analysis of interview scores and differences for each grade are presented in Table 15. Note that because the interview tasks are common to both grade 3 and 4 pupils, the combined results are also shown. Cronbach's alpha coefficient was approximately 0.8, indicating that the internal validity of the task was ensured. The effect of the intervention was estimated using a difference-in-differences analysis. The estimated effect of the intervention for each grade ranged from 0.43 to 0.84. In particular, grade 4 pupils showed an improvement of approximately 0.84.

Table 15 Differential analysis of interview scores and differences for each grade

Grade	Cronbach's α			control		experiment		Estimated intervention effect	p-value
	all (40)	pre (20)	post (20)	pre	post	pre	post		
G1	0.85	0.83	0.81	2.90	3.21	2.56	3.51	0.64	0.10
G2	0.81	0.73	0.74	3.14	3.79	3.11	4.20	0.44	0.29
G3	0.84	0.79	0.72	2.79	3.37	2.78	3.79	0.43	0.18
G4	0.90	0.90	0.82	3.16	3.56	2.89	4.12	0.84	0.04
G3 & G4	0.88	0.79	0.72	2.98	3.46	2.84	3.96	0.63	0.02
G1-G4 common items	0.81	0.80	0.80	3.15	3.64	3.06	4.31	0.76	0.00

Next, we compared the mean values of the experimental and control groups for each grade (Figures 5 to 8). The growth of the experimental group was greater than that of the control group for each grade. Moreover, the mean value of the experimental group increased by more than 1.0 point.

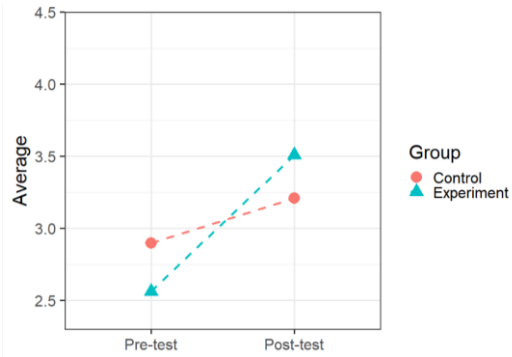


Figure 5 Result of grade 1 (11 tasks, N=20)

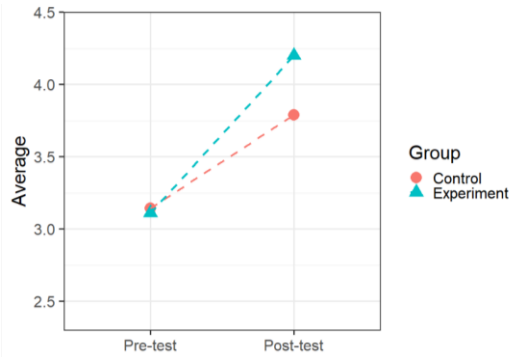


Figure 6 Result of grade 2 (9 tasks, N=20)

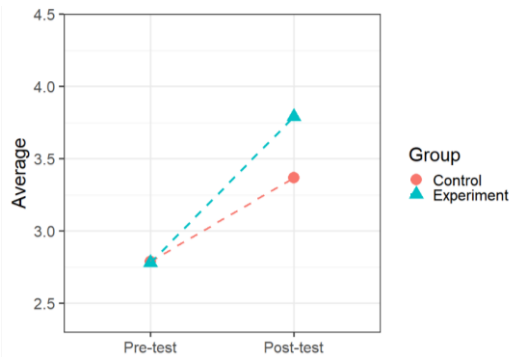


Figure 7 Result of grade 3 (20 tasks, N=20)

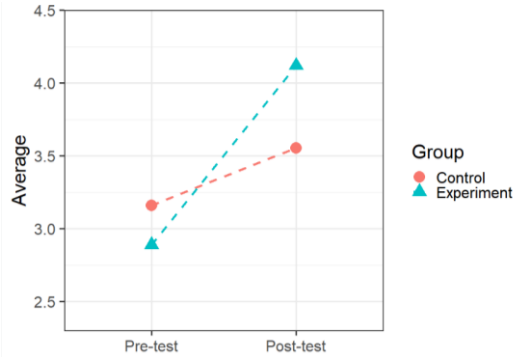


Figure 8 Result of grade 4 (20 tasks, N=20)

In Figure 9 we show a comparison of the means of the experimental and control groups on common tasks, which was 3.1 to 3.4 for grades 1 to 4. When the common tasks are compared between all pupils

in the experimental and control groups, the experimental group (blue line) shows a larger increase, and there is a difference of more than 1.0 point in the response level. In addition, in grade 2, both the experimental and control groups had a mean score of 3.0 or higher at the pre-survey, and many pupils answered correctly, including counting all strategies.

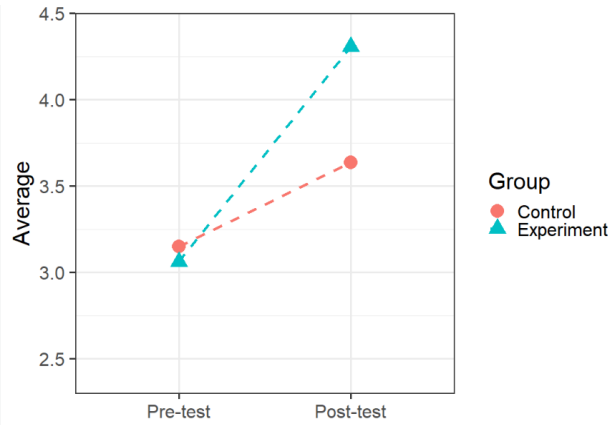


Figure 9 Mean score of the experimental and control groups on common tasks 3.1 to 3.4 for grades 1 to 4 (N=80)

3.2.2 Changes in interview scores for each task

We focused on the changes in the scores and means for each task (Table 16, Figure 10). In Table 16, tasks with an estimated intervention effect of ≥ 1.0 are shown in red, and tasks with an estimated intervention effect of 0.1 or less are shown in blue. Those with an estimated intervention effect of 1.0 or more are considered tasks with large changes, and the ones with an estimated intervention effect of 0.1 or less are considered tasks with almost no change.

Table 16 Scores of each interview task item and result of difference-in-differences analysis

No.	item	control		experiment		difference		Estimated intervention effect	p-value
		pre	post	pre	post	control	experiment		
1	q1.1	3.90	4.30	2.50	4.10	0.40	1.60	1.20	0.07
2	q1.2	4.10	4.20	3.20	4.10	0.10	0.90	0.80	0.17
3	q1.3	2.60	2.80	1.67	2.90	0.20	1.23	1.03	0.02
4	q2.1	2.35	2.05	2.10	2.40	-0.30	0.30	0.60	0.10
5	q2.2	3.10	3.70	3.15	4.55	0.60	1.40	0.80	0.04
6	q2.3	2.65	3.35	3.15	4.05	0.70	0.90	0.20	0.70
7	q2.4	3.20	3.85	3.05	4.15	0.65	1.10	0.45	0.39
8	q3.1	3.40	3.88	3.25	4.50	0.48	1.25	0.78	0.00
9	q3.2	3.38	3.80	3.03	4.33	0.43	1.30	0.88	0.01
10	q3.3	2.95	3.40	3.00	4.08	0.45	1.08	0.63	0.07
11	q3.4	2.88	3.48	2.98	4.33	0.60	1.35	0.75	0.06
12	q4.1	3.87	4.40	3.37	4.13	0.53	0.77	0.23	0.62
13	q5.1	3.65	3.90	3.00	4.55	0.25	1.55	1.30	0.01
14	q5.2a	3.05	3.80	3.20	4.35	0.75	1.15	0.40	0.53
15	q5.2b	2.95	3.40	3.20	4.35	0.45	1.15	0.70	0.15
16	q5.3a	3.70	4.20	3.50	4.45	0.50	0.95	0.45	0.48
17	q5.3b	1.30	1.30	1.45	2.80	0.00	1.35	1.35	0.00
18	q5.3c	2.55	3.10	2.70	3.55	0.55	0.85	0.30	0.64
19	q5.3d	2.70	3.50	3.15	4.45	0.80	1.30	0.50	0.42
20	q6.a1	2.90	2.95	3.00	3.80	0.05	0.80	0.75	0.04
21	q6.a2	3.30	3.30	3.30	4.10	0.00	0.80	0.80	0.11
22	q6.s1	2.20	2.55	2.10	2.85	0.35	0.75	0.40	0.46
23	q6.s2	2.50	2.95	2.20	3.50	0.45	1.30	0.85	0.17
24	q6.m1	3.35	4.20	3.05	3.70	0.85	0.65	-0.20	0.77
25	q6.m2	2.35	3.75	2.20	3.40	1.40	1.20	-0.20	0.73
26	q6.d1	2.95	3.80	2.00	2.90	0.85	0.90	0.05	0.95
27	q6.d2	2.55	2.95	2.00	3.20	0.40	1.20	0.80	0.27

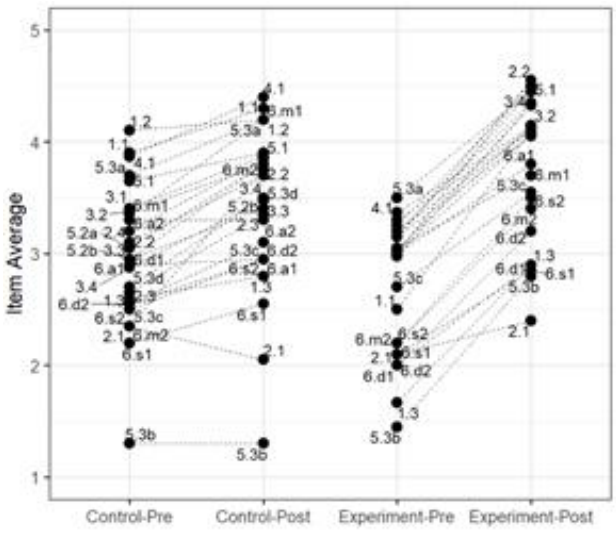


Figure 10 Change of the average in each task of control and experimental groups

According to the estimates of the intervention effect in each task, tasks 1.1, 1.3, 5.1, and 5.3b are the ones in which the intervention effect is likely to appear. On the contrary, no effect of the intervention was found in tasks 6.m1, 6.m2, and 6.d1. Looking at each task in which the effect of the intervention was seen, task 1.1 asked pupils to count the number of discrete bottle tops (20). Task 1.3 asked pupils to count down from 20. Task 5.1 was a question of counting the number of bottle tops in a frame of 10, showing four frames of 10 and 27 bottle tops, and asking, "How many more bottle tops do you need to place 40?" In Task 5.3b, we showed 20 black circles of the same shape on a sheet of paper as frame of 10 and asked the question, "Please enclose 13 black circles." The common point of these tasks was to reveal the number of concrete and semi-concrete objects by counting and capturing groups of 10. This was improved by the intervention.

This suggests that the pupils in the experimental group changed their behavior in Task 1.1 from counting down one by one to counting in groups. As for Task 3, the pupils in the experimental group were not able to count down in the pre-survey; however, they were approaching the stage where they could count down one by one. For Task 1.3, the post-survey mean was 4.55, which means that the number of pupils who answered using groups of 10 increased. For task 5.3b, the overall level of the task was lower because of the use of semi-concrete objects, but it improved to a point where it was close to level 3, where pupils answered by counting one by one.

On the contrary, no intervention effect was found for tasks 6.m1, 6.m2, and 6.d1. Task 6.m1 asked them to represent 2×3 with 10-frames and bottle tops, and task 6.m2 asked them to represent 12×3 with 10-frames and bottle tops. Task 6.d1 asked them to represent $8 \div 2$ using 10-frames and bottle tops. These tasks are related to multiplication and division. Therefore, the results indicate that the intervention of frame 10 was effective for the content related to counting and capturing the groups of 10. In other words, it was effective for capturing the number of concrete objects, the manipulation of concrete objects for composition and decomposition, and addition and subtraction by manipulating concrete

objects. On the other hand, when the pupils were asked to perform multiplication and division operations, it became clear that the intervention was not effective in expressing them with concrete objects. In the case of multiplication, since most of the pupils thought that a unit quantity was multiplied by the number of units, they could not use the frame of 10 effectively. Thus, we observed that it was difficult to emphasize the frame of 10 and the groups of 10 in multiplication. A further explanation is given later, together with the results of the tests.

3.2.3 Changes between pre- and post-surveys in the individual pupils

In Figure 10 we present the changes in the average of 71 pupils who received both pre- and post-surveys.

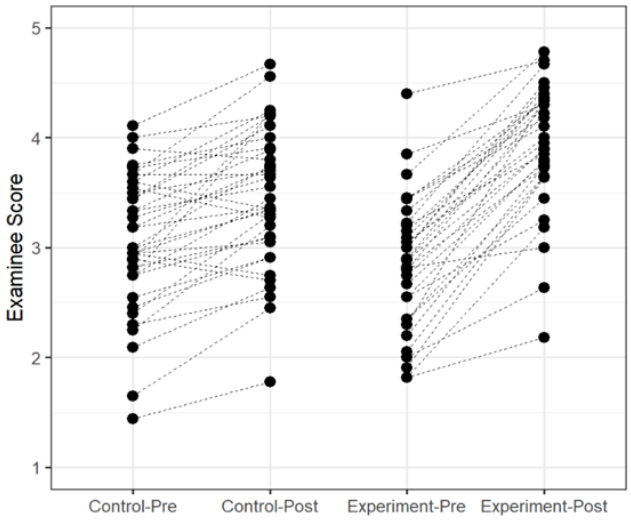


Figure 11 Change of the average of each pupil in the control and experimental groups

The changes in the interview scores of the experimental group are shown in Figure 11. All pupils in the experimental group showed an improvement. Furthermore, the values for 21 pupils in the experimental group increased by more than 1.0 point, while only two pupils in the control group exhibited the same increase. A student with the largest increase in the score (experimental group, grade 4) had 2.3 before the interview and 4.350 after the interview (a difference of 2.050 points). This was a drastic improvement as the score had increased by 2.0 points in accordance with the response level. There were

seven pupils whose scores dropped, all of whom were in the control group.

Our analysis further focused on the results of pupils whose scores increased the most in each grade. Table 17 presents the scores of pupils who had improved the most at each grade, their scores at the pre- and post-surveys, and the differences between them. All of these pupils belonged to the experimental group; only the second graders showed a different trend, with a mean pre-survey score above 3.00.

Table 17 Pupils with the highest increase in each grade

Grade	group	pre	post	difference
1	experimental	1.91	3.64	1.73
2	experimental	3.22	4.67	1.44
3	experimental	2.05	3.65	1.60
4	experimental	2.30	4.35	2.05

Table 18 shows the interview tasks and the results of the pupils who showed the greatest improvement in grade 1.

Table 18 A pupil who showed the most improvement in Grade 1

G1	1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4
pre	2	3	1	1	3	2	3	3	1	1	1
post	5	5	4	3	3	3	3	4	4	3	3

In the pre-survey, a student had problems in counting objects, but in the post-survey, this problem improved, and he was able to count. However, in the post-survey, the scores of tasks 1.1 to 1.3 were over 4, which indicates that the student was able to capture numbers as groups of 10. In addition, the scores of 4 for tasks 3.1 and 3.2 indicate that the student was able to move the bottle tops to make groups of 10. On the other hand, the scores of 3 for tasks 3.3 and 3.4 indicate that further intervention is needed to capture them as a group.

Table 19 shows the interview tasks and results for a student in grade 2 who showed the greatest

improvement.

Table 19 A pupil who showed the most improvement in Grade 2

G2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.1
pre	1	3	3	5	4	4	3	2	4
post	2	5	5	5	5	5	5	5	5

The pupil scored 5 on the post-survey from tasks 2.2 to 4.1. In tasks 2.2 and 2.3, the pupil's pre-survey score was 3, but the post-survey score improved to 5. These tasks involved recognizing the number of bottle tops placed in frames of 10. In the pre-survey, the pupil counted them one by one, but in the post-survey, the pupil was able to recognize the number of bottle tops by focusing on groups of 5 or 10 and to explain verbally how they did so. The pupil was also at levels 2 and 3 in the pre-survey for tasks 3.3 and 3.4, but improved to level 5 in the post-survey. In these tasks, the pupil could not even count one by one or answer the appropriate number in the pre-survey but was able to focus on groups of 5 or 10, recognize the number, and explain the method in the post-survey. On the other hand, in Task 2.1, the pupil did not show significant improvement, which remained at Level 2 in the post-survey. In Task 2.1, the pupil had to make a straight-line pattern using white and red bottle tops. However, the pupil was not able to make a pattern in the pre-survey and made a non-straight-line pattern in the post-survey.

Table 20 shows the interview tasks and results of a pupil in grade 3, who showed the most improvement.

Table 20 A pupil who showed the most improvement in Grade 3

G3	3.1	3.2	3.3	3.4	4.1	5.1	5.2a	5.2b	5.3a	5.3b	5.3c	5.3d	6.a1	6.a2	6.s1	6.s2	6.m1	6.m2	6.d1	6.d2
pre	1	1	5	1	1	1	2	2	3	1	2	1	3	3	3	1	5	3	1	1
post	5	5	5	5	5	5	2	3	2	3	1	5	3	3	2	2	5	4	4	4

In the case of this student, the improvement from Task 3.1 to Task 4.1 is noteworthy. Tasks 3.1 to 3.4 relate to the composition and decomposition of numbers, while task 4.1 is for recognizing the number of 49 bottle tops placed in frames of 10. In the pre-survey, most of the tasks were rated as low stage,

except for task 3.3. On the other hand, in the post-survey, in all tasks, the student was able to recognize the composition and decomposition of numbers by focusing on the grouping of numbers, and the pupil was able to explain verbally how to compose. On the other hand, in Task 6.s1 and 6.s2, the level remained at 2 in the post-survey, and no significant improvement was observed. Tasks 6.s1 and 6.s2 are subtraction tasks with bottle tops, but the pupil answers by adding the number of bottle tops. These results indicate that the pupil had a problem in relating subtraction to concrete objects.

Table 21 shows the interview tasks and results of a pupil who showed the most improvement in Grade 4.

Table 21 A pupil who showed the most improvement in Grade 4

G4	3.1	3.2	3.3	3.4	4.1	5.1	5.2a	5.2b	5.3a	5.3b	5.3c	5.3d	6.a1	6.a2	6.s1	6.s2	6.m1	6.m2	6.d1	6.d2
pre	3	3	3	3	3	3	4	3	4	2	1	1	3	3	1	1	2	1	1	1
post	5	5	5	5	5	5	5	5	5	2	5	5	3	3	5	5	1	5	4	4

In the case of this pupil, the improvement from Task 3.1 to Task 4.1 is noteworthy. Tasks 3.1 to 3.4 are concerned with the composition and decomposition of numbers, while task 4.1 is about recognizing the number of 49 bottle tops placed in frames of 10. In the pre-survey, the pupil counted one by one and answered all the tasks. On the other hand, in the post-survey, in all tasks, the pupil was able to recognize the composition and decomposition of numbers by groupings, and was able to explain verbally the method. Significant improvements were also observed in tasks 5.3c, 5.3d, and 6.s1 and 6.s2. Tasks 5.3c and 5.3d are for capturing the black circles as groups and tasks 6.s1 and 6.s2 are for subtraction. In the pre-survey, the pupils performed poorly and were incorrect in their answers to all the tasks. On the other hand, in the post-survey, the pupil was able to grasp the groups of 10, and in some tasks, the score improved to level 5, where the pupil was able to explain the reason verbally. Considering the relationship between the pupil and the intervention, it became clear that the use of the frame of ten and the emphasis on groups of 10 enabled the pupil to grasp the number in groups rather than counting one

by one.

Based on the above discussion, we summarize the trends and issues observed among the four pupils. Tasks 3.1 to 3.4, which were common to all grades, except for grade 1 all other grades (2 to 4), reached Level 5, and were able to focus on the groups of 10 and explain them in words, indicating the effectiveness of frames of ten. In grade 1, the pupils improved from Level 1 in the pre-survey to Levels 3 and 4 in the post-survey. In grades 3 and 4, other than Task 3, pupils were able to focus on the groups of 10. Although there are still some challenges, our data confirmed these pupils were able to find a solution to replace counting one by one. Previous studies suggest that Zambian pupils have difficulty in explaining reasons linguistically (Shibuya, 2008; 2009), however, the fact that the pupils in our study were able to explain linguistically in their early grades is a major achievement for our intervention method.

3.3 Test results

The test (written test) was administered only to grade 3 and 4 pupils. We planned for 40 pupils of each grade from the 10 schools, which means that a total of 800 pupils were supposed to have participated in the test. Table 22 shows the actual number of participants in the pre-test and post-test for the experimental and control groups, respectively. There were 776 and 695 pupils who participated in the pre-test and post-test, respectively. Among them, 555 pupils took both tests (hereafter referred to as the same pupils). Among the "same pupils" 27 pupils had also participated in both the interviews during the pre- and post-surveys.

Table 22 Number of participants in the control and experimental groups

Group	School	Pre			Posy			Common Students between pre and post		
		G3	G4	Total	G3	G4	Total	G3	G4	Total
Control	A	26	25	51	25	23	48	22	21	43
	C	36	36	72	26	36	62	25	27	52
	E	50	39	89	48	32	80	29	24	53
	H	50	47	97	29	42	71	26	42	68
	J	40	51	91	39	34	73	32	26	58
Experiment	B	10	19	29	22	38	60	5	16	21
	D	36	43	79	33	45	78	27	37	64
	F	54	53	107	44	45	89	36	41	77
	G	38	30	68	26	30	56	26	22	48
	I	44	49	93	34	44	78	34	37	71
Total number of Contorol		202	198	400	167	167	334	134	140	274
Total number of Experiment		182	194	376	159	202	361	128	153	281
Total		384	392	776	326	369	695	262	293	555

3.3.1 Distribution of test scores

The test score of 11 questions (Q 1 to 6, 9 to 11) that ask "making groups" and "counting" and the test scores of 10 questions (Q 14a to 14j) that ask "calculation" were converted to binary data and each of the sums was calculated respectively. They are referred to as the MC (Making groups and Counting) and CA (Calculation) scores, respectively. The distributions of the MC and CA scores at the pre- and post-surveys are shown in Figure 12 as box plots. The descriptive statistics are shown in Table 23. As can be seen from the boxplots and descriptive statistics, both MC and CA scores improved after the test. The scatter plots of the MC and CA scores in the pre- and post-surveys are shown in Figures 13 and 14, respectively. The correlation coefficients are 0.50 and 0.47 respectively, which indicate that although the MC and CA scores are moderately correlated, they capture different rather than the same cognitive aspect. Therefore, the MC and CA scores were analyzed separately.

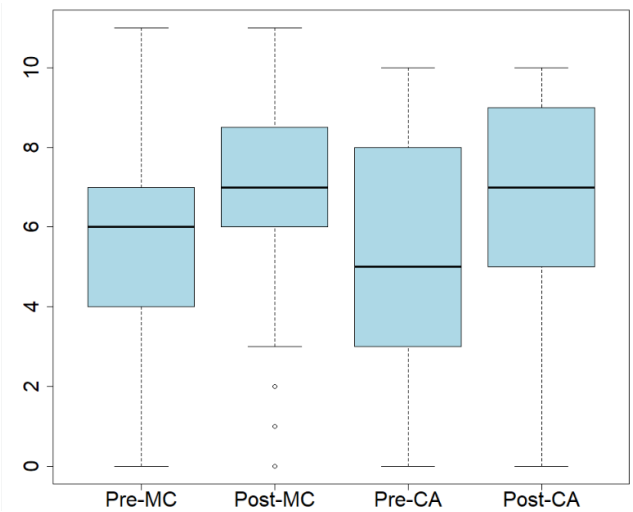


Figure 12 Boxplots of test scores (MC score and CA score)

Table 23 Descriptive statistics for MC and CA scores

		Average	Median	SD	Max	Min	Cronbach's α
"Grouping"・"Counting"	Pre	5.69	6.00	2.11	11.00	0.00	0.69
	Post	7.00	7.00	2.07	11.00	0.00	
Calculation	Pre	5.28	5.00	2.91	10.00	0.00	0.84
	Post	6.77	7.00	2.75	11.00	0.00	

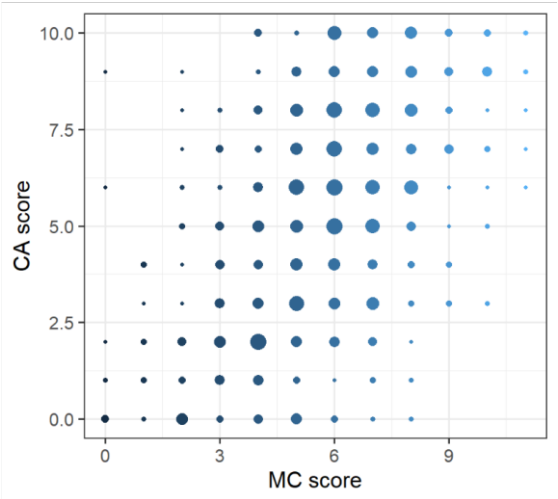


Figure 13 Scatter plot of MC and CA scores in pre-test

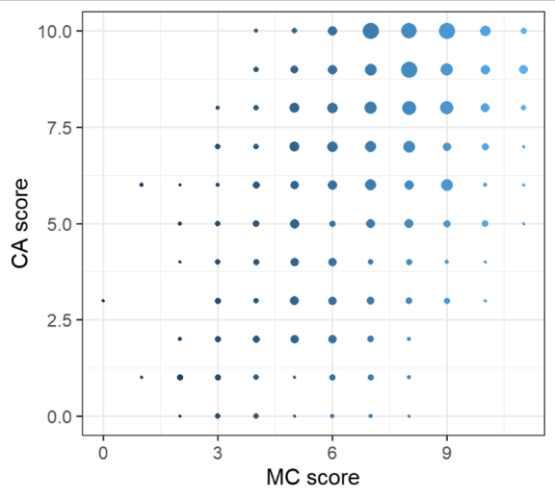


Figure 14 Scatter plot of MC and CA scores in post-test

3.3.2 Comparison of pre and post test scores between control and experimental groups

The MC and CA scores of the pre- and post-tests in the control and experimental groups were compared. Figures 15 and 16 show the changes in the mean MC and CA scores of each group. As shown in Figure 15, the increase in the MC score was more in the experimental group than in the control group. Regarding the CA score, Figure 16 shows a similar trend for both the control and experimental groups. The 11 questions for the MC score consisted of five questions on "making groups" and six questions on "counting." Therefore, we also analyzed the changes of the mean scores (M-scores) of the five questions on "making groups" and the mean scores (C-scores) of the six questions on "counting." The results are shown in Figures 17 and 18. From these figures, it can be seen that both M-score and C-score increased more in the experimental group than in the control group. Table 24 shows the results of the difference analysis to estimate the effect of the intervention on the experimental group. We found that the intervention effect was observed for MC, M, and C scores.

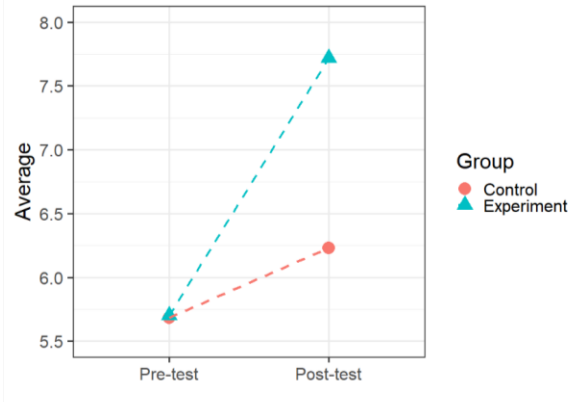


Figure 15 Change of average MC score

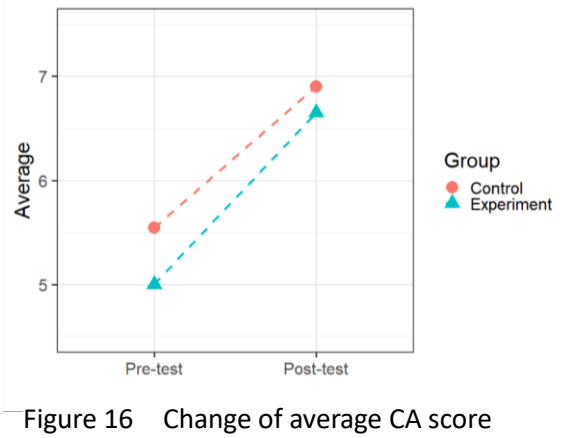


Figure 16 Change of average CA score

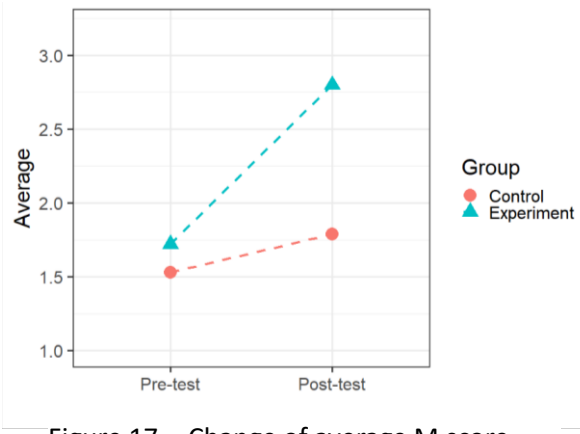


Figure 17 Change of average M score

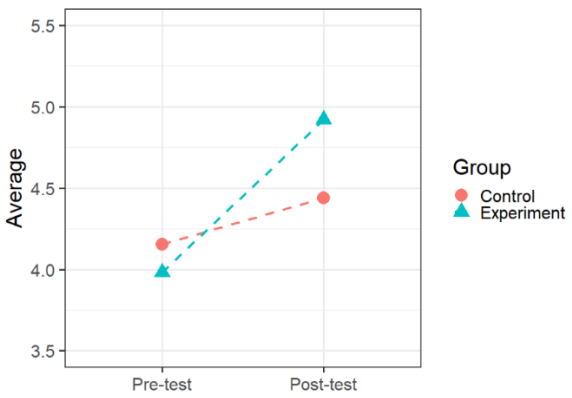


Figure 18 Change of average C score

Table 24 Difference-in-differences analysis of test score

	Number of items	Control		Experiment		Estimated intervention effect	p-value
		Pre	Post	Pre	Post		
MC score (Grouping & counting)	11	5.68	6.23	5.70	7.72	1.47	0.00
M score (Grouping)	5	1.53	1.79	1.72	2.80	0.82	0.00
C score (counting)	6	4.15	4.44	3.98	4.92	0.65	0.00
CA score (calculation)	10	5.55	6.90	5.00	6.65	0.29	0.32

3.3.3 Change in the percentage of correct answers in the control and experimental groups

We further analyzed for changes in the percentage of correct answers for 11 questions related to "making groups" and "counting" and 10 questions related to "calculation." Table 25 shows the correct answer rate and odds ratio for each question as the intervention effect of each question estimated using the logit regression model. In addition, Figures 19 and 20 show the changes in the percentage of correct answers. From Figure 19, we confirmed that questions 4rd and 6 were greatly increased in the experimental group,

which was not observed in the control group. The results also suggest that the intervention effect is likely to appear in the six questions 4ld, 4rd, 5, 6, 8, and 10m when an odds ratio of 2.0 is used. These questions relate to placing the bottle top in the frame of 10 and identifying the groups of 10, which was done in the intervention. In addition, Table 25 and Figure 20 show that there is no significant difference in the 10 calculation problems between the pre- and post-surveys. The reason why the effect of the intervention did not clearly appear in the 10 calculation problems may be that since they are the calculation up to two digits, pupils were able to find correct answers by counting the same as before by using the new method of intervention.

Table 25 Changes in the percentage of correct answers and odds ratios for questions on grouping and calculations

No.	Code	Item content	Category	Control		Experiment		Odds ratio	p-value
				Pre	Post	Pre	Post		
1	q1m10	Drawing 10 dots in a group of 10.	Grouping	10%	27%	22%	44%	0.84	0.50
2	q2	Counting 35 dots.	Counting	50%	58%	43%	63%	1.63	0.02
3	q3	Counting 14 dots in the frame of 10.	Counting	87%	91%	86%	93%	1.36	0.38
4	q4ld	Drawing 5 dots in the bottom row of the frame of 10.	Grouping	86%	90%	87%	98%	4.00	0.00
5	q4rd	Drawing 2 dots in the bottom row of the right side of the frame of 10.	Grouping	46%	48%	43%	88%	8.63	0.00
6	q5	Counting 11 dots in the frame of 10.	Counting	94%	96%	90%	97%	2.33	0.09
7	q6	Counting the number of dots needed to fill the two frames of 10.	Counting	47%	56%	41%	72%	2.53	0.00
8	q7	Counting the number of dots needed to fill the two frames of 10.	Counting	66%	69%	70%	82%	1.76	0.02
9	q8	Counting the 51 dots.	Counting	72%	74%	67%	84%	2.36	0.00
10	q9m	Circling 12 dots.	Grouping	7%	8%	13%	24%	1.64	0.15
11	q10m	Circling 76 dots.	Grouping	5%	6%	7%	26%	4.14	0.00
12	q14.a	3+4	Caluclation	88%	94%	85%	91%	0.81	0.57
13	q14.b	7+9	Caluclation	79%	86%	71%	84%	1.29	0.35
14	q14.c	12+23	Caluclation	67%	78%	64%	68%	0.72	0.16
15	q14.d	6-2	Caluclation	65%	78%	60%	77%	1.18	0.49
16	q14.e	13-7	Caluclation	58%	67%	55%	73%	1.45	0.09
17	q14.f	24-12	Caluclation	55%	63%	50%	70%	1.59	0.03
18	q14.g	4×6	Caluclation	40%	61%	33%	56%	1.12	0.60
19	q14.h	12×3	Caluclation	35%	56%	31%	49%	0.93	0.75
20	q14.i	9÷3	Caluclation	39%	56%	27%	53%	1.52	0.06
21	q14.j	26÷2	Caluclation	28%	51%	24%	44%	0.95	0.81

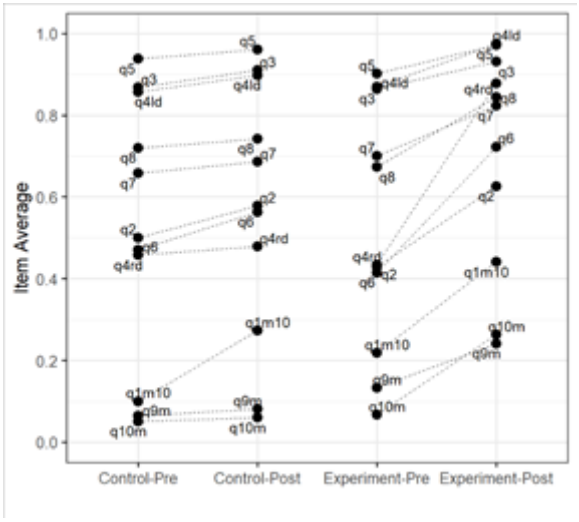


Figure 19 Change of percentage of correct answer in MC

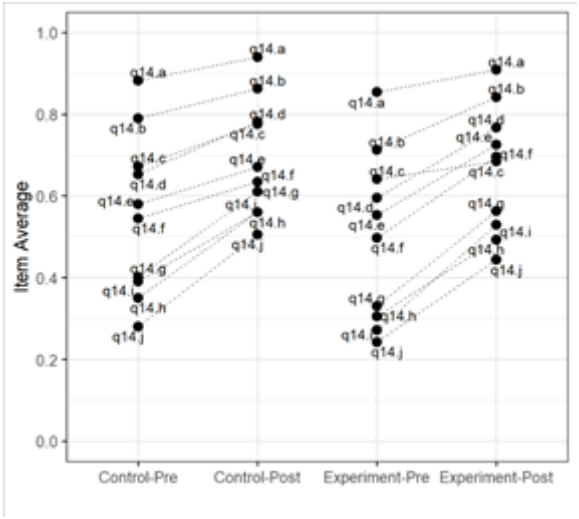


Figure 20 Change of percentage of correct answer in CA

3.4 Summary

The following two points were clarified in the interview.

First, comparing the results of the pupils in the control group and the experimental group, the pupils in the experimental group improved from the stage of counting one by one to the stage of grasping numbers in groups by using concrete objects. We also found that the use of concrete objects (bottle tops) yielded better results than the use of semi-concrete objects (black circles)[3]. This indicates that the manipulation

[3] In the tasks 5.3c and d, there could have been a language factor here, e.g. circle 76 dots did not

of concrete objects is effective for grasping numbers. Analysis of the results for individual pupils also showed that some of the pupils of lower grades were able to move from counting one by one to explaining mathematical events and operations.

Second, regarding the interview scores, all pupils in the experimental group improved. This shows that the difference in the experimental group was larger than that in the control group.

There are two main points that the test has revealed.

First, the odds ratio of the experimental group and control group was more than 2.0, for the questions about seeing numbers as groups and counting, which means that the intervention was sufficiently effective. It can be said that the same results of the interviews were shown in the test.

Second, in the calculation problems, there was no statistically significant difference between the experimental and control groups. This may be due to the fact that all the questions were presented with numbers up to two digits, so the pupils were able to find answers by counting in the same way as before.

This study aimed to develop an exploratory interview-based research method to identify the reasons for low academic achievement of Zambian pupils and to develop methods of intervention to clarify such reality. On the other hand, in consideration of future implementation, we also developed a test based on what was suggested in the interviews. The test results were similar to those of the interviews in some areas, but there were no significant differences in some areas.

Correlation coefficients between the interview and test scores were also calculated for the 27 pupils who participated in both the interview and the test. In the control group, the correlation coefficient was quite high in the pre-survey (0.72) but decreased in the post-survey (0.50). In the experimental group, there was little correlation in the pre-survey (0.02), but it tended to be slightly higher (0.30) (Table 26, Figure 21).

distinguish whether the circling should be 1x1 or a single circle. This complicated the analysis.

Table 26 Relationship between interview and test

	Control		Experiment	
	Pre	Post	Pre	Post
Correlation coefficient	0.72	0.50	0.02	0.30

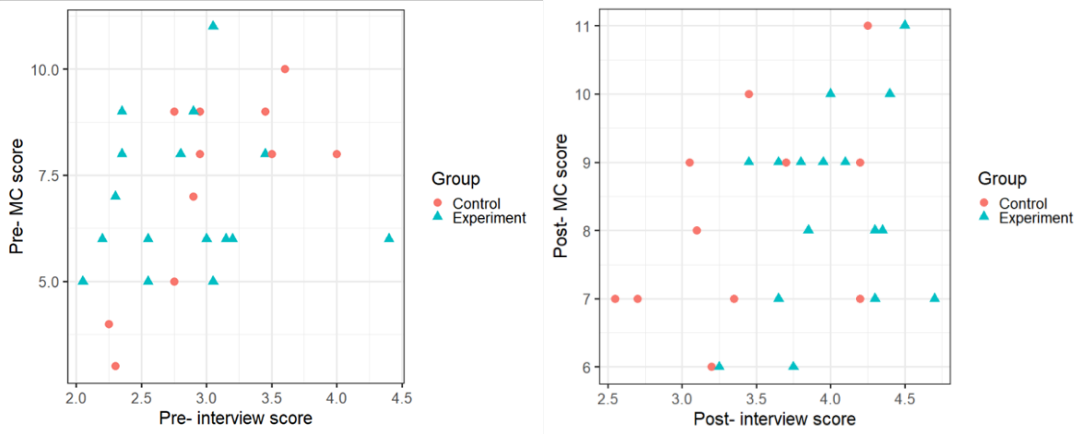


Figure 21 Correlation between interviews and tests

Chapter 4 Discussion

4.1 Discussion of the interview analysis

This research project aimed to develop an assessment tool to identify the basic arithmetic skills of Zambian pupils and obtain suggestions for improvement. This section discusses, two points the improvement of numeracy competence and the validity of the developed assessment tool.

With regard to "numeracy competence," two points are discussed: the basic part of calculation skills, such as "using groups of 10" and "capturing set numbers without counting," which are equivalent to levels 4 and 5 of the interview, and the applied part, which is the higher-order skill of "expressing one's thoughts in words," which is equivalent to Level 5.

First, regarding the groups of 10 and counting, there have been many discussions in mathematics educational research regarding counting and addition strategies (Baroody, 1987; Fuson & Burghardt,

2003; Verschaffel, Greer, & De Corte, 2007). Among them, several studies have pointed the importance of recognizing the groups of 10 empirically by demonstrating the developmental stages of computation (e.g., Murata & Fuson, 2006) and have shown how to add and subtract several digits by using a theoretical framework. Herzog et al. (2017) and other research groups have shown that understanding the base ten place value system is related to understanding higher-level mathematics problems and basic mathematics operations (Jordan, N. C., Glutting, J., & Ramineni, 2010). Thus, the purpose, content, and methods of this research project are important for research in mathematics education.

Although the groups of 10 are recognized as important in mathematics education, before introducing abstract numerical methods for pupils, the manipulation of concrete objects to form a conceptual image behind numbers and use of semi-concrete objects such as circles shown in a paper for the preparation of complete transition to abstract numbers are not given due attention in the Zambian syllabus. (Tall, D. et al., 2000). For example, in Grade 1, only "recognizing, counting, reading, and writing numbers from 1 to 100" and "interpreting numbers with 10 as the unit" are presented (Ministry of Education, Vocational Training and Early Education, 2013, p. 1). Figure 22 shows pages of a textbook for grade 1 pupils in Zambia. It can be seen that although concrete objects are drawn on the textbook, there is no emphasis on manipulating them.

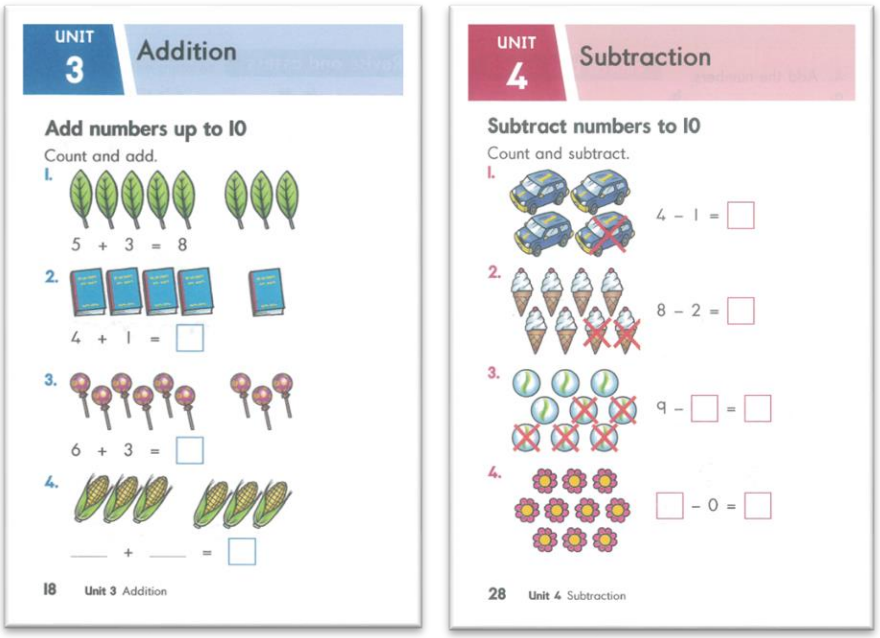


Figure 22 Example of calculation of Zambian grade 1 textbook

This illustrates the challenge that the learning of mathematics expected in Zambia is abstract from the beginning.

This study attempts to address the research gap left by previous research. Regarding the manipulation of concrete objects and attention to the groups of 10, we found that there was improvement, especially from level 3 to level 4, through the interviews and the tests using 10-frames and bottle tops during the intervention.

The results of interviews of individual pupils also showed that they were able to move ahead and learn more than counting, which had been a challenge in mathematics education in Zambia. This is a significant achievement, as it leads pupils to be able to manipulate numbers in formal calculations, focusing on groups of 10. This is particularly related to the manipulation of concrete objects before progressing to numerical computation in lower grades of primary and preschool mathematics education.

The results of interviews, mainly in relation to Level 5 "Demonstrate and explain your ideas verbally"

were analyzed. We found that the pupils were able to reflect on the calculations they performed and told others why they did them. This aspect could be an important outcome for the development of higher-order skills in Zambian mathematics education, which tends to emphasize acquisition of procedural knowledge to find an answer without understanding the reason for it. In a previous study, it was reported in a Grade 5 mathematics class pupils used only standard expressions to express their opinions and ideas (Nakawa, 2010). From the results of the post-interviews, we found that some pupils, even in Grade 1, could express the reasons and methods of calculation orally and through gestures using their local language. This means that even in Grade 1, pupils should be actively given the opportunity to explain their calculations, whenever possible. The act of explaining leads to discussions with others, which may lead to the development of an individual's capacity for logical thinking. The results of this study can be used to identify the potential of pupils in mathematics education in Zambia.

A future issue is how to create a relationship between calculations by manipulating concrete objects and calculations in written operations. Additionally, it became clear empirically that 10-frame does not work effectively in multiplication and division. Since these points were not the main focus of this research project, we will continue to study them in the future.

Second, the validity of the developed assessment tool is discussed as it clearly distinguishes between the levels of counting and recognizing numbers as groups. Moreover, the tool was able to accurately diagnose how pupils capture and calculate numbers, as well as relate to the stages in the learning trajectory (Clements & Sarama, 2013) and patterns and structure (Mulligan & Mitchelmore, 2009; 2013). It is also possible to identify pupils who are moving towards higher levels, such as levels 4 and 5. Furthermore, it can be used as an indicator to assess individual pupils' progress and consider effective teaching. For example, focusing on individual pupils, if she or he reaches Level 5 in some tasks and Level 3 or lower in others, it can be determined that she or he is able to explain verbally. Therefore, for problems with low response levels, the teacher can support the pupil by determining whether she or he

grasps the meaning of the task or has difficulty in any part of the calculations, and if the average response level of a particular problem is 3 in the whole class, then most pupils in the class have difficulty grasping the numbers as groups of 10. Therefore, it is possible to strengthen that point by dealing with it intensively. In other words, by using the assessment tools, we can consider teaching methods for individual pupils and the whole class. It can be said that there is a possibility to realize the integration of evaluation and instruction in Zambia, which is often emphasized in Japan (National Institute for Educational Policy Research, 2020). Even if teachers do not have enough time, they can easily make a diagnosis by asking pupils to raise their hands. Therefore, this can be part of the recommendations made later.

4.2 Discussion of the test analysis

We found that many Zambian pupils count and calculate primarily by "counting all." This further means that several of them have not reached the stage of counting and calculating using the idea of decimal numeration and structure of the base ten place value system. Therefore, they cannot accurately grasp large numbers or perform the four arithmetic operations correctly and it is not distinguishable if they don't understand the calculation principle or make a simple calculation mistake when the number becomes large at higher grades. The situation becomes worse when they enter into a junior high school and the contents become more sophisticated. They simply memorize the formula without understanding and that is the only strategy.

In general, the first step in acquiring the concept of number is to connect concrete objects, semi-concrete objects, and numbers to each other, as shown in Figure 23. After that, the understanding of the meaning of the number itself progresses, leading to an understanding of the meaning and method of calculation.

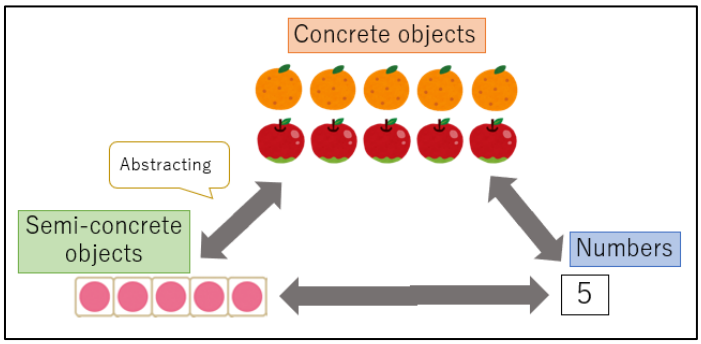


Figure 23 Relationship among concrete object, semi-concrete object and number

In the analysis of the test data, questions related to "grouping," "counting," and "calculation" were dealt with. The "grouping" and "counting" questions were included to evaluate whether the pupils could understand how to form groups by grouping 10 semi-concrete objects together, and verify the connection between semi-concrete objects and numbers in Figure 23. In "Calculation," instead of answering the question by counting all, we consider how to use the structure of base ten place value system in the calculation. "Grouping," "Counting," and "Calculating" have different perspectives of assessment. However, they are not completely independent of each other.

In the analysis of the test data, the MC and CA scores were calculated. The correlation coefficient was 0.50 for the pre-test and 0.47 for the post-test. The absence of a strong correlation such as 0.8 or higher supports the fact that, as mentioned earlier, the MC scores for "grouping" and "counting" and the CA scores for "calculation" have different perspectives on assessment.

The results of the analysis showed an intervention effect on MC scores (Figure 15, 19, Table 24, and 25). This confirms that the developed materials are effective in evolving the concept of counting all in pupils, which is the basis of the base ten system. For example, it was suggested that placing the bottle tops into the frame of 10 was effective.

On the other hand, there was no positive intervention effect on the CA score for "calculation" (Figures

16, 20, Table 24, and 25). As prerequisite knowledge for calculations using the structure of the base ten place value system (calculation with carrying or borrowing, calculation in vertical form), it is essential to see numbers as groups of 10. However, understanding the structure of numbers as groups of 10 and how to calculate using that structure are different cognitive aspects. When applying the understanding of the number structure to the calculation method, it is necessary to consider more effective teaching materials and teaching methods. Moreover, the 10 questions are calculations with numbers of one or two digits. Therefore, it is possible to find answers by counting all of them. In order for pupils to assess the calculation method, it is necessary to prepare questions using larger numbers of two digits.

Chapter 5 Recommendation

5.1 Policy recommendations

Through this exploratory approach, we were able to identify the pupils' numeracy competence within one-digit and two-digit numbers. This is a very useful method for approaching even very poor performance. This was achieved through a collaboration between the Zambian team and the Japanese team. This study can be extended to other areas of education.

(1) [PRESET] Regarding teacher education, we propose that it is possible to write a textbook for undergraduate students at UNZA and teacher education colleges, who do not have any teaching experience. They can be prepared for teaching various competence levels of pupils, even before becoming teachers. Different interview guides contain much information regarding Zambian pupils. The video data can be used to understand the behavior of different competence levels of pupils and the intervention approach according to the level.

(2) [INSET] Regarding classroom teaching and assessment methods, the developed intervention tools (pupils' workbook and teacher's guide) can be used directly and/or for the INEST. The language used in the developed materials was only Chinyanja. Thus, it is necessary to translate it into other languages.

(3) [CURRICULUM] The whole approach can be called evidence-based curriculum development. This exploratory approach was adapted to modify the draft tools to suit the pupils' necessity through analysis and discussion on collected evidence. As this covers only one-digit and two-digit numbers, the exploration can be extended to larger and smaller numbers, such as decimal numbers. As an extension of this effort, the current Curriculum Development Center (CDC) can be reformed to the Curriculum Research and Development Center (CRDC).

5.2 Research recommendations

As mentioned above, the current study has limitations such as mathematical topics and target areas.

(1) [Mathematics extension] The100 is ten groups of 10 and 1000 is ten groups of 100, that is ten groups of ten groups of 10. In this way, we can extend this principle to larger numbers by extending the mutual relationship between adjacent digits such as 100s and 10s, 1000s and 100s. Once the pupils are able to master this relationship, this principle can be extended to smaller numbers such as 0.1s and 0.01s. In addition, there were almost no effects of intervention on multiplication and division during this research project. It is important to explore on its reason and approach to improve the competence in those contents. They are very critical in the number domain because they lead to ration and proportion at higher grades. Further, we can use similar principle to develop skills in other domains such as geometry and statistics.

(2) [Pupils (grade-wise) extension] We could not follow how pupils grow longitudinally. If we could follow some pupils from grades 1 to 4, we might be able to identify how each one grows in a longer term. Unfortunately, there are a few pupils who could show much change despite the intervention. We might follow such pupils more closely.

(3) [Area-wise extension] We have shown the relationship between the interview results and test results. They do not show a high level of relation, and thus, it is important to approach pupils

diagnostically. To increase the number of pupils, we might consider some kind of ICT technology and devices (iPad).

(4) [Language-wise extension] Language in mathematics education is a critical factor. Our approach in this research is not only linguistically correct, but also mathematically friendly and appropriate. When languages other than Chinyanja are used, this approach of mathematical friendliness can be proposed. Regarding the medium of instruction at early stage of schooling, there are some countries, which have been argued the preference between a medium like English and a local language. For example, in the Philippines, one view is that children can understand more easily by connecting their learning to daily life using local language and another view is that it is advantageous for children to start using English as global language at early stage and to get used to it. Language issue has not only cognitive significance but also social and national significance such as working abroad (Hashimoto).

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Appendix 1

Interview Guide

Interview Guide

for

Numeracy Competence

Content

[1.1 Counting objects one by one, by groups]

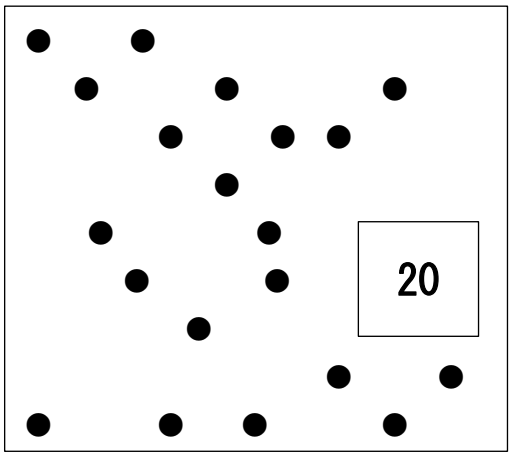
Places 20 bottle tops randomly

Q. 'Count and tell me the number'
When s/he counts one by one correctly
Q. 'Count in 2s and 5s'

Local language

Penda, uniuze tuli tungati

Penda tubili tubili; penda five-five



Intention of the question	To correspond one to one up to 20 correctly.
Materials	20 bottle tops

[Response levels]

1Not at all	S/he makes a mistake in counting, 1, 2, 3, 4, or 5.	
2 Partially Implicit	S/he can count correctly up to 5.	Incorrect
3 Implicit	S/he can count one by one up to 20 s	Correct It does not matter the counting speed. (S/he can count correctly corresponding one by one up to 20)
4 Structural	S/he can count up to 20 in 2s or 5s	**It's level 4 if s/he cannot count either 2s or 5s.**
5 Advanced structural	S/he can count up to 20 both in 2s **and** 5s	

[1.2 Counting forward]

Q. 'Count up to 20.'
For those who reached the fourth response category,
Q. 'Count 2s and 5s up to 20'.

Local language
Penda kufika pa 20
Penda muma 2 kufika pa 20
Penda muma 5 kufika pa 20

Counting upward

Intention of the question	To count numbers from 1 up to 20 upward correctly
Materials	None

[Response levels]

1Not at all	S/he cannot count numbers up to 10.	
2 Partially Implicit	S/he tries to count numbers but failed to count up to 20	
3 Implicit	S/he can count numbers upward one by one.	Counting all
4 Structural	S/he can count numbers upward up to 20 in 2s **or** 5s.	**It's level 4 if s/he cannot count either 2s or 5s.**
5 Advanced structural	S/he can count numbers upward up to 20 both in 2s **and** 5s.	

[1.3 Counting backward]

Q. 'Count down from 20 to 1.
For those who reached the fourth response category,
Q. 'Count 2s and 5s from 20 downward. '

Local language
Penda kuchoka pa 20 kubwela pansi
Manje penda muma 2 kuchoka pa 20 kubwela pansi
Manje penda muma 5 kuchoka pa 20 kubwela pansi

Counting downward

Intention of the question	To say numbers from 20 down to 1 downward correctly
Materials	More than 20 bottle tops

[Response levels]

1Not at all	S/he cannot count numbers downward to 10.	
2 Partially Implicit	S/he tries to count numbers downward but failed to count to 1.	
3 Implicit	S/he can count numbers downward one by one.	Counting all.
4 Structural	S/he can count numbers one by one downward to 1 says in 2s or 5s.	**It's level 4 if s/he cannot count either 2s or 5s.**
5 Advanced structural	S/he can count numbers one by one downward to 1 both 2s and 5s.	

[2.1Recognizing patterns]

Places 10 each of white and red bottle tops (altogether 20)

Q. “Show a patterns of bottle tops on a line.”

Local language

Nipangileko ka mu line ka nkhale na ka pattern ku sebenzesa utu tonse tupendelo

Ni uze mwamene wa pangila pattern yako

(If the learner gets response 3 category: Nipangileko ka mu line kali na pattern inangu.

Intention of the question	To make original patterns on a line.
Materials	・10 red and white bottle tops respectively

[Response levels]

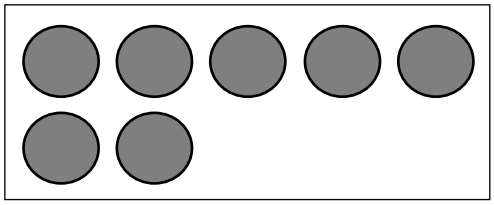
1Not at all	S/he cannot make any patterns.	
2 Partially Implicit	S/he makes a line without any patterns.	Two lines of white and red bottle tops. ○○○○○○○○○○ ●●●●●●●●●●
3 Implicit	S/he can make a line with one by one patterns or 1 red and white line or 5 reds consecutively and whites.	Example: ●○●○●○●○●○●○ Red and white alternately ○○○○○○●●●●●● All white and all red
4 Structural	S/he can make a line with original patterns.	Making a pattern other than arranging one by one alternately. Example: ○○●●●○○●●●○○
5 Advanced structural	Besides level 4, S/he can explain by words.	

[2.2 Recognising structure of numbers]

(Introducing the frame of 10)
Places 7 bottle tops on the frame of 10
Q. 'How many bottle tops are there?

<u>Local language</u>
Tuli tungati tu pendelo utu?
Wapenda bwanji?

How many?



Intention of the question	To identify the bottle tops in a structured way.
Materials	A frame of 10 and 7 bottle tops

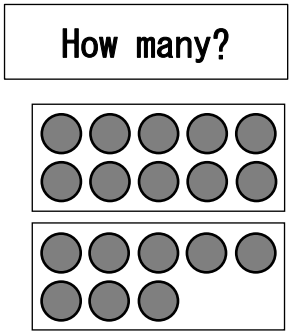
[Response levels]

1Not at all	S/he tries to count, but cannot do it completely in some reasons	
2 Partially Implicit	S/he makes a mistake in counting.	
3 Implicit	S/he can identify the number (7) by counting one by one.	<u>Counting all</u> Judge whether counting one by one or not attentively from student's physical actions.
4 Structural	S/he can identify the number (7) using any groups or counting on from a certain number.	<u>Counting on or using groups</u> Judge from student's actions. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4, s/he can explain by words.	

[2.3 Recognising structure of numbers]

Places 18 bottle tops on the frameworks of 10 vertically
Q. 'How many bottle tops are there?

Local language
Tuli tungati tu pendelo utu?
Wapenda bwanji? (Unless the counting was clear enough)



Intention of the question	To identify the bottle tops in a structured way.
Materials	18 bottle tops

[Response levels]

1Not at all	S/he tries to count, but can not do it completely in some reasons	
2 Partially Implicit	S/he makes a mistake in counting.	Incorrect
3 Implicit	S/he can identify the number (18) by counting one by one from 1	Counting all Judge whether counting one by one or not from student's physical actions.
4 Structural	S/he can identify the number (18) using any groups or counting on from a certain number.	Counting on or using groups Judge from student's physical actions. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4, s/he can explain by words.	

[2.4 Recognising structure of numbers]

※ Do not show and place the 10-frame nearby.

Prepares 20 bottle tops.

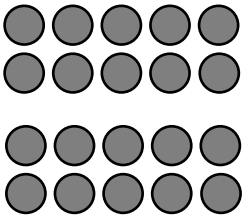
Q. 'Suppose there are two 10 frames and arrange the bottle tops in the imaginary 10 frames.'

Local Language

Khuti pali ma frame of 10 yabili, tutantike tupendelo utu mwamene tunga nkhalile pa ma frame of 10 yabili.

Wachita bwanji?

Imaginary Frames



Intention of the question	To Imagine the frame of 10 in mind and place the bottle tops in such a order.
Materials	・2 frames of 10 ・20 bottle tops

[Response levels]

1Not at all	S/he cannot arrange the bottle tops.	
2 Partially Implicit	S/he can place 20 bottle tops, but they are not placed structurally. (place them randomly)	
3 Implicit	S/he can place 20 bottle tops structurally but not 5 × 2.	[level 3] in case s/he made any structural groups, but did not placed them 5×2.
4 Structural	S/he can place 20 bottle tops correctly considering frame of 10 (5×2).	[level 4] In case s/he placed them 5×2 even when they are spread. In case s/he placed them 5 × 4 (There is no space between two 10s and s/he cannot explain about two 10s)
5 Advanced structural	Besides level 4, s/he can explain by words.	The term 'Ten (10)' should contain in the verbal explanation.

[3.1 Composing and decomposing numbers]

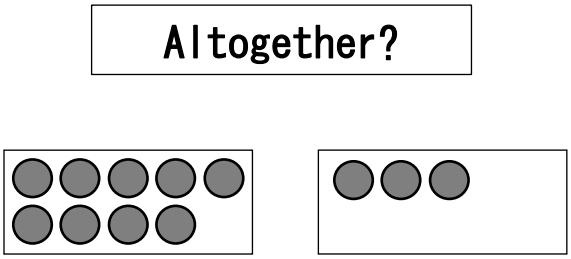
Prepares two frames of 10. On one side, place 9 bottle tops and on the other side, place 3 bottle tops.

Q. 'How many bottle tops are there altogether? You may move the bottle tops'

Local Language

Tuli tungati tupendelo utu pamodzi; ungatu tatike bwino kuti upendze bwino ansa?

Watantika bwanji?



Intention of the question	To add bottle tops in two frames in a structured way.
Materials	・2 frames of 10 and 12 white bottle tops

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he tells the incorrect answers which are closed to the right answer, e.g. 10, 12	
3 Implicit	S/he can find an answer (12) by counting mentally or physically, not moving bottle tops.	Judge whether counting one by one or not from student's physical actions.
4 Structural	S/he can find an answer (12) by moving bottle tops.	Record the method in the individual observation sheet. [Level 4] In the case of counting one by one, after making 10 and 2 as a group by moving bottle tops.
5 Advanced structural	Besides level 4, s/he also can explain by words using group of 10.	(e.g.) Get one top from 3 and place it on the other frame so that we can get a group of 10.

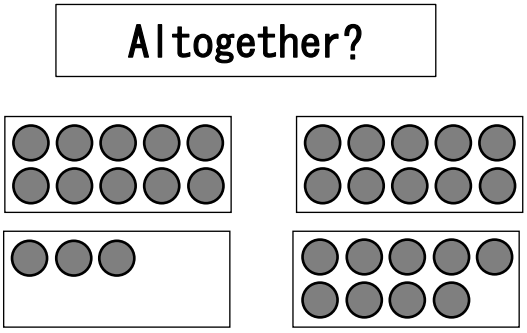
[3.2 Composing and decomposing numbers]

Prepares four frames of 10. On one side, place 13 bottle tops and on the other side, place 19 bottle tops.

Q. 'How many bottle tops are there altogether? You may move the bottle tops.

Local language

Tuli tungati tupendelo utu pamodzi; ungatu tatike bwino kuti upendze bwino ansa? Watantika bwanji?



Intention of the question	To add bottle tops in a structured way
Materials	・2 frames of 10・32 white bottle tops

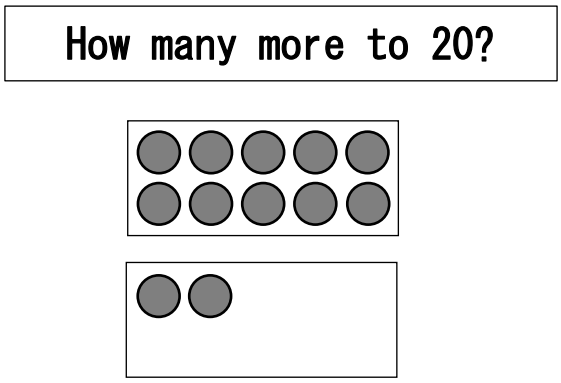
[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he tells the incorrect answers which are closed to the right answer, e.g. 30, 31, 33 or 34.	
3 Implicit	S/he can find an answer (32) by counting mentally or physically **not moving bottle tops.**	Judge whether counting one by one or not from student's physical actions.
4 Structural	S/he can find an answer (32) by moving bottle tops.	Record the method in the individual observation sheet. [Level 4] includes the case of counting one by one after making 30 (three 10s) and 2 by moving bottle tops.
5 Advanced structural	Besides level 4, s/he also can explain by words using groups of 10.	(e.g.) Getting one top from 3 and place it on the other frame so that s/he has a group of 10. Altogether there are three 10s and 2 remaining.

[3.3 Composing and decomposing numbers]

Prepares two frames of 10. Place 12.
Q. 'How many bottle do you need to fill up to 20?

Local language
Pafunika tupendelo tungati kuti tu nkhale 20?
Waziba bwanji?
(If pupil says 'napenda', follow up with, 'wapenda bwanji?')



Intention of the question	To identify the number of bottle tops to fill up to 20 in a structured.
Materials	・2 frames of 10 ・12 bottle tops

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he tells incorrect answers which are close to numbers such as 7 or 9.	
3 Implicit	S/he can find the answer (8) by counting blank boxes mentally or physically one by one from 1.	Counting all Count blank boxes one by one. Judge whether counting one by one or not from student's action.
4 Structural	S/he can find an answer (8) by counting on blank boxes by using any groups.	Counting on or using groups S/he answered 8 without counting blank boxes or counting after a certain group. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4, s/he also can explain by words.	(e.g.) 8 blanks are seen, or the blank part has 5 and 3 in a structure.

[3.4 Composing and decomposing number]

Prepares four frames of 10. Interviewer places 27.

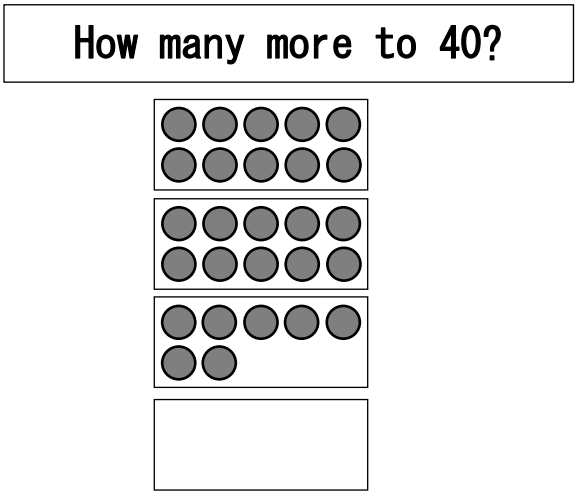
Q. 'How many bottle tops do you need to fill up to 40?

Local Language

Pafunika tupendelo tungati kuti tu nkhale 40?

Waziba bwanji?

(If pupil says 'napenda', follow up with, 'wapenda bwanji?')



Intention of the question	To identify the number of bottle tops to fill up to 40 in a structured.
Materials	・4 frames of 10 and 27 bottle tops

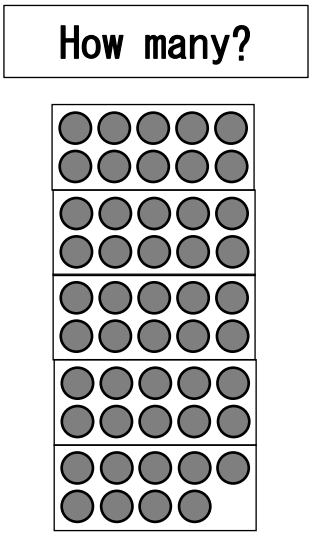
[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he tells incorrect answers which are close to numbers such as 11, 12 or 14.	
3 Implicit	S/he can find an answer (13) by counting mentally or physically one by one from 1.	Counting all:Count blank boxes one by one. Judge whether counting one by one or not from student's physical action.
4 Structural	S/he can find an answer (13) by counting blank boxes on or by using group of 5 or 10.	Counting on or using groups S/he answered 13 without counting blank boxes or counting after 10. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4, s/he also can explain verbally by using group of 5 or 10.	(e.g.) 13 blanks are seen, or the blank part has 10 and 3 in a structured way.

[4.1 Seeing numbers in terms of unit and relative size of numbers]

Prepares five frames of 10 vertically.
Interviewer fills 49 bottle tops.
Q. 'How many bottle tops are there?

Local language
Tuli tungati tu pendelo utu?
Wapeza bwanji ansa?
(If pupil says 'napenda', follow up with, 'wapenda bwanji?')



Intention of the question	To identify the number of bottle tops by seeing the groups of 10.
Materials	・Five frames of 10 ・Forty nine bottle tops

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he tells incorrect answers such as 48 or 50 which is near 49 by counting.	Incorrect but close to the right answer
3 Implicit	S/he can tell 49 by counting one by one.	Judge whether counting one by one or not from student's physical actions.
4 Structural	S/he can tell 49 quickly by using group of 10. or, S/he can tell 49 by using '50'.	Judge from student's physical actions. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4 s/he can explain verbally using group of 5 or 10.	

[5.1 Understanding decimal system]

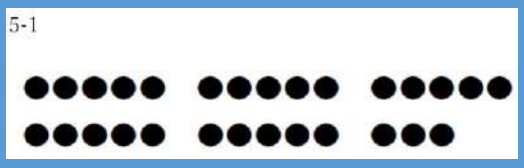
Q. "How many ● are there in the following dot diagram."

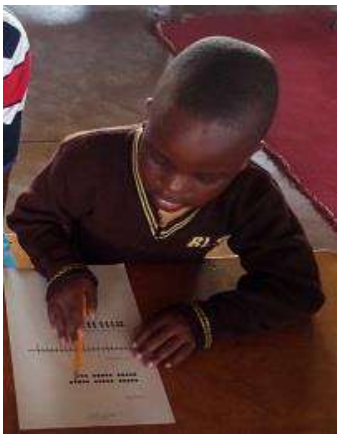
Local language

Tuli tu ngati tu ma dot apa?

Wapeza bwanji ansa?

(If pupil says 'napenda', follow up with, 'wapenda bwanji?')





Intention of the question	To see the numbers considering group of 10.
Materials	Interview material 5-1

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he count the number one by one, however, miscounted in the middle of counting.	Incorrect but close
3 Implicit	S/he can count the number one by one from 1.	Judge whether counting one by one or not from student's physical actions.
4 Structural	S/he can find an answer by using group of 10.	Judge from student's physical actions. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4 s/he can explain verbally by using group of 10.	

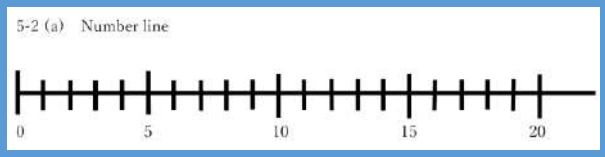
[5.2a Understanding decimal system]

Q. "Point the number (13) indicated on the number line.

Local language

Ni ikile ka dot pa namba line pamene pa funika ku nkhala 13.

Wazibwanji kuti ndiye pamene ifunika ku nkhalila apa



Intention of the question	To understand the position of a number on a number line.
Materials	Interview material 5.2a

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he cannot indicate correctly, however the answer is close to 13.	Incorrect but close
3 Implicit	S/he can indicate the number 13 by counting one by one from 1.	Counting all Count all the numbers from 1. Judge whether counting one by one or not from student's physical actions.
4 Structural	S/he can indicate the number 13 at glance or counting on from a certain number.	At glance or counting on Tell the answer at glance. Count after a certain number such as after 5 or after 10. Record the method in the individual observation sheet. .
5 Advanced structural	Besides level 4 s/he can explain by words.	

[5.2b Understanding decimal system]

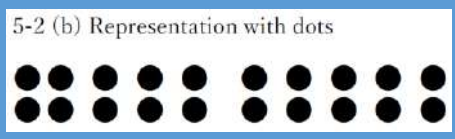
Q. “Circle the amount of 13 marbles on the dotted marble sheet."

Local language

Sekoling’a tuma dot tuli 13

Waziba bwanji tuli 13?

5-2 (b) Representation with dots



Intention of the question	To see the numbers considering group of 10.
Materials	Interview material 5.2b

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he cannot count and circle the amount of 13 marbles, however the answer is close to 13.	Incorrect but close to the correct answer.
3 Implicit	S/he can circle the amount of 13 marbles by counting one by one from 1.	Judge whether counting one by one or not from student’s physical actions.
4 Structural	S/he can circle the amount of 13 dots by counting on from a certain number or using groups.	Circle two groups of numbers such as 10 and 3. Judge from student’ s physical actions.. Record the method in the individual observation sheet. .
5 Advanced structural	Besides level 4 s/he can explain by words.	

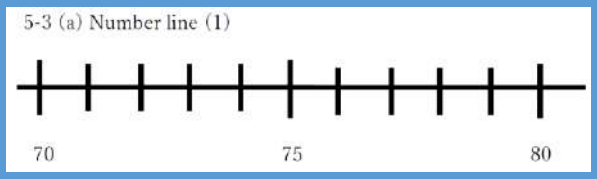
[5.3a Understanding decimal system]

Q. "Indicate the number (76) on the number line."

Local language

Ni ikile ka dot pa namba line pamene pa funika ku nkhala 76.

Wazibwanji kuti ndiye pamene ifunika ku nkhalila apa



Intention of the question	To understand the position of a number on a number line. To show the amount of a given number.
Materials	Interview material 5.3a

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he cannot indicate correctly, however the answer is close to 76.	Incorrect but close to 76. (Between 75 and 77)
3 Implicit	S/he can indicate the number 76 by counting one by one from 70.	Count one by one from 70. Judge whether counting one by one or not from student's physical actions.
4 Structural	S/he can indicate the number 76 at glance or counting from 75.	Judge from student's physical actions. Record the method in the individual observation sheet. .
5 Advanced structural	Besides level4, s/he can explain by words.	

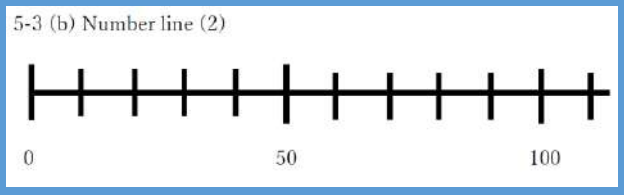
[5.3b Understanding decimal system]

Q. "Indicate the number (76) on the number line"

Local language

Ni ikile ka dot pa namba line pamene pa funika ku nkhala 76.

Wazibwanji kuti ndiye pamene ifunika ku nkhalila apa



Intention of the question	To understand the position of a number on a number line. To show the amount of a given number.
Materials	Interview material 5.3b

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	Except for 70 or 80.
2 Partially Implicit	S/he cannot indicate correctly, however the answer is close to 76.	Incorrect but close (70 or 80)
3 Implicit	S/he can indicate the number between 70 and 80, but not close to 76.	
4 Structural	S/he can indicate the number in the middle between 70 and 80 (Close to 76)	
5 Advanced structural	Besides level4, s/he can explain by words.	(e.g.) 76 is between 70 and 80, and it's around the middle between 70 and 80.

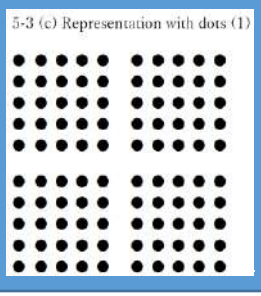
[5.3c Understanding decimal system]

Q. "Circle the amount of 76 marbles on the dotted marble sheet"

Local language

Sekoling'a tuma dot tuli 76

Waziba bwanji tuli 76?



Intention of the question	To see the numbers considering group of 10.
Materials	Interview material 5.3c

[Response levels]

1Not at all	S/he tells a wrong answer that is beyond our expectations	
2 Partially Implicit	S/he cannot count and circle the amount of 76 marbles, however the answer is close to 76.	Incorrect but close to 76. (Between 70 to 80)
3 Implicit	S/he can circle the amount of 76 marbles by counting one by one from 1.	Count from 1 without considering group of 5 or 10. Judge from student's physical actions.
4 Structural	S/he can circle the amount of 76 marbles by counting on from a certain number or using group of 5 or 10.	Consider a group of 5 or 10. Judge from student's physical actions. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4 s/he can explain by words.	

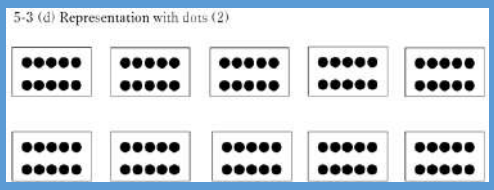
[5.3d Understanding decimal system]

Q. “Circle the amount of 76 marbles on the dotted marble sheet"

Local language

Sekoling’a tuma dot tuli 76.

Waziba bwanji tuli 76?



Intention of the question	To see the numbers considering group of 10.
Materials	Interview material 5.3d

[Response levels]

1Not at all	S/he can count from 1 by corresponding to the bottle tops, however s/he cannot answer correctly.	
2 Partially Implicit	S/he cannot count and circle the amount of 76 marbles, however the answer is close to 76.	Incorrect but close to the 76 (Between 70 and 80)
3 Implicit	S/he can circle the amount of 76 marbles by counting one by one from 1.	Counting all Count from 1 by not considering any groups. Judge whether counting one by one or not from student’s physical actions.
4 Structural	S/he can circle the amount of 76 marbles by counting on from a certain number or using groups.	Consider groups of 10. Judge from student’s physical actions. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4 s/he can explain by words.	

[6.a1 Significance, procedure and proficiency of calculation (Addition)]

Shows “7+8”
Q. “Represent it by bottle tops, tell the sum. If you want to use the frame of 10, you can use it.”
Local language
Sebenzesa tupendelo kuonesa vamene ba lemba apa. Unga sebenzese tuma frame of 10 ngati unfuna.
Nichani ansa?
Wapeza bwanji?

Intention of the question	1-digit+ 1-digit without carrying
Materials	15 Bottle tops, 2 frames of 10.

[Response levels]

1Not at all	S/he cannot place bottle tops correctly.	
2 Partially Implicit	S/he can place 7 and 8 bottle tops correctly but cannot answer correctly.	
3 Implicit	S/he can place 7 and 8 bottle tops and tell the sum by counting all or by memorisation.	
4 Structural	S/he can place 7 and 8 bottle tops and tell the sum by manipulating bottle tops to make 10.	Students should fulfill following all two points. (1) To place the bottle tops structurally (2) To solve the question by moving bottle tops
5 Advanced structural	Besides level 4, s/he can explain using base 10 by words.	

[6.a2 Significance, procedure and proficiency of calculation (Addition)]

Shows "11+13"

Q. "Represent it by bottle tops, tell the sum. If you want to use the frame of 10, you can use it."

Local language

Sebenzesa tupendelo kuonesa vamene ba lemba apa. Unga sebenzese tuma frame of 10 ngati unfuna.

Nichani ansa?

Wapeza bwanji?

Intention of the question	Addition of 2-digit number
Materials	24 Bottle tops, 4 frames of 10.

[Response levels]

1Not at all	S/he used bottle tops, however could not answer correctly.	
2 Partially Implicit	S/he can place 11 and 13 bottle tops correctly but S/he cannot answer correctly.	
3 Implicit	S/he can place 11 and 13 bottle tops and tell the sum by counting all bottle tops or counting on.	Counting after one side of number (Counting on)
4 Structural	S/he can place 11 and 13 bottle tops and tell the sum by manipulating bottle tops considering tens and ones.	Adding numbers according to place value (ones and tens respectively). Record the method in the individual observation sheet. .
5 Advanced structural	Besides level 4, s/he can explain using base 10 by words.	

[6.s1 Significance, procedure and proficiency of calculation (Subtraction)]

Shows “15-8”

Q. “Represent it by bottle tops, tell the answer. If you want to use the frame of 10, you can use it.”

Local language

Sebenzesa tupendelo kuonesa vamene ba lemba apa. Unga sebenzese tuma frame of 10 ngati unfuna.

Nichani ansa?

Wapeza bwanji?

Intention of the question	Subtraction with borrowing
Materials	15 Bottle tops, 2 frames of 10.

[Response levels]

1Not at all	S/he used bottle tops, however could not answer correctly.	
2 Partially Implicit	S/he can place the necessary number of bottle tops but S/he cannot answer correctly. Wrong answer/counting all.	Incorrect
3 Implicit	S/he can place 15 bottle tops and remove 8 from them and counting all bottle tops, (Counting all)	Judge whether counting one by one or not from student’s physical actions.
4 Structural	S/he can place 15 bottle tops and remove 8 from them using base 10.	Counting on or using groups Use the method of 15-5= 10 and 10-3=7, 10-8=2 and 2+5=7. Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4, s/he can explain using base 10 by words.	

[6.s2 Significance, procedure and proficiency of calculation (Subtraction)]

Shows “25-12”

Q. “Represent it by bottle tops , tell the answer. If you want to use the frame of 10, you can use it.”

Local language

Sebenzesa tupendelo kuonesa vamene ba lemba apa. Unga sebenzese tuma frame of 10 ngati unfuna.

Nichani ansa?

Intention of the question	Subtraction with 2-digit number
Materials	25 Bottle tops, 3 frames of 10

[Response levels]

1Not at all	S/he used bottle tops, however could not answer correctly.	
2 Partially Implicit	S/he can place the necessary number of bottle tops but S/he cannot answer correctly.	Incorrect
3 Implicit	S/he can place 25 bottle tops and remove 12 from them by counting all bottle tops, (Counting all)	
4 Structural	S/he can place 25 bottle tops and remove 12 from them by manipulating bottle tops considering tens and ones.	Subtract according to place value, tens and ones respectively.
5 Advanced structural	Besides level 4, s/he can explain using base 10 by words.	

[6.m1 Significance, procedure and proficiency of calculation (Multiplication)]

Shows “2x3”
Q. “Represent it by bottle tops, tell the answer.”
Local language
Sebenzesa tu pendelo kuonesa vamene ba lemba apa
Nichani answer?
Wapeza bwanji?

Intention of the question	Multiplication、 To see the numbers by group、Represent by numbers、Be able to calculate
Materials	Bottle tops,

[Response levels]

1Not at all	S/he used bottle tops, however could not answer correctly.	
2 Partially Implicit	S/he can place 6 bottle tops in groups but S/he cannot answer correctly.	Incorrect
3 Implicit	S/he can place 6 bottle tops in groups and tell the answer verbally by counting, or by memorisation.	Counting all Judge whether counting one by one or not from student’s physical actions. ○○ ○○ ○○ or ○○○ ○○○
4 Structural	S/he can place 6 bottle tops in groups, and tell the answer verbally using groups.	Record the method in the individual observation sheet.
5 Advanced structural	Besides level 4, s/he can explain using concept of multiplication by words.	The term ‘2’ and ‘3’ must be contained in the explanation.

[6.m2 Significance, procedure and proficiency of calculation (Multiplication)]

Shows “12x3”

Q. “Represent it by bottle tops, tell the answer.” If you want to use the frame of 10, you can use it.”

Local language

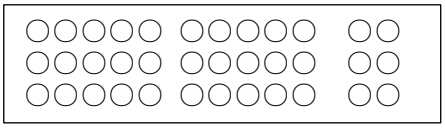
Sebenzesa tu pendelo kuonesa vamene ba lemba apa

Nichani answer?

Wapeza bwanji?

Intention of the question	2-digt x 1-digit, Emphasis on place value
Materials	Bottle tops

[Response levels]

1Not at all	S/he used bottle tops, however could not answer correctly.	
2 Partially Implicit	S/he can place 12 bottle tops in 3 rows, but S/he cannot answer correctly.	Incorrect
3 Implicit	S/he can place 36 bottle tops and tell the answer by counting.	Different representations (three 12s and twelve 3s) are both acceptable.
4 Structural	S/he can place 36 bottle tops structurally considering tens and ones, and tell the answer according to place value, tens and ones respectively.	Place the bottle tops structurally by three 12s 
5 Advanced structural	Besides level 4, s/he can explain using the meaning of multiplication by words.	Explain by using three 10s and three 2s or explain by using the term ‘12’ and ‘3’.

[6.d1 Significance, procedure and proficiency of calculation (Division)]

Shows “8÷2”

Q. “Represent it by bottle tops, tell the answer.”

Local language

Sebenzesa tu pendelo kuonesa vamene ba lemba apa

Nichani answer?

Wapeza bwanji?

Intention of the question	・Division, To see the numbers by group, To represent by numbers and To be able to calculate
Materials	Bottle tops

[Response levels]

1Not at all	S/he used bottle tops, however could not answer correctly.	
2 Partially Implicit	S/he can place 8 bottle tops, however could not answer correctly.	Incorrect
3 Implicit	S/he can place 8 bottle tops in a scattered way and find the answer by dividing one by one, or by memorisation.	Different arrangements (2,2,2,2, or 4,4) can be fine).
4 Structural	S/he can place 8 bottle tops 2 by 4 in order, and tell the answer verbally.	○○ ○○ ○○ ○○ or ○○○○ ○○○○
5 Advanced structural	Besides level 4, s/he can explain using the meaning of division by words.	

[6.d2 Significance, procedure and proficiency of calculation (Division)]

Shows "30÷3"
Q. "Represent it by bottle tops, tell the answer." If you want to use the frame of 10, you can use it."

Local language
Sebenzesa tu pendelo kuonesa vamene ba lemba apa
Nichani answer?
Wapeza bwanji?

Intention of the question	2-digt ÷ 1-digit, Emphasis on place value
Materials	Bottle tops, 3 frames of 10

[Response levels]

1Not at all	S/he used bottle tops, however could not answer correctly.	
2 Partially Implicit	S/he can place 30 bottle tops, however could not answer	Incorrect
3 Implicit	S/he can place 30 bottle tops in a scattered way and find the answer by dividing one by one, or by memorisation.	Different arrangements (three 10s, or ten 3s) can be fine.
4 Structural	S/he can place 30 bottle tops structurally and tell the answer using group of 10.	Place the bottle tops structurally by three 10s. ○○○○○○○○○○ ○○○○○○○○○○ ○○○○○○○○○○
5 Advanced structural	Besides level 4, s/he can explain using the meaning of division by words.	

Appendix 2

Test

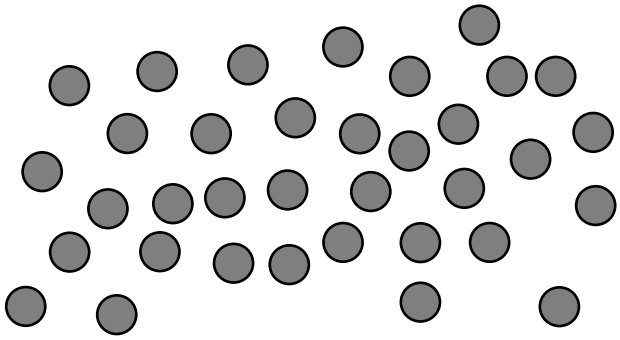
No. _____

Name: _____ Age _____ Grade and Class _____

(1) Draw 20 dots. (Drawinga tuma dot tuli 20.) (1'30)

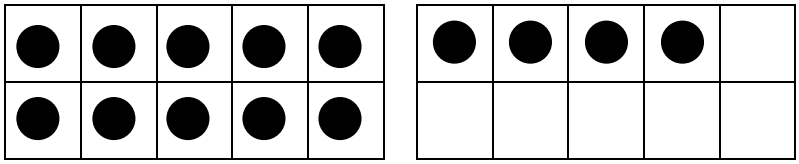
No. _____

(2) How many dots are there ? Show your working just here where the question is. (Tuli tungati tuma dot utu? Onetsa mwamene wapezela pemene apa pali funso.) (2'00)



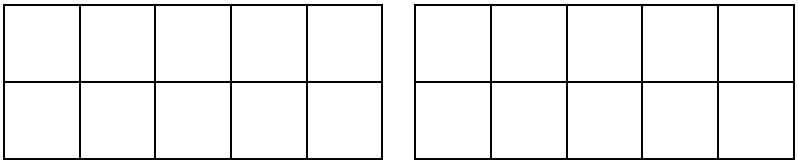
_____

(3) How many dots are there altogether? Show your working just here where the question is. (Tuli tungati tuma dot utu pamodzi? Onetsa mwamene wapezela pemene apa pali funso.) (1'00)

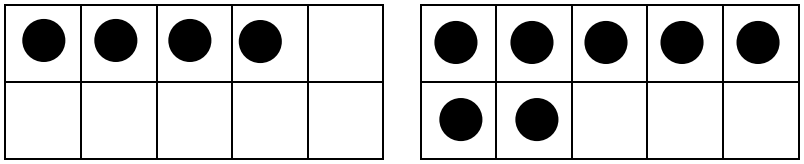


_____

(4) Please draw 17 dots in the following frames. (Drawinga ma dot 17 muma frames aya.) (1'00)



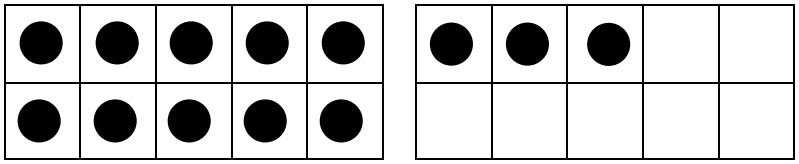
(5) How many dots are there altogether? Show your working just here where the question is. (Tuli tungati tuma dot utu pamodzi? Onetsa mwamene wapezela pemene apa pali funso.) (1'00)



_____

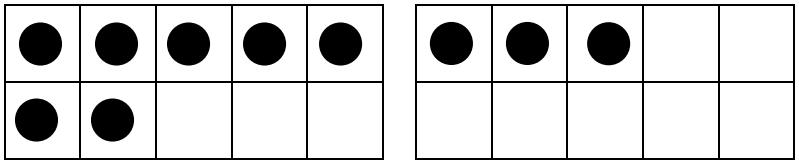
No. _____

(6) How many dots do you need to fill up to 20? Show your working just here where the question is. (Pafunika tuma dot tungati kuti tu kwane 20? Onetsa mwamene wapezela pemene apa pali funso.) (1'00)



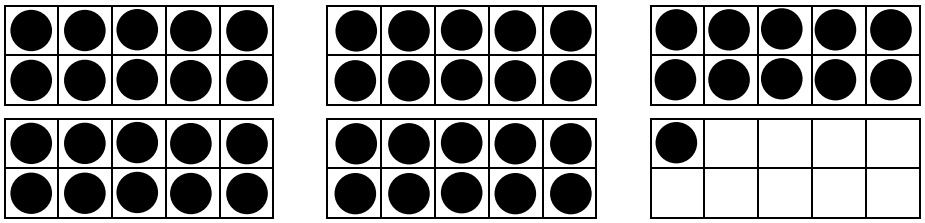
_____

(7) How many dots do you need to fill up to 20? Show your working just here where the question is. (Pafunika tuma dot tungati kuti tu kwane 20? Onetsa mwamene wapezela pemene apa pali funso.) (1'00)



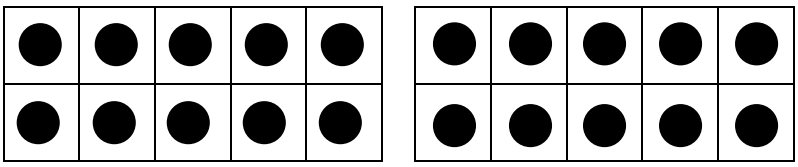
_____

(8) How many dots are there altogether? Show your working just here where the question is. (Tuli tungati tuma dot utu pamodzi? Onetsa mwamene wapezela pemene apa pali funso.) (1'00)



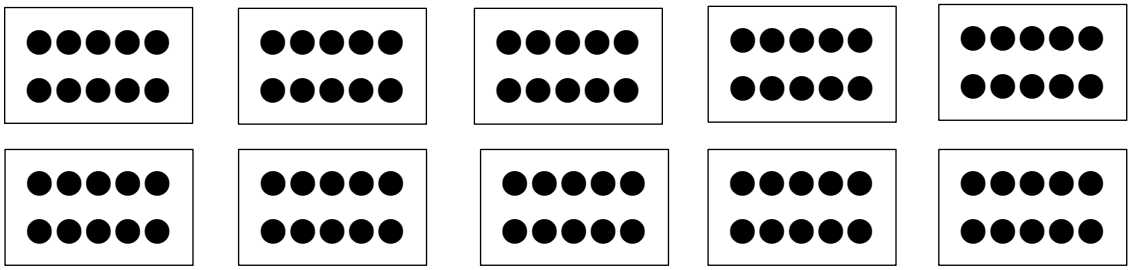
_____

(9) Circle 12 dots on the following diagram. (Pali tu dot utu, circlinga tuli 12.)(1'00)



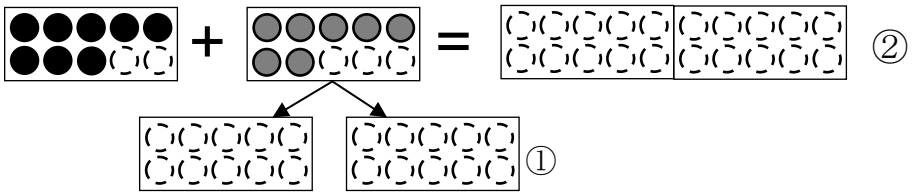
No. _____

(10) Circle 76 dots on the following diagram. (Pali tu dot utu, circlinga tuli 76.) (2'30)



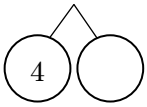
(11) Find the answer and shade in the diagram the dots that will show you the answer. (Penza answer elo shadinga tuma dot twamene tu onse answer.) (3'00)

8 + 7 =

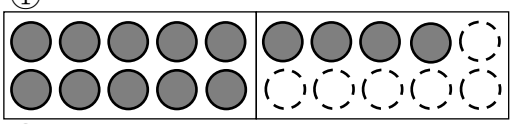


(12) Write the number which should be in the circle. Show dots to be taken away and write the answer. Lemba number yamene ifunika ku nkhala mu circle. Cancellinga tuma dot twamene ufunika ku chosapo kuti upeze answer elo lemba answer. (2'00)

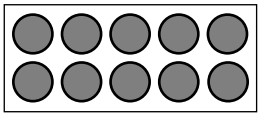
14 − 5 =



①



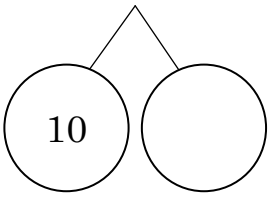
②



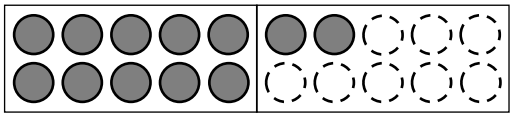
No. _____

(13) Write the number, circle the dots to be taken away and give the answer.
Lemba number yamene ifunika ku nkhala mu circle. Cancellinga tuma dot twamene ufunika ku chosapo kuti upeze answer elo lemba answer. (2'00)

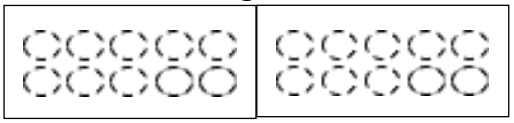
12 − 8 = ____



Take away 8 from a group of 10



① Add remaining:_____



No. _____

(14) Calculate and show your working on this paper (Show how you find the answer and write the answer). Peza answer, elo uonse mwamene yaipenzela pasi pa ma sumu yamene upeza. (13'00)

(a) $3 + 4 =$

(b) $7 + 9 =$

(c) $12 + 23 =$

(d) $6 - 2 =$

(e) $13 - 7 =$

(f) $24 - 12 =$

(g) $4 \times 6 =$

(h) $12 \times 3 =$

(i) $9 \div 3 =$

(j) $26 \div 2 =$

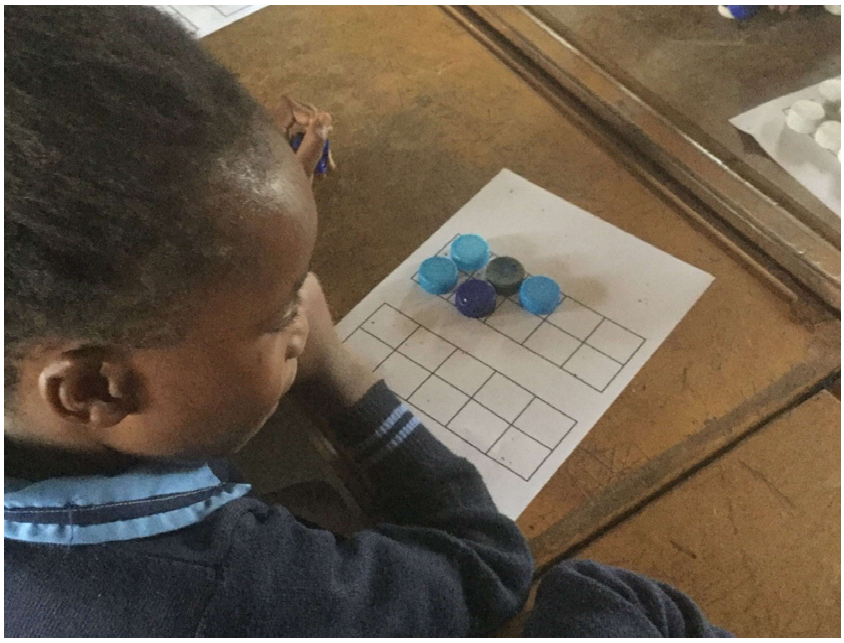
Appendix 3

Teacher's Guide

Teachers' Guide

for

Numeracy Competence



Title: Teachers' Guide for Numeracy Competence

Author: ARTHUR, Mungalu
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NKHATA, Bentry,
SPIWE, Tafeni
WATANABE, Koji

Dear teachers,

We would like to thank you for implementing these new materials and teaching in Zambia. We appreciate your effort. The following four points are very important concepts for mathematics teaching and learning:

・To pay attention to children's understanding

We tend to judge if answers in mathematics are correct or not. On the other hand, children's thinking has a variety. Some have correct answers but they sometimes do not understand the concept we want to teach well. Others have incorrect answers but they have a very right way to do. Thus, we want value the process of children's thinking and operations in class. We value a lot of ideas from pupils from different angles.

・To expect children to grasp place values

We expect pupils to fully understand place value system using the material we developed. Before the place value, therefore, we would like them to understand ones and tens with concrete materials and after that we can reach the stage of understanding and operating numerals.

・To move from counting all to systematic ways of counting and calculating

We strongly value children's counting behaviours but not up to Grade 4. Young children gradually understand numbers by counting in nature and they do enjoy the counting activities. But let us strategically move from counting to see the systematic identification of numbers in teaching. Counting at the later stage, such as Grade 3 and 4 (even upper than them) may hinder children from calculating mentally or systematically. Let us expect children to explain HOW and WHY they move bottle tops and find the efficient way to calculate fast in mind in an economical way. The structured calculation will help children grow mathematically at the later stage of learning mathematics.

・To respect Zambian culture, e.g. local languages, local available materials such as bottle tops, and YOUR creative mind

We strongly recommend that you could respect your Zambian culture and modify the teaching materials given, according to your classroom setting. Let us try something creative if you think it is suitable for this concept and context.

We hope that you and your children will be enjoying the activities!

Content

1. Counting objects one by one, by groups, count forward and backward

Objectives:

The pupil is expected to:

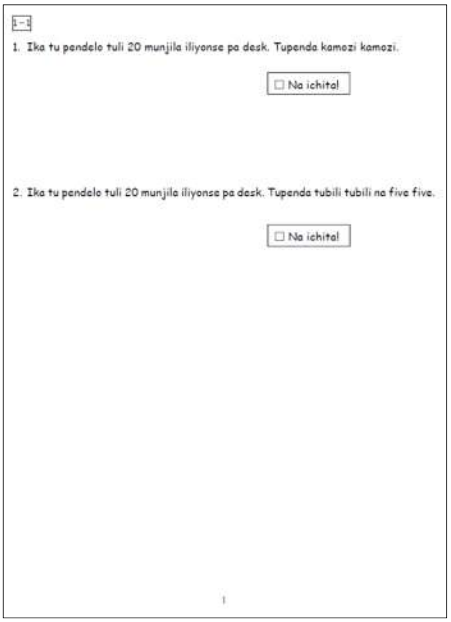
i. Count bottle tops
ii. Say numbers upward from 1
iii. Say numbers downward from 20

Materials used:

20 bottle tops

Tasks:

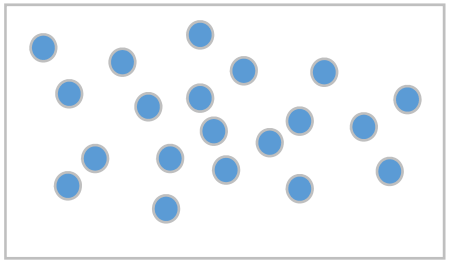
1-1 Pupils' workbook p.1



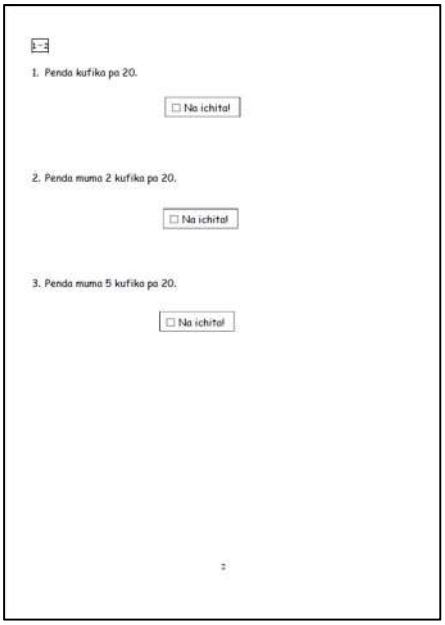
Guide for teachers:

Teacher places 20 bottle tops randomly and ask pupils, 'Count and tell me the number'. When s/he counts one by one correctly, ask 'Count in 2s' and 'Count in 5s'.

e.g.) 'Count one by one and tell me the number.'



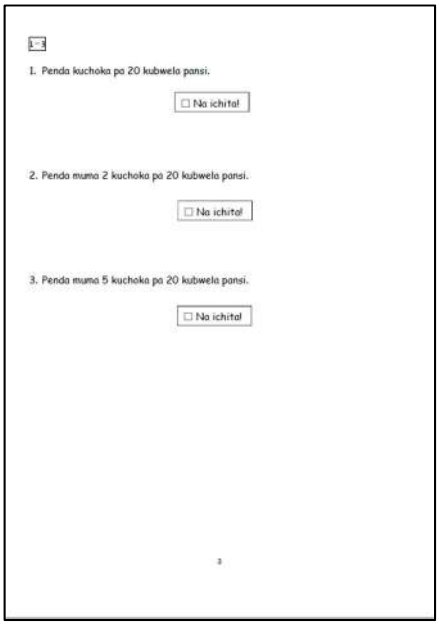
1-2 Pupils' workbook p.2



Guide for teachers:

Teacher asks pupils 'count up to 20'. If it is too hard for them without concrete things, the teacher can tell 'You may use bottle tops for counting'. For those pupils who can tell numbers upward correctly without using any tools, teacher can ask 'count 2s and 5s up to 20'. (Teacher may ask pupils to do the activities in pairs)

1-3 Pupils' workbook p.3



Guide for teachers:

Ask 'count down from 20'. If it is too hard for them without concrete things, the teacher can tell 'You may use bottle tops for counting'. For those pupils who can tell numbers upward correctly without using any tools, teacher can ask 'count 2s and 5s from 20 downward'. (Teacher may ask pupils to do the activities in pairs.)

Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 1-1	S/he makes a mistake in counting, 1, 2, 3, 4, or 5.	S/he can count correctly up to 5.	S/he can count one by one up to 20 s	S/he can count up to 20 in 2s or 5s	S/he can count up to 20 both in 2s and 5s
Activity 1-2	S/he cannot count numbers up to 10.	S/he tries to count numbers but failed to count up to 20	S/he can count numbers upward one by one.	S/he can count numbers upward up to 20 in 2s or 5s.	S/he can count numbers upward up to 20 both in 2s or 5s.
Activity 1-3	S/he cannot count numbers downward to 10.	S/he tries to count numbers downward but failed to count to 1.	S/he can count numbers downward one by one.	S/he can count numbers one by one downward to 1 says 2s or 5s.	S/he can count numbers one by one downward to 1 both 2s and 5s.

2. Recognizing patterns and structure of numbers

Objectives

The pupil is expected to:

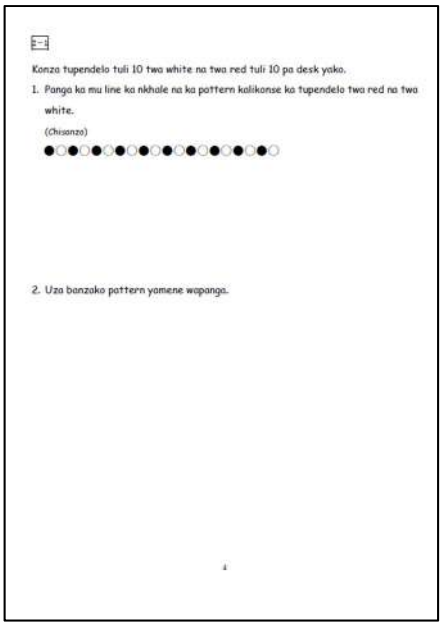
i. Make original patterns on their own
ii. See and identify the number of bottle tops in a structured way, e.g. 10＋4, or 20-6
iii. Imagine the frame of 10 in mind and place the bottle tops in such an order.

Materials used

- 20 white bottle tops and 20 red bottle tops
- Two 10-frames

Tasks:

2-1 Pupils' workbook p.4


Konza tupendelo tuli 10 twa white na twa red tuli 10 pa desk yako.

1. Panga ka mu line ka nkhale na ka pattern kalikonse ka tupendelo twa red na twa white.

(Chisanzo)

●○●○●○●○●○●○●○●○●○●○

2. Uza banzako pattern yamene wapanga.

Guide for teachers:

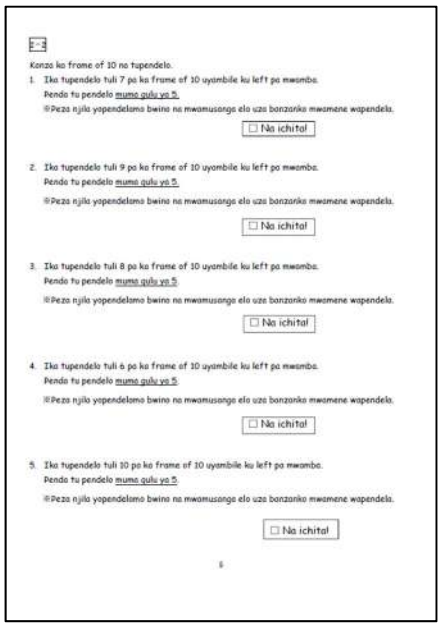
Teacher explains the patterns with bottle tops that we follow certain rule to make a line. Teacher can show a pattern using red and white bottle tops as below.

e.g) ○●○●○●○●○●○●○●○●○●○●○●

Teacher ask what kind of patterns there are in a line. After that, ask pupils to create any line with patterns. (Ask pupils to do the activities in pairs or groups of 4 or 5 pupils.)

Teacher should pick up some good and creative patterns of the line and show them to the class. Value different ideas in class.

2-2 Pupils' workbook p.5


Konza ka frame of 10 na tupendelo.

1. Ika tupendelo tuli 7 pa ka frame of 10 uyambile ku left pa mwamba.
Penda tu pendelo muma gulu ya 5.
※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.
☐ Na ichita!

2. Ika tupendelo tuli 9 pa ka frame of 10 uyambile ku left pa mwamba.
Penda tu pendelo muma gulu ya 5.
※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.
☐ Na ichita!

3. Ika tupendelo tuli 8 pa ka frame of 10 uyambile ku left pa mwamba.
Penda tu pendelo muma gulu ya 5.
※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.
☐ Na ichita!

4. Ika tupendelo tuli 6 pa ka frame of 10 uyambile ku left pa mwamba.
Penda tu pendelo muma gulu ya 5.
※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.
☐ Na ichita!

5. Ika tupendelo tuli 10 pa ka frame of 10 uyambile ku left pa mwamba.
Penda tu pendelo muma gulu ya 5.
※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.
☐ Na ichita!

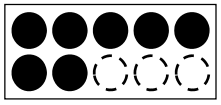
Guide for teachers:

Pupils places 7 bottle tops neatly, start from the left on top, on the 10-frame. (Teach children to place bottle tops at the upper left.)

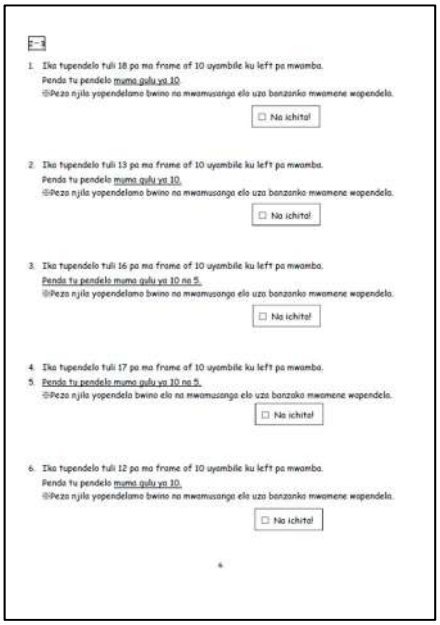
Then, teacher tell 'Let's count the bottle tops using group of 5.' (Encourage pupils to find the better way to count fast and let pupils to tell their own way to friends.)

※Teacher should encourage children to explain their ways verbally to recognise the total number of bottle tops.

e.g.) There are group of 5, so 6 and 7.



2-3 Pupils' workbook p.6

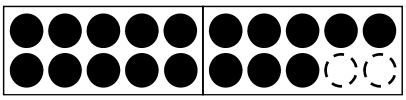


Guide for teachers:

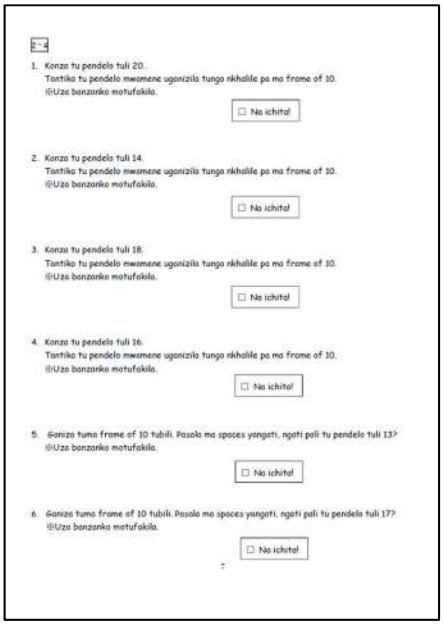
Pupils places 18 bottle tops neatly, start from the left on top, on the two 10-frames. Then, teacher tells 'Let's count the bottle tops using group of 10.' (Encourage pupils to find the better ways to count fast and correctly, and let pupils to tell their own way to friends.)

※Teacher should encourage children to explain their ways verbally to recognise the total number of bottle tops.

e.g.) There are one group of 10 and 8 more, so 18.
There are two groups of 10 so it is 20, 2 less is 18.



2-4 Pupils' workbook p.7



Guide for teachers:

Students prepares 20 bottle tops. The teacher tells pupils 'Suppose there is a 10-frame and arrange the bottle tops in the imaginary 10-frames.' Let pupils practice different numbers, for example 14, 18, 16 etc.

※Let pupils tell how they arranged the number to friends.

After that, teacher ask pupils 'Imagine two 10-frames in your head. How many blank spaces are there?' Let pupils practice different numbers, for example 11, 13, 17, 18 etc. Let pupils tell how they arranged the number to friends.)

※Let pupils tell how they arranged the number to friends.

Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 2-1	S/he cannot make any patterns.	S/he makes a lines without any pattern.	S/he can make a line with one by one patterns or 1red and white line.	S/he can make a line with original patterns.	Besides level 4, S/he can explain it
Activity 2-2 2-3	S/he tries to count, but cannot do it completely in some reasons	S/he makes a mistake in counting.	S/he can identify the number by counting one by one.	S/he can identify the number using any groups or counting on from a certain number.	Besides level 4, s/he can explain by words.
Activity 2-4	S/he cannot arrange the bottle tops	S/he can place the bottle tops but they are not placed structurally (place randomly)	S/he can place the bottle tops structurally but not 5 ×2	S/he can place 20 bottle tops correctly considering frame of 10 (5×2).	Besides level 4, s/he can explain verbally what s/he has done.

3. Composing and decomposing numbers

Objectives

The pupil is expected to:

i. Calculate by identifying the less than 10 bottle tops in a structured way and write the operation in the mathematical sentence.

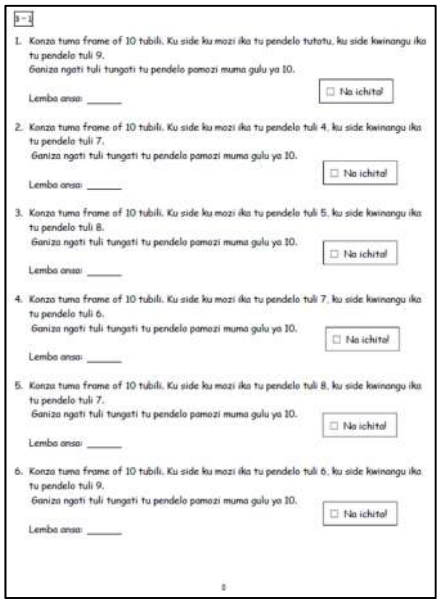
Materials used

- 40 bottle tops
- Four 10-frames
- Paper (If it is needed)

Tasks

3-1 Pupils' workbook p. 8.

Guide for teachers:


3-1

1. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tutatu, ku side kwinangu ika tu pendelo tuli 9.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

2. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 4, ku side kwinangu ika tu pendelo tuli 7.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

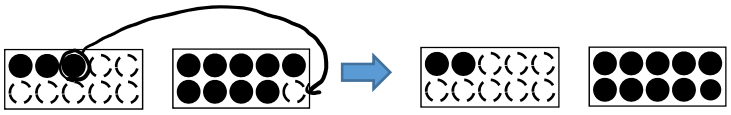
3. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 5, ku side kwinangu ika tu pendelo tuli 8.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

4. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 7, ku side kwinangu ika tu pendelo tuli 6.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

5. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 8, ku side kwinangu ika tu pendelo tuli 7.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

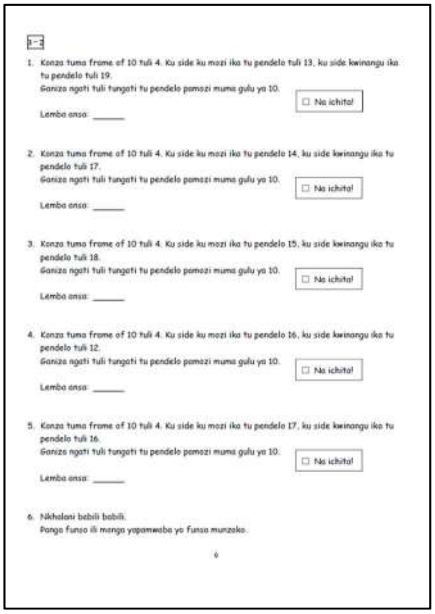
6. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 6, ku side kwinangu ika tu pendelo tuli 9.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

Pupils prepares two 10-frams. On one side, place 3 bottle tops and on the other side, place 9 bottle tops. Teacher asks pupils 'How many bottle tops are there altogether?', 'Choose the best and quickest way and tell me the answer.' and 'You may move the bottle tops and write something on the paper if you like to'. For fast learner, teacher also ask, 'Can you express what you did using number and mathematical sentence?'



※Teacher should encourage children to explain how they did verbally.

3-2 Pupils' workbook p. 9.


3-2

1. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo tuli 13, ku side kwinangu ika tu pendelo tuli 19.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

2. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 14, ku side kwinangu ika tu pendelo tuli 17.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

3. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 15, ku side kwinangu ika tu pendelo tuli 18.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

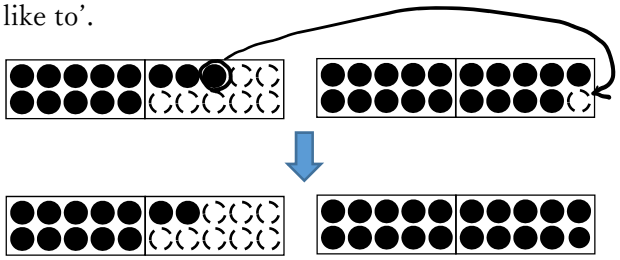
4. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 16, ku side kwinangu ika tu pendelo tuli 12.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

5. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 17, ku side kwinangu ika tu pendelo tuli 16.
Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichitaf

6. Nikholosi bebili bebili.
Panga funso ili monga yapamwaba ya funsa munzako.

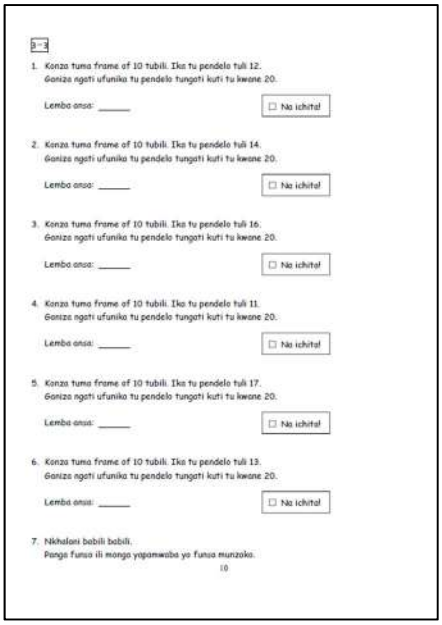
Guide for teachers:

Pupils prepare four 10-frams shown below. On one side, place 13 bottle tops and on the other side, place 19 bottle tops. Teacher asks 'How many bottle tops are there altogether?', 'Choose the best and quickest way and tell me the answer.' and 'You may move the bottle tops and write something on the paper if you like to'.



※Teacher should encourage children to explain how they did verbally.

3-3 Pupils' workbook p. 10.


3-3

1. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 12.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.
Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 14.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.
Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 16.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.
Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 11.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.
Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 17.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.
Lemba ansa: _____ ☐ Na ichita!

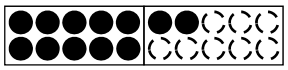
6. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 13.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.
Lemba ansa: _____ ☐ Na ichita!

7. Nkhalani babili babili.
Panga funso ili monga yapamwaba yo funsa munzako.

10

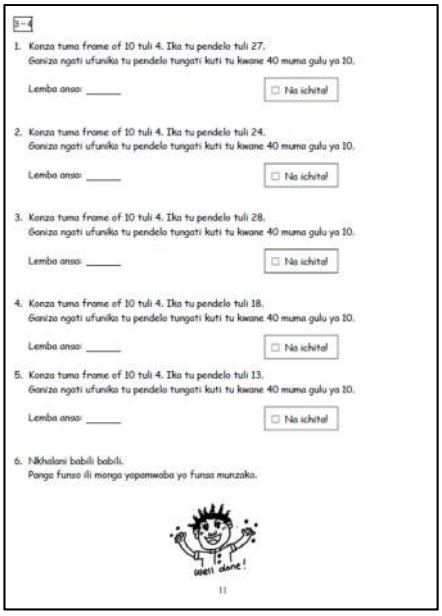
Guide for teachers:

Pupils prepare two 10-frames shown below, and place 12. Teacher asks pupils 'How many bottles do you need to fill up to 20? and please explain the reason.'



※Teacher should encourage children to explain how they did verbally.

3-4 Pupils' workbook p. 11


3-4

1. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 27.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 24.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 28.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 18.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 13.
Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.
Lemba ansa: _____ ☐ Na ichita!

6. Nkhalani babili babili.
Panga funso ili monga yapamwaba yo funsa munzako.

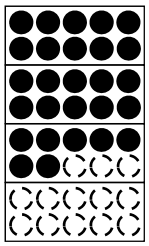
Well done!

11

Guide for teachers:

Prepare four 10-frams. Place 27. Ask 'How many bottles do you need to fill up to 40? and explain the reason.'

※Teacher should encourage children to explain how they did verbally.



Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 3-1	S/he tells a wrong answer that is beyond our expectations	S/he tells the incorrect answers which are closed to the right answer	S/he can find an answer by counting mentally or physically one by one from 1.	S/he can find an answer by moving bottle tops or by using any groups.	Besides level 4, s/he also can explain with mathematical expressions.
Activity 3-2	S/he tells a wrong answer that is beyond our expectations	S/he tells the incorrect answers which are closed to the right answer.	S/he can find an answer (32) by counting mentally or physically one by one from 1.	S/he can find an answer by moving bottle tops or by using any groups.	Besides level 4, s/he also can explain with any mathematical expressions.
Activity 3-3	S/he tells a wrong answer that is beyond our expectations	S/he tells incorrect answers which are close to numbers.	S/he can find the answer by counting mentally or physically one by one from 1.	S/he can find an answer by counting on or by using any groups.	Besides level 4, s/he also can explain with mathematical expressions.
Activity 3-4	S/he tells a wrong answer that is beyond our expectations	S/he tells incorrect answers which are close to numbers such as 11, 12 or 14.	S/he can find an answer by counting mentally or physically one by one from 1.	S/he can find an answer by counting on or by using base 10.	Besides level 4, s/he also can explain with mathematical expressions by using base 10.

4. Seeing numbers in terms of unit and relative size of numbers

Objectives

The pupil is expected to:

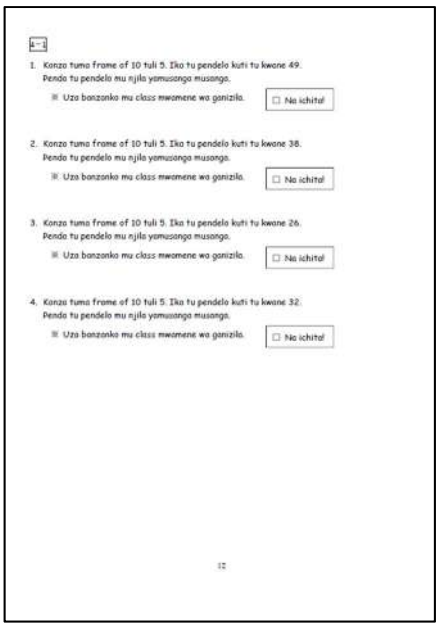
i. Identify the number of bottle tops by seeing the groups of 10 .

Materials used

- Five frames of 10
- 50 bottle tops
- Paper (If it is needed)

Tasks

4-1 Pupils' workbook p. 12


4-1

1. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwone 49.
Penda tu pendelo mu njila yamusanga musanga.
Uza banzanko mu class mwamene wa ganizila. No ichita!

2. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwone 38.
Penda tu pendelo mu njila yamusanga musanga.
Uza banzanko mu class mwamene wa ganizila. No ichita!

3. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwone 26.
Penda tu pendelo mu njila yamusanga musanga.
Uza banzanko mu class mwamene wa ganizila. No ichita!

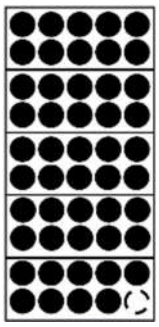
4. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwone 32.
Penda tu pendelo mu njila yamusanga musanga.
Uza banzanko mu class mwamene wa ganizila. No ichita!

12

Guide for teachers:

Prepare five 10-frames. Fill 49 bottle tops and teacher asks 'Count the number of bottle tops as fast and correct as possible. You may write something if you want.' For those students who finished the activity, teacher asks 'Write the numeral of the number you got'.

※Teacher let pupils share their own idea with friends.



Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 4-1	S/he tells a wrong answer that is beyond our expectations	S/he tells incorrect answers such as 48 or 50 which is near 49 by counting.	S/he can tell 49 by counting one by one from 1.	S/he can tell 49 quickly by using base 10 or counting on from a certain number or using groups.	Besides level 4 s/he can explain verbally using base 10.

Extra Activity 1

Objectives

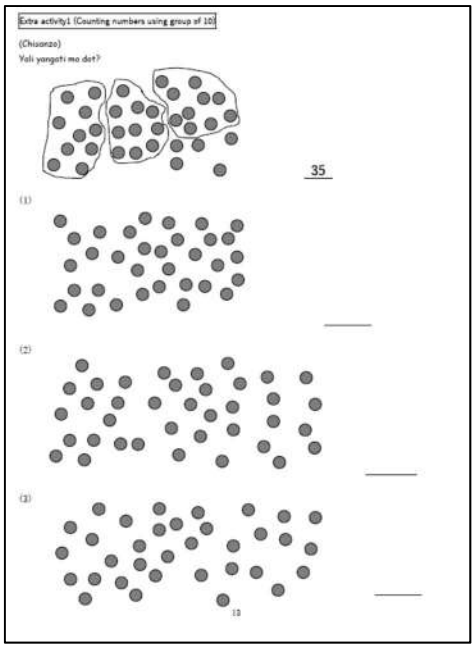
The pupil is expected to:

i. count the objects using group of 10.

Materials used

- Any concrete material
- Students workbook

Tasks Pupils' workbook p. 13

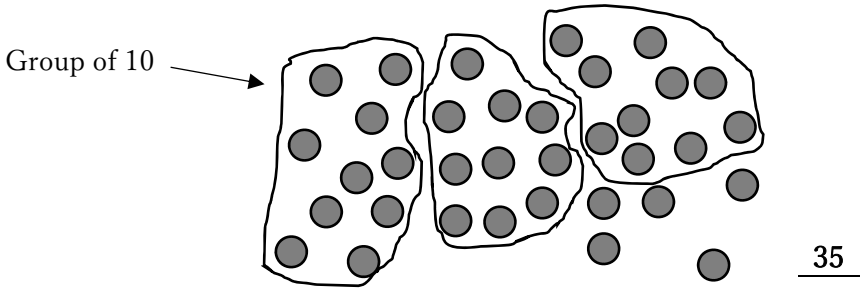


Guide for teachers:

Teacher ask pupils 'Think about how to count these dots correctly as fast as possible. Let pupils notice that group of 10 is useful to count many things.

Also, teacher ask students to solve the exercise in the workbook.

※Let students notice the group of 10 is useful to count many things.



5. Understanding the base ten numeration system

Objectives

The pupil is expected to:

ii. see the numbers considering group of 10.

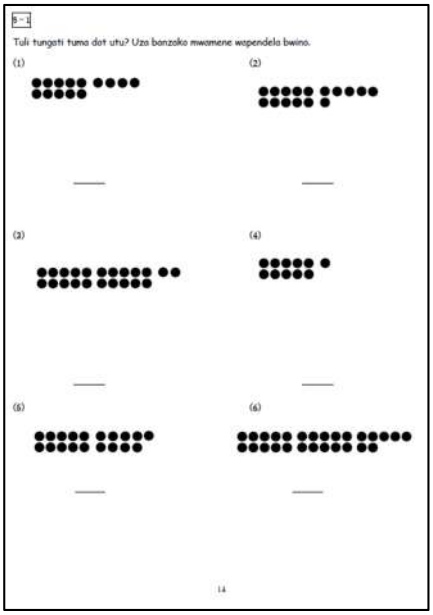
iii. understand the position of a number on a number line.

Materials used

- Dot diagram
- Number line sheets

Tasks (Use pupils' workbook)

5-1 Pupils' work book p. 14



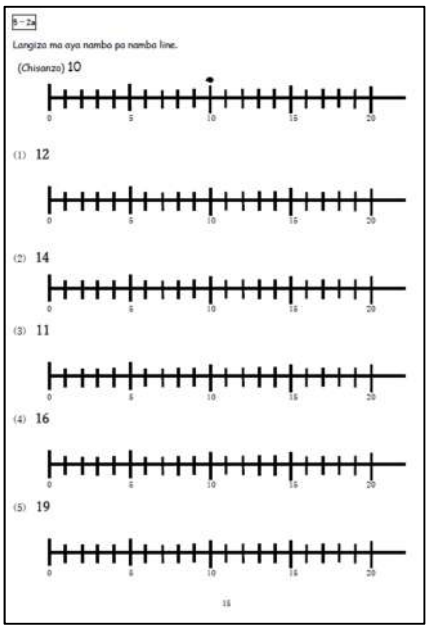
Guide for teachers:

Pupils tell the number of ● looking at the following diagrams. Teacher asks how pupils identify the number.

※Teacher should encourage children to focus on groups of 10.

e.g.) The examples of pupils' responses are as follows:
'10+6=16', '10+5+1=16, 5+5+5+1=16, 20-4=16' Pupils do not necessarily use mathematical sentences, but they also can express the same thing verbally. Value the multiple answers from children.

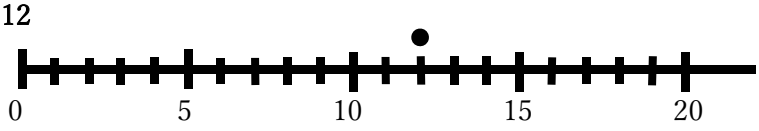
5-2a Pupils' workbook p.15



Guide for teachers:

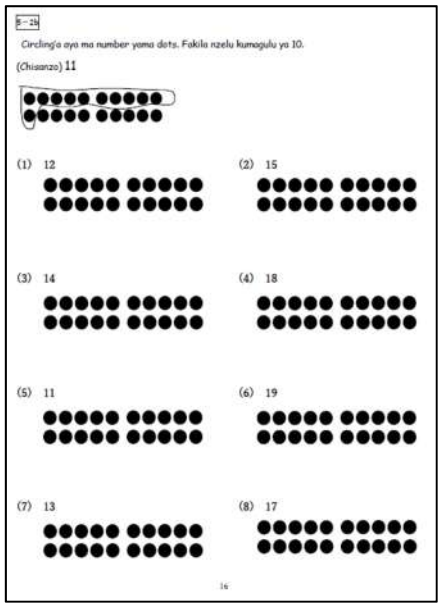
Pupils point out the number on the number line. Teacher asks how they identify the number and appreciates many ways of thinking.

e.g.) **12**



e.g.) Let pupils point out "12" on the number line. The examples of pupils' responses are as follow: '10+2=12, 5+5+2=12, 15-3=12'.
Pupils do not necessarily use mathematical sentences, but they also can express the same thing verbally. Value the multiple answers from children.

5-2b Pupils' workbook p. 16



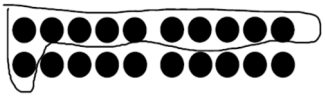
Guide for teachers:

Pupils surround the given total numbers of the dots on the sheet by focusing on the group of 10. Teacher asks pupils that how they identify the number and appreciate many ways of thinking.

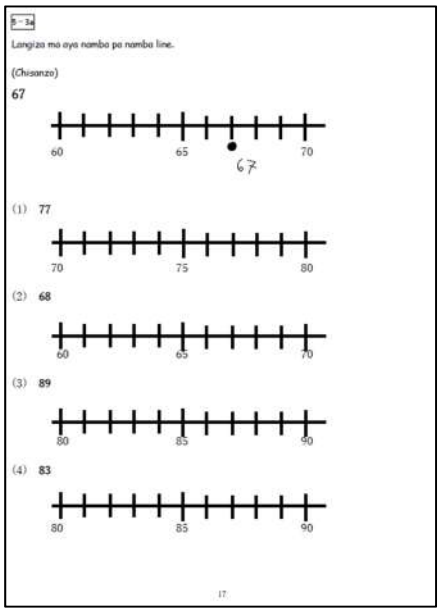
※Teacher should encourage children to focus on groups of 10.

e.g.) Let pupils surround total of "11". The examples of pupils' responses are as follows: '10+1=11, 5+5+1=11, 20－9=11, 20-5-4=11'.

Pupils do not necessarily use mathematical sentences but they also can express the same thing verbally. Value the multiple answers from children.



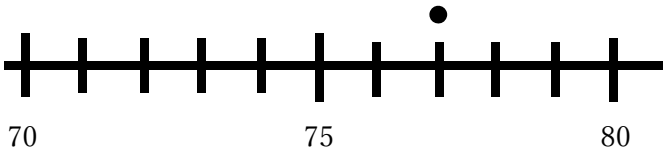
5-3a Pupils' workbook p. 17



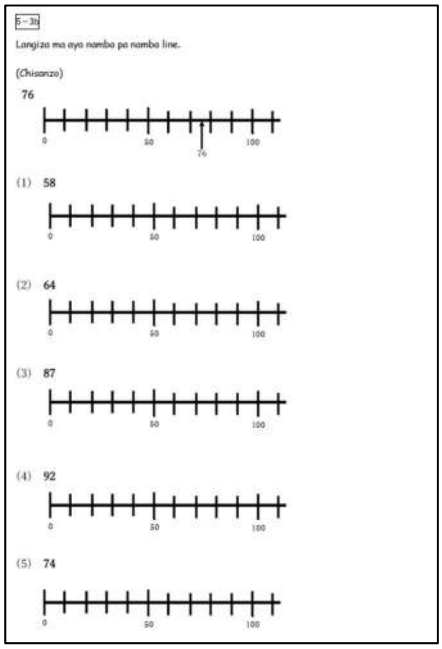
Guide for teachers:

Pupils point out the number on the number line as below. Teacher distributes the sheet of number line for pupils and let them aware and utilize the numbers of benchmarks such as 5's and 10's in order to identify the number on number line.

e.g.) Locate the position of 77 on number line and let pupils explain their thinking.



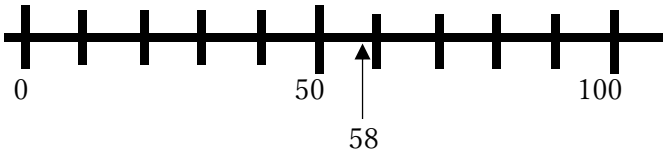
5-3b Pupils' worksheet pp. 18-19



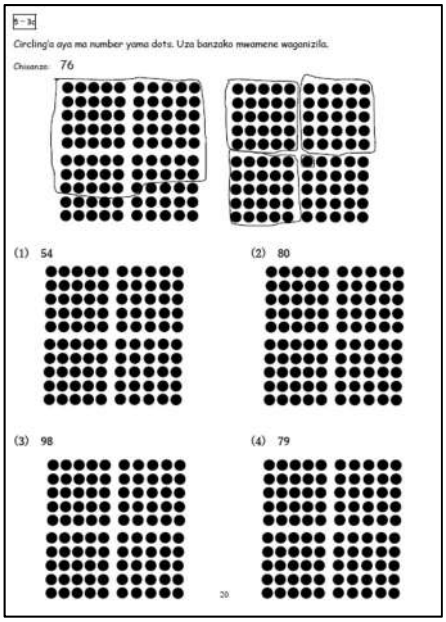
Guide for teachers:

Pupils point out the number on the number line as below. Teacher distributes the sheet of number line for pupils and let them aware and utilize the numbers of benchmarks such as 0, 50, 100 in order to identify the number on number line.

e.g.) Locate the position of 58 on number line and let pupils explain their thinking.



5-3c Pupils' worksheet p.20



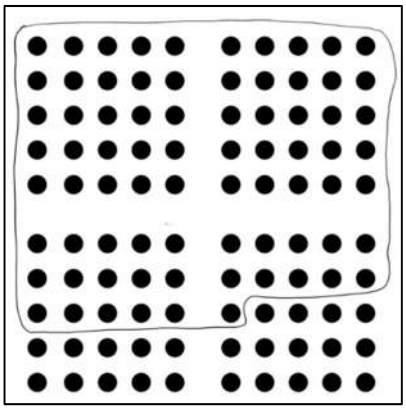
Guide for teachers:

Pupils surround the given total numbers of dots on the sheet. Let pupils explain their thinking in the class. Different ways of thinking are appreciated, in order to develop the different way of grouping by using group of 5 and group of 10. All examples represent 76. There will be more different ideas.

※Teacher should encourage children not to count one by one and to explain their ideas in many different ways as shown in the example.

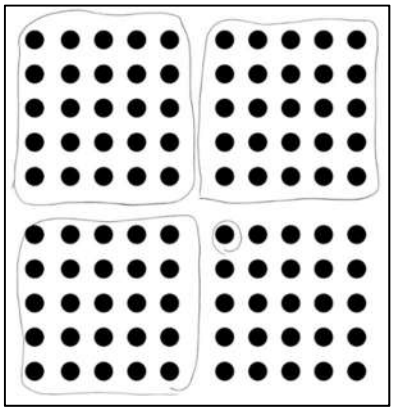
e.g.1)

Surrounding 76 in one-time

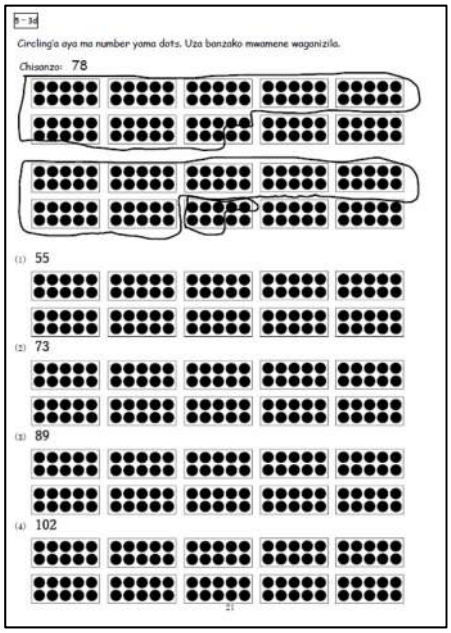


e.g.2)

76 as $3\times(5\times5)+1$



5-3d Pupils' workbook p. 21

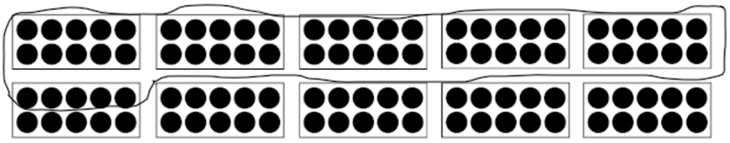


Guide for teachers:

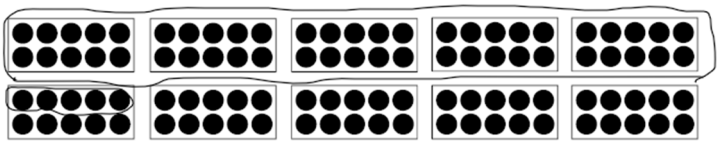
Pupils surround a given total numbers of dots on the sheet. Let pupils explain their thinking in the class. Different ways of thinking are appreciated, in order to develop the different way of grouping by using group of 5 and group of 10. All examples represent 55. There will be more different ideas.

※Teacher should encourage children not to count one by one and to explain their ideas in many different ways as shown in the example.

e.g.) Surrounding 55 in one-time



e.g.) 55 as 50+5.



Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 5-1	S/he tells a wrong answer that is beyond our expectations	S/he count the number one by one, however, miscounted in the middle of counting.	S/he can count the number one by one from 1.	S/he can find an answer by counting on from a certain number or using groups.	Besides level 4 s/he can explain by words.
Activity 5-2a	S/he tells a wrong answer that is beyond our expectations	S/he cannot indicate correctly, however the answer is close to 13.	S/he can indicate the number 13 by counting one by one from 1.	S/he can indicate the number 13 at glance or counting on from a certain number.	Besides level 4 s/he can explain by words.
Activity 5-2b	S/he tells a wrong answer that is beyond our expectations	S/he cannot count and surround the total of 13 dots, however the answer is close to 13.	S/he can surround the total of 13 dots by counting one by one from 1.	S/he can surround the amount of 13 dots by counting on from a certain number or using groups.	Besides level 4 s/he can explain by words.
Activity 5-3a	S/he tells a wrong answer that is beyond our expectations	S/he cannot indicate correctly, however the answer is close to 76.	S/he can indicate the number 76 by counting one by one from 70.	S/he can indicate the number 76 at glance or counting from 75	Besides level4, s/he can explain by words.
Activity 5-3b	S/he tells a wrong answer that is beyond our expectations	S/he cannot indicate correctly, however the answer is close to 76.	S/he can indicate the number 76 by counting one by one from 50.	S/he can indicate the number 76 at glance or counting from 50	Besides level4, s/he can explain by words.
Activity 5-3c	S/he tells a wrong answer that is beyond our expectations	S/he cannot count and surround the amount of 76 dots, however the answer is close to 76.	S/he can surround the amount of 76 dots by counting one by one from 1.	S/he can surround the total of 76 dots by counting on from a certain number or using groups.	Besides level 4 s/he can explain by words.
Activity 5-3d	S/he can count from 1 by corresponding to the bottle tops, however s/he cannot answer correctly.	S/he cannot count and surround the amount of 76 dots, however the answer is close to 76.	S/he can surround the amount of 76 dots by counting one by one from 1.	S/he can surround the total of 76 marbles by counting on from a certain number or using groups.	Besides level 4 s/he can explain by words.

Extra Activity 2 (Number bond with dots)

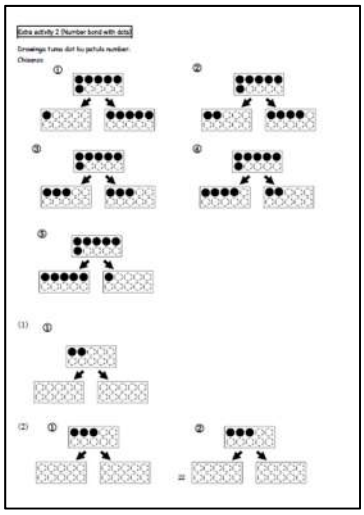
Objectives

The pupil is expected to:

i. decompose numbers 2 to 10.

Tasks (Use pupils' workbook)

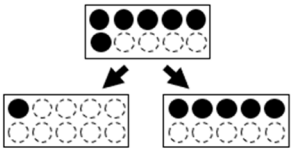
Pupils' workbook pp.22-24



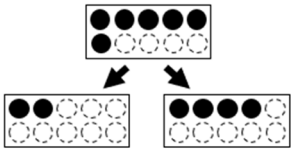
Guide for teachers:

Teacher asks pupils to draw the dots to break down the number into 10-frame and pupils explain how it is broken down. Teacher may ask pupils that how to break down numbers which are not seen in the workbook such as 4, 8 and 9.

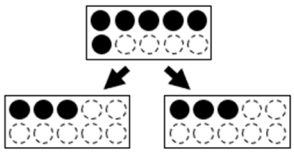
Avoid the blank one (which means 0). It is okay to write the combinations of e.g. 3 and 4, 4 and 3.



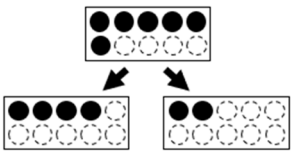
6 dots are broken down into 1 and 5.



6 dots are broken down into 2 and 4.



6 dots are broken down into 3 and 3.



6 dots are broken down into 4 and 2.

Extra Activity 3 (Number bond)

Objectives

The pupil is expected to:

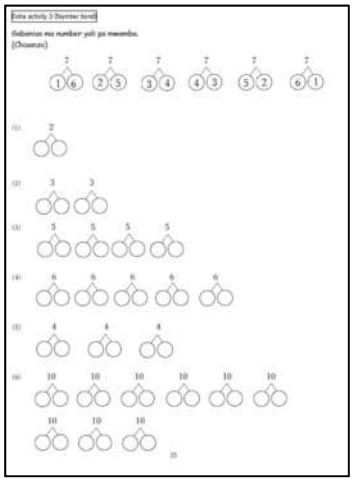
ii. decompose numbers 2 to 10.

Materials used

— Workbook for students

Tasks (Use pupils' workbook)

Pupils' workbook p. 25

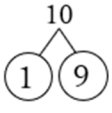


Guide for teachers:

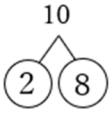
Teacher asks pupils to break down the number on top and pupils explain how it is broken down. Teacher may ask pupils that how to break down numbers which are not seen in the workbook such as 8, and 9.

Avoid 0. It is okay to write the combinations of e.g. 3 and 4, 4 and 3.

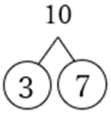
e.g.)



10 is broken down into 1 and 9.



10 is broken down into 2 and 8.



10 is broken down into 3 and 7.

6. Performing the four basic arithmetical operations

6.a Addition

Objectives

The pupil is expected to:

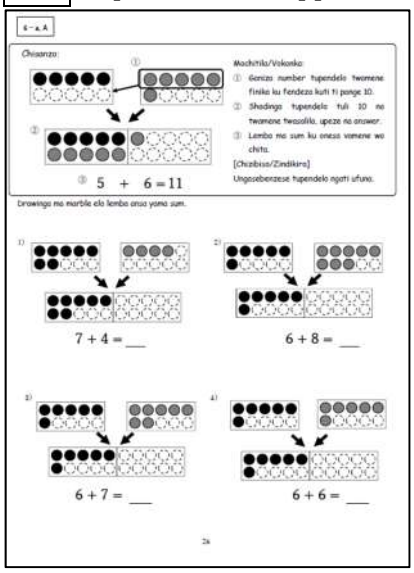
i. 1-digit+ 1-digit
ii. Addition of 2-digt number

Materials used

– 20 bottle tops

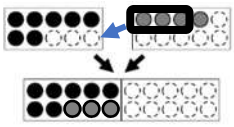
Tasks

6-a,A Pupils' workbook pp. 26-27



Guide for teachers:

Teacher shows 7 +4 and ask pupils to represent it by using bottle tops. Pupils explain the procedure and tell the sum. Teacher asks pupils to make 10 in the process of calculation. 4 bottle tops are broken down into 3 and 1. Then, 3 bottle tops move next to the 7 bottle tops to make 10. So, 10 and 1 is 11 bottle tops.

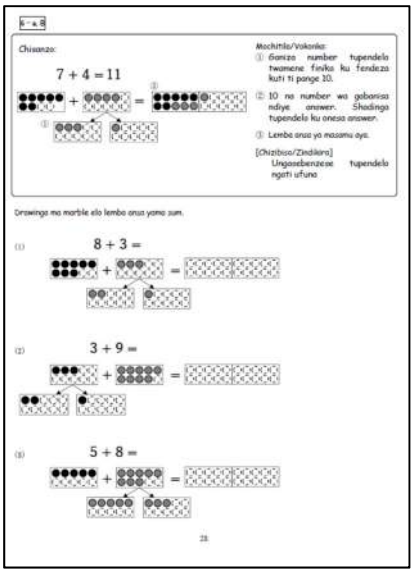


e.g.1) Teacher shows 4 + 7 and ask students to represent it by bottle tops, explain the procedure and tell the sum.

e.g.2) Teacher shows 9 + 3 and ask students to represent it by bottle tops, and explain the procedure and tell the sum.

After finishing above activities, ask pupils to do Pupils' work book p.26-27

6-a,B Pupils' workbook pp. 28-29



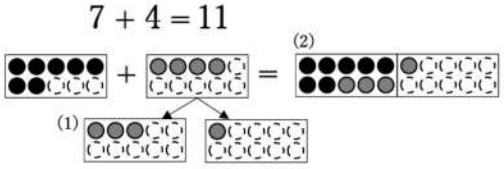
Guide for teachers:

Teacher shows 7 + 4 and ask pupils to represent it by using bottle tops. Pupils write and explain the procedure and tell the sum. Teacher asks pupils to make 10 in the process of calculation.

(1) 4 bottle tops are broken down into 3 and 1.

(2) 3 bottle tops move next to the 7 bottle tops to make 10. So, 10 and 1 is 11 bottle tops.

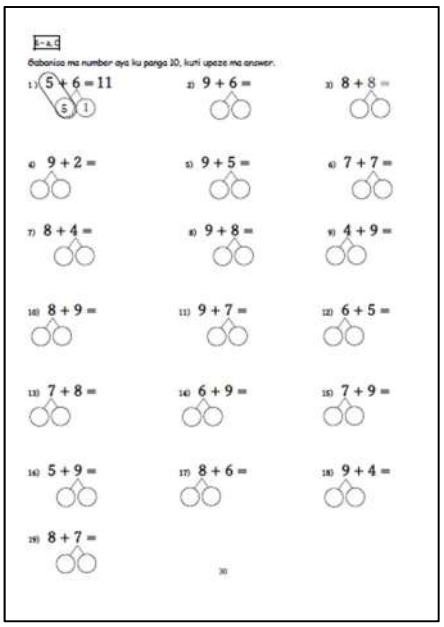
(3) Write the answer 11 in the mathematical sentence.



After finishing above activities, ask pupils to do Pupils' work book p.28-29

※Teacher should encourage them not to count but to think for the calculation. So do not just let them write the answer but see the process of the calculations important.

6-a,C Pupils' workbook pp. 30-31



Guide for teachers:

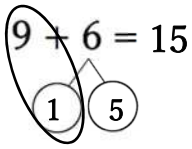
Teacher shows mathematical expression and asks pupils to think how to break down the number into two numbers in order to make 10. Pupils write the numbers in the given circles and explain the procedure for telling the sum.

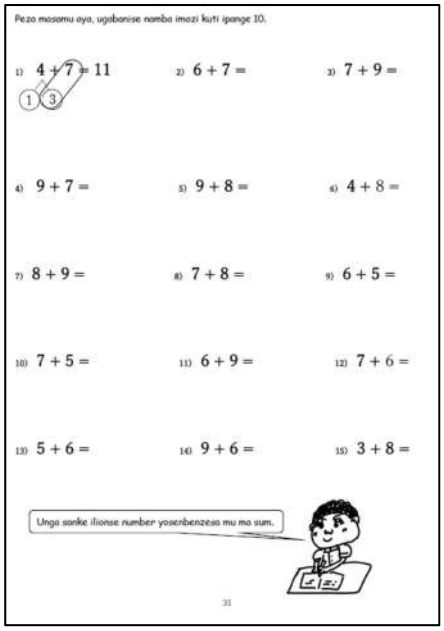
(1) 6 is divided 1 and 5 to make 10. Write 1 and 5 in the circles.

(2) 9 +1 = 10

(3) 10 +5 = 15

(4) Write the answer 15 in the mathematical sentence.





First, pupils decide which number should be divided to make ten. Next, they do the same steps as previous exercises.

※Teacher asks pupils to draw the process of calculation according to the example.

※Teacher should encourage them not to count but to think for the calculation. So do not just let them write the answer but see the process of the calculations important.

Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 6-a1	S/he cannot place bottle tops correctly.	S/he can place 7 and 8 bottle tops correctly but cannot answer correctly.	S/he can place 7 and 8 bottle tops and tell the sum by counting all.	S/he can place 7 and 8 bottle tops and tell the sum by manipulating bottle tops considering the groups.	Besides level 4, s/he can explain using base 10 by words.
Activity 6-a2	S/he used bottle tops, however could not answer correctly.	S/he can place 11 and 13 bottle tops correctly but S/he cannot answer correctly.	S/he can place 11 and 13 bottle tops and tell the sum by counting all bottle tops.	S/he can place 11 and 13 bottle tops and tell the sum by manipulating bottle tops considering the groups.	Besides level 4, s/he can explain using base 10 by words.

6.s Subtraction

Objectives

The pupil is expected to:

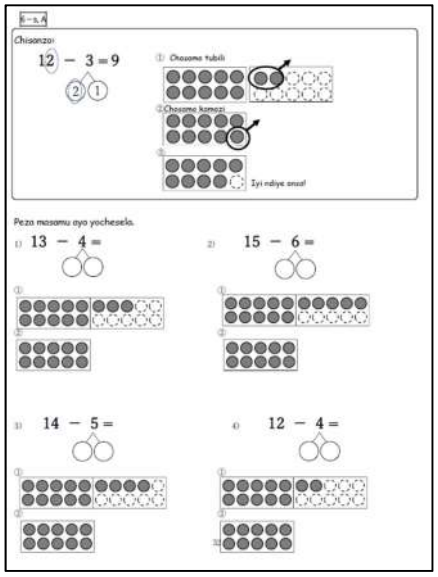
i. 1- digit - 1-digt

ii. Subtraction with 2-digt number

Materials used

– 20 bottle tops

Tasks



6-s,A Pupils' workbook pp.32-33

Guide for teachers:

Teacher shows 13－4 and ask pupils to do following steps.

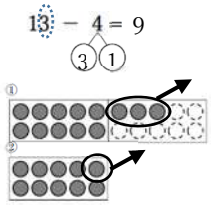
(1) Prepare 13 bottle tops.

(2) Think about how break down subtrahend in order to make 10 (3 and 1)

(3) Take away 3

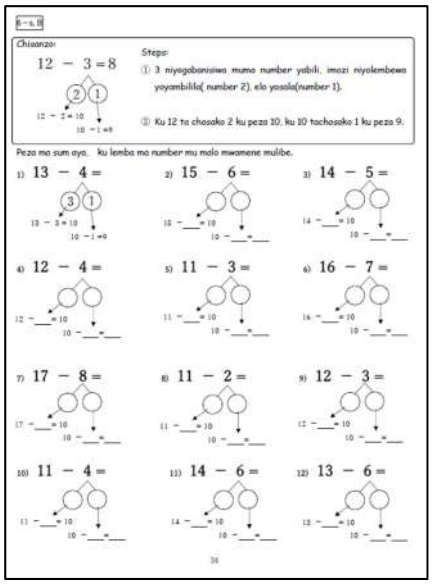
(4) Take away 1

(5) Write the answer 9 in the mathematical sentence.



After doing various exercises using bottle tops, ask pupils to do Pupils' work book p.32-33

6-s,B Pupils' workbook p.34



Guide for teachers:

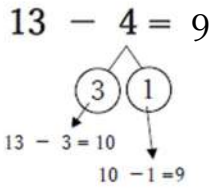
Teacher asks pupils to calculate in the following steps.

(1) 4 is divided 3 and 1 to make 10. Write 3 and 1 in the circles.

(2) 13-3= 10

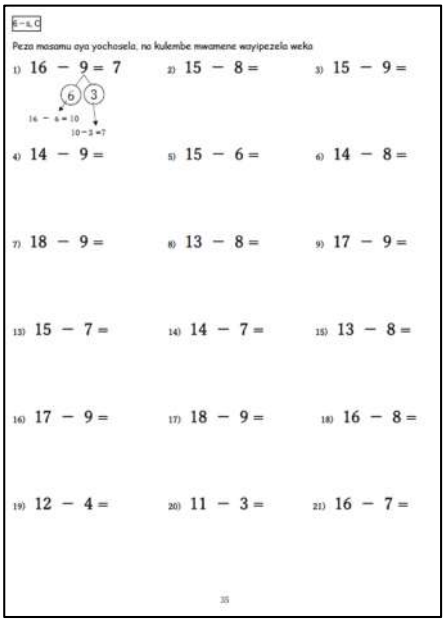
(3) 10-1 = 9

(4) Write the answer 9 in the mathematical sentence.



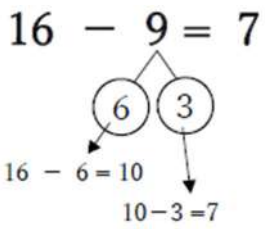
※Teacher should encourage them not to count but to think for the calculation. So do not just let them write the answer but see the process of the calculations important.

6-s,C Pupils' workbook p.35

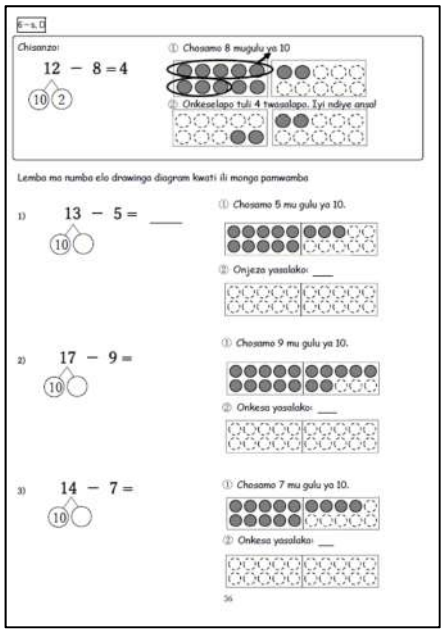


Guide for teachers:

Teacher ask pupils to do by using same steps of 6-s,B.



6-s,D Pupils' workbook pp.36-37



Guide for teachers:

Teacher shows 13－5 and ask pupils to do following steps.

(1) Prepare 13 bottle tops.

(2) 13 is divided into 10 and 3. Write 10 and 3 in the circles.

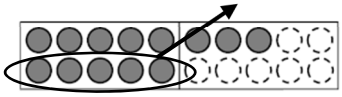
(3) Subtract 5 from 10 (10-5 =5)

(4) 3 is added to 5 (5 +3=8)

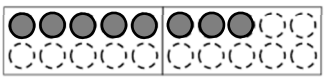
(5) Write the answer 8 in the mathematical sentence.

e.g.)

①Take away 5 from group of 10



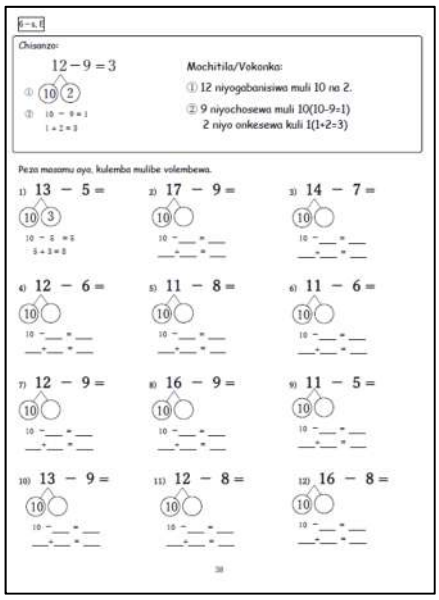
②Adding remaining: 8



After doing various exercises using bottle tops, ask pupils to do Pupils' work book p.36-37

※Teacher should encourage them not to count but to think for the calculation. So do not just let them write the answer but see the process of the calculations important.

6-s,E Pupils' workbook p.38



Guide for teachers:

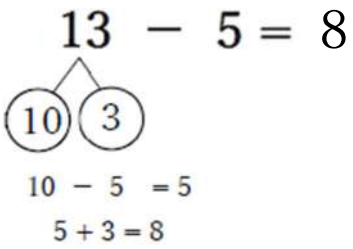
Teacher shows 13－5 and ask pupils to do following steps.

(1) 13 is divided into 10 and 3. Write 10 and 3 in the circles.

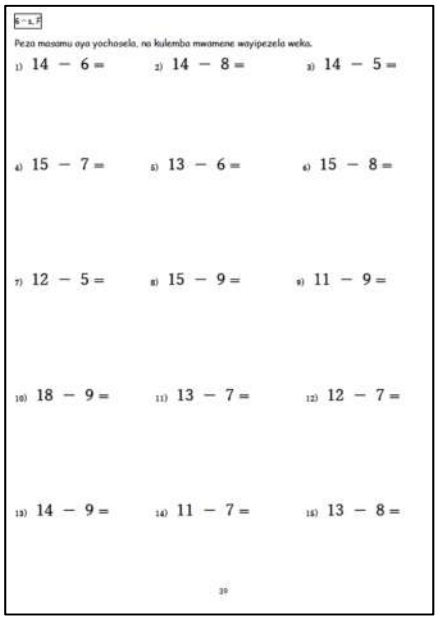
(2) 10-5 =5

(3) 5 +3=8

(4) Write the answer 8 in the mathematical sentence.

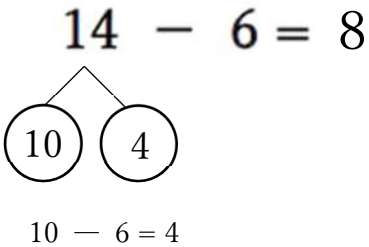


6-s,F Pupils' workbook p.39



Guide for teachers:

Teacher ask pupils to do by using same steps of 6-s,E



※Teacher should encourage them not to count but to think for the calculation. So do not just let them write the answer but see the process of the calculations important.

Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 6-s1	S/he used bottle tops, however could not answer correctly.	S/he can place the necessary number of bottle tops but S/he cannot answer correctly. Wrong answer/counting all.	S/he can place 15 bottle tops and remove 8 from them and counting all bottle tops, (Counting all)	S/he can place 15 bottle tops and remove 8 from them, tell the answer verbally by considering the groups.	Besides level 4, s/he can explain using base 10 by words.
Activity 6-s2	S/he used bottle tops, however could not answer correctly.	S/he can place the necessary number of bottle tops but S/he cannot answer correctly.	S/he can place 25 bottle tops and remove 12 from them and counting all bottle tops.	S/he can place 25 bottle tops and remove 12 from them, tell the answer verbally by considering the groups and place value.	Besides level 4, s/he can explain using base 10 by words.

6.m Multiplication

Objectives

The pupil is expected to:

i. Multiply to see the numbers by group. Represent by numbers. Be able to calculate.

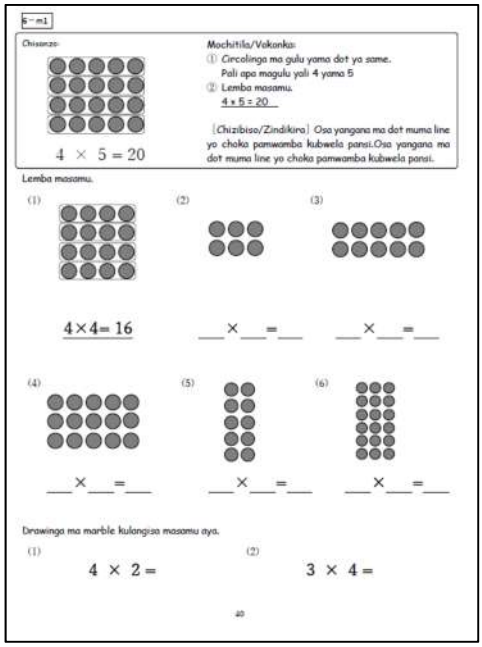
ii. 2-digt × 1-digit, Emphasis on place value.

Materials used

– 20 bottle tops

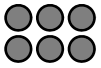
Tasks

6-m1 Pupils' workbook p.40



Guide for teachers:

Teacher shows 2 × 3 and ask students to represent it by bottle tops, explain the procedure and tell the answer.



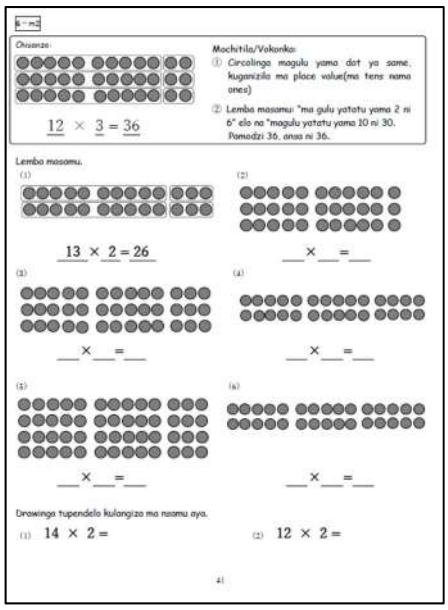
※Ask students to consider not by counting all but by using groups. Teacher should not allow children to circle the dots vertically in this particular case, otherwise the order of multiplication will be changed which makes me more complicated in teaching.

(e.g.1) Teacher shows 4×2 and ask students to represent it by bottle tops.
Explain the procedure and tell the answer.

(e.g. 2) Teacher shows 3×6 and ask students to represent it by bottle tops.
Explain the procedure and tell the answer.

After finishing above activities, ask pupils to do Pupils' work book p.40

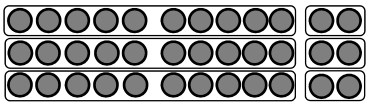
6-m2 Pupils' workbook p.41



Guide for teachers:

Teacher shows 12 × 3 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

* Ask pupils to calculate considering place value. '3×2 is equal to 6' and '3×10 is equal to 30'. Therefore, the answer is 36. Teacher should not allow children to circle the dots vertically in this particular case, otherwise the order of multiplication will be changed which makes me more complicated in teaching.



3 ×10=30 3×2 =6

(e.g.1) Teacher shows 13×3 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

(e.g. 2) Teacher shows 14×2 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

After finishing above activities, ask pupils to do Pupils' work book p.41

Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 6-m1	S/he used bottle tops, however could not answer correctly.	S/he can place 6 bottle tops in groups but S/he cannot answer correctly.	S/he can place 6 bottle tops in groups and tell the answer verbally by counting. (Counting all)	S/he can place 6 bottle tops in groups, and tell the answer verbally the groups.	Besides level 4, s/he can explain using base 10 by words.
Activity 6-m2	S/he used bottle tops, however could not answer correctly.	S/he can place 12 bottle tops in 3 rows, but S/he cannot answer correctly.	S/he can place 36 bottle tops and tell the answer verbally by counting.	S/he can place 36 bottle tops in groups, and tell the answer verbally the groups and place value.	Besides level 4, s/he can explain using base 10 by words.

6.d Division

Objectives

The pupil is expected to:

i. see the numbers by group, represent by numbers, and be able to calculate'.

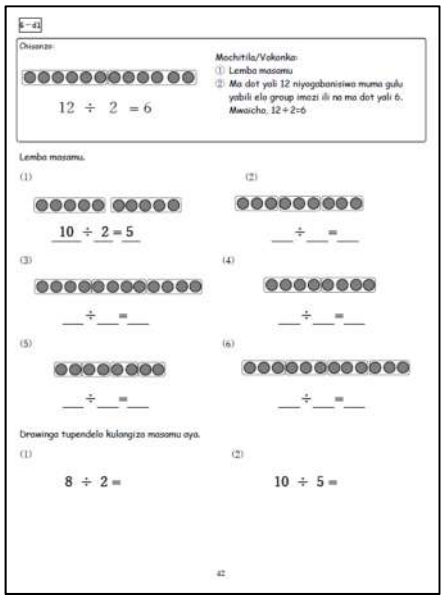
ii. 2-digt ÷ 1-digit, Emphasis on place value'.

Materials used

– 20 bottle tops

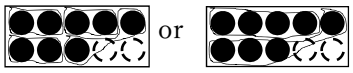
Tasks

6-d1 Pupils' workbook p. 42



Guide for teachers:

Teacher shows 8 ÷ 2 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

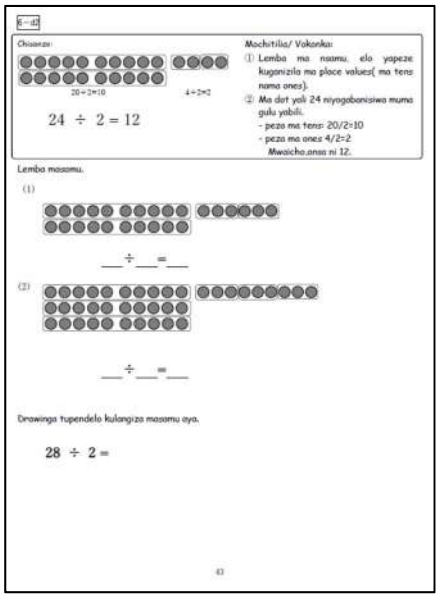


e.g.) Teacher shows 6 ÷ 3 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

e.g.) Teacher shows 9 ÷ 3 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

After finishing above activities, ask pupils to do Pupils' work book p.42

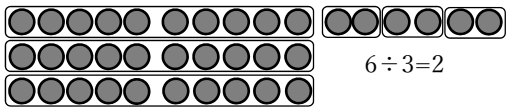
6-d2 Pupils' workbook p. 43



Guide for teachers:

Teacher shows 36 ÷ 3 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

* Ask students to calculate considering place value. '30 ÷ 3 is equal to 10' and '6 ÷ 3 is equal to 2'. Therefore, the answer is 12.



e.g.) Teacher shows 24 ÷ 2 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

e.g.) Teacher shows 48 ÷ 4 and ask students to represent it by bottle tops, explain the procedure and tell the answer.

After finishing above activities, ask pupils to do Pupils' work book p.43

Rubric for assessment

	1. No at all	2. Partly implicit	3. Implicit	4. Structural	5. Advanced
Activity 6-d1	S/he used bottle tops, however could not answer correctly.	S/he can place 8 bottle tops, however could not answer correctly.	S/he can place 8 bottle tops and find the answer by dividing one by one. S/he can say the answer instantly but failed to express it with bottle tops.	S/he can place 8 bottle tops 2 by 4 in order, and tell the answer verbally.	Besides level 4, s/he can explain using base 10 by words.
Activity 6-d2	S/he used bottle tops, however could not answer correctly.	S/he can place 30 bottle tops, however could not answer.	S/he can find the answer by dividing one by one. S/he can say the answer instantly but failed to express it with bottle tops.	S/he can divide the 30 bottle tops by using group of 5 or 10.	Besides level 4, s/he can explain by words.

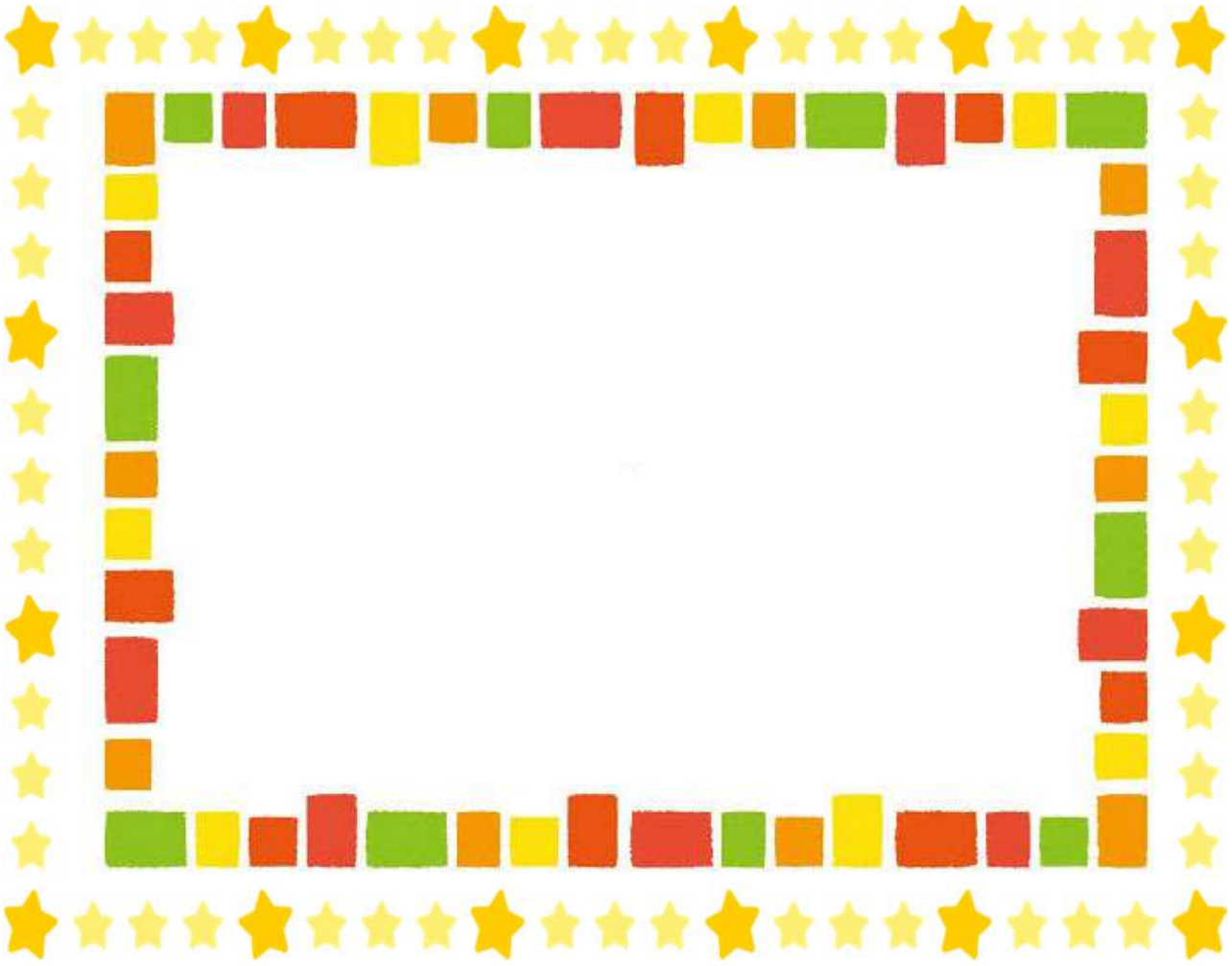
Appendix 4-1

Pupil's Workbook

Grade 1

Buku la bana ba sikulu yosebenzela mu masamu

(Grade 1)



Sukulu: _____ Dzina: _____

Title: Buku la bana ba sikulu yosebenzela mu masamu

Author: ARTHUR, Mungalu
BABA, Takuya
BARBARA, Mudenda
CHIKOLA, Doye
EMMANUEL, Kaabo
KOSAKA, Masato,
KUSAKA, Satoshi
MAMBWE, Bareford
MINAGOSHI, Kanae
NAKAWA, Nagisa,
NKHALAMO, Chimwemwe Joy
NKHATA, Bentry,
SPIWE, Tafeni
WATANABE, Koji

Pepala yolangiza pamene muyendela

Dzina: _____

Siku	Zamkati
Chisanzo Makumi Atatu	1 - 1

Siku	Zamkati

Vili Mu Book

1 – 1

1. Ika tu pendelo tuli 20 munjila iliyonse pa desk. Tupenda kamozi kamozi.

☐ Na ichita!

2. Ika tu pendelo tuli 20 munjila iliyonse pa desk. Tupenda tubili tubili na five five.

☐ Na ichita!

1－2

1. Penda kufika pa 20.

☐ Na ichita!

2. Penda muma 2 kufika pa 20.

☐ Na ichita!

3. Penda muma 5 kufika pa 20.

☐ Na ichita!

1 – 3

1. Penda kuchoka pa 20 kubwela pansi.

☐ Na ichita!

2. Penda muma 2 kuchoka pa 20 kubwela pansi.

☐ Na ichita!

3. Penda muma 5 kuchoka pa 20 kubwela pansi.

☐ Na ichita!

2 – 1

Konza tupendelo tuli 10 twa white na twa red tuli 10 pa desk yako.

1. Panga ka mu line ka nkhale na ka pattern kalikonse ka tupendelo twa red na twa white.

   (Chisanzo)

   ●○●○●○●○●○●○●○●○●○●○●○

2. Uza banzako pattern yamene wapanga.

2－2

Konza ka frame of 10 na tupendelo.

1. Ika tupendelo tuli 7 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

2. Ika tupendelo tuli 9 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

3. Ika tupendelo tuli 8 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

4. Ika tupendelo tuli 6 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

5. Ika tupendelo tuli 10 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

2－3

1. Ika tupendelo tuli 18 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

2. Ika tupendelo tuli 13 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

3. Ika tupendelo tuli 16 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10 na 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

4. Ika tupendelo tuli 17 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10 na 5.
   ※Peza njila yopendela bwino elo na mwamusanga elo uza banzako mwamene wapendela.

   ☐ Na ichita!

5. Ika tupendelo tuli 12 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

2－4

1. Konza tu pendelo tuli 20.
   Tantika tu pendelo mwamene uganizila tunga nkhalile pa ma frame of 10.
   ※Uza banzanko motufakila.

   ☐ Na ichita!

2. Konza tu pendelo tuli 14.
   Tantika tu pendelo mwamene uganizila tunga nkhalile pa ma frame of 10.
   ※Uza banzanko motufakila.

   ☐ Na ichita!

3. Konza tu pendelo tuli 18.
   Tantika tu pendelo mwamene uganizila tunga nkhalile pa ma frame of 10.
   ※Uza banzanko motufakila.

   ☐ Na ichita!

4. Konza tu pendelo tuli 16.
   Tantika tu pendelo mwamene uganizila tunga nkhalile pa ma frame of 10.
   ※Uza banzanko motufakila.

   ☐ Na ichita!

5. Ganiza tuma frame of 10 tubili. Pasala ma spaces yangati, ngati pali tu pendelo tuli 13?
   ※Uza banzanko motufakila.

   ☐ Na ichita!

6. Ganiza tuma frame of 10 tubili. Pasala ma spaces yangati, ngati pali tu pendelo tuli 17?
   ※Uza banzanko motufakila.

   ☐ Na ichita!

3 – 1

1. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tutatu, ku side kwinangu ika tu pendelo tuli 9.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 4, ku side kwinangu ika tu pendelo tuli 7.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 5, ku side kwinangu ika tu pendelo tuli 8.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 7, ku side kwinangu ika tu pendelo tuli 6.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 8, ku side kwinangu ika tu pendelo tuli 7.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

6. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 6, ku side kwinangu ika tu pendelo tuli 9.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

3 – 2

1. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo tuli 13, ku side kwinangu ika tu pendelo tuli 19.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

2. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 14, ku side kwinangu ika tu pendelo tuli 17.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

3. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 15, ku side kwinangu ika tu pendelo tuli 18.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

4. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 16, ku side kwinangu ika tu pendelo tuli 12.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

5. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 17, ku side kwinangu ika tu pendelo tuli 16.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

6. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

3 – 3

1. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 12.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 14.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 16.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 11.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 17.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

6. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 13.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

7. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

3 – 4

1. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 27.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 24.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 28.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 18.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 13.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

6. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

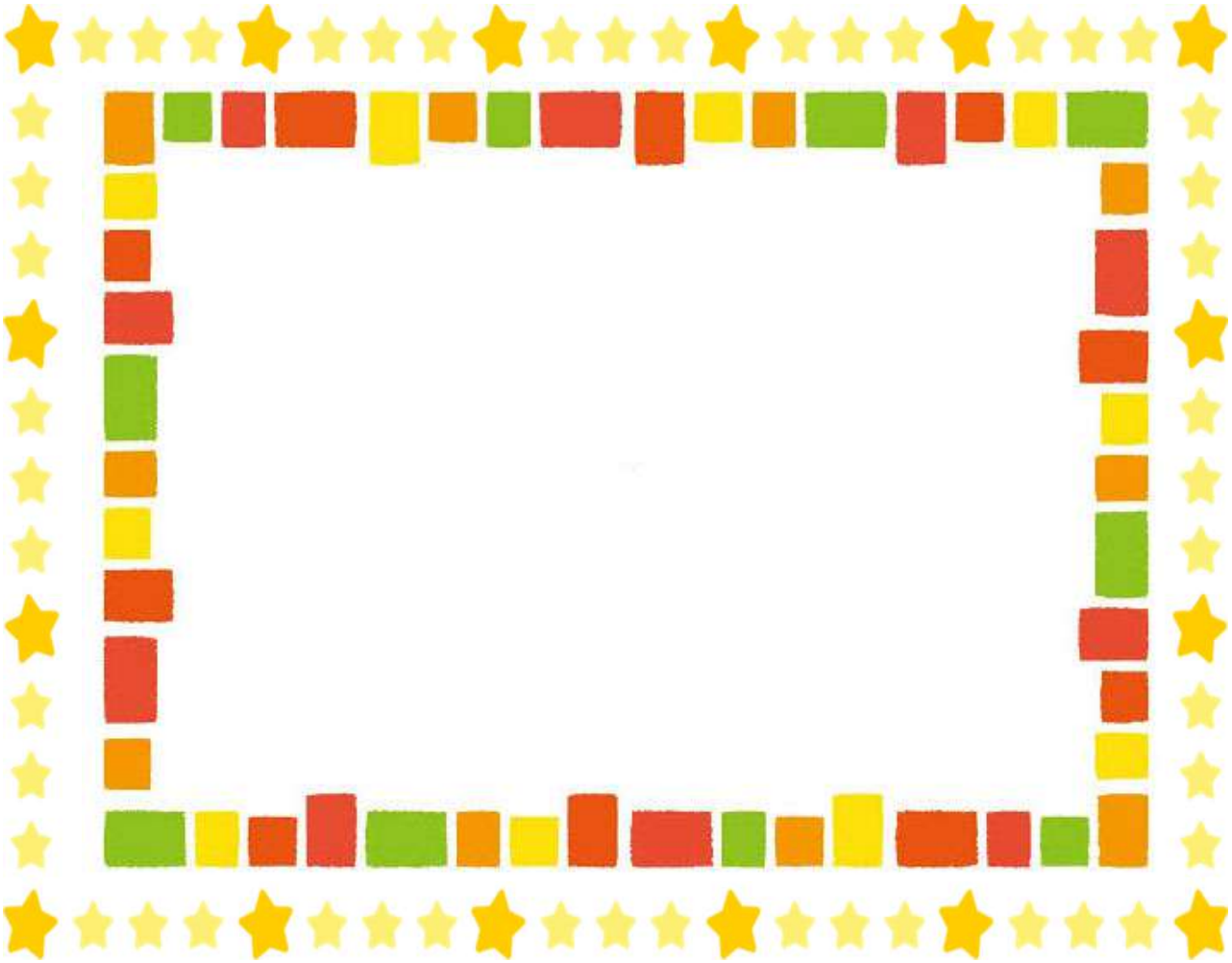
Appendix 4-2

Pupil's Workbook

Grade 2

Buku la bana ba sikulu yosebenzela mu masamu

(Grade 2)



Sukulu:_____ Dzina:_____

Title: Buku la bana ba sikulu yosebenzela mu masamu

Author: ARTHUR, Mungalu
BABA, Takuya
BARBARA, Mudenda
CHIKOLA, Doye
EMMANUEL, Kaabo
KOSAKA, Masato,
KUSAKA, Satoshi
MAMBWE, Bareford
MINAGOSHI, Kanae
NAKAWA, Nagisa,
NKHALAMO, Chimwemwe Joy
NKHATA, Bentry,
SPIWE, Tafeni
WATANABE, Koji

Pepala yolangiza pamene muyendela

Dzina: _____

Siku	Zamkati
Chisanzo Makumi Atatu	1 - 1

Siku	Zamkati

Vili Mu Book

2 – 1

Konza tupendelo tuli 10 twa white na twa red tuli 10 pa desk yako.

1. Panga ka mu line ka nkhale na ka pattern kalikonse ka tupendelo twa red na twa white.

   (Chisanzo)

   ●○●○●○●○●○●○●○●○●○●○●○

2. Uza banzako pattern yamene wapanga.

2－2

Konza ka frame of 10 na tupendelo.

1. Ika tupendelo tuli 7 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

2. Ika tupendelo tuli 9 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

3. Ika tupendelo tuli 8 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

4. Ika tupendelo tuli 6 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

5. Ika tupendelo tuli 10 pa ka frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

2－3

1. Ika tupendelo tuli 18 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

2. Ika tupendelo tuli 13 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

3. Ika tupendelo tuli 16 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10 na 5.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

4. Ika tupendelo tuli 17 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10 na 5.
   ※Peza njila yopendela bwino elo na mwamusanga elo uza banzako mwamene wapendela.

   ☐ Na ichita!

5. Ika tupendelo tuli 12 pa ma frame of 10 uyambile ku left pa mwamba.
   Penda tu pendelo muma gulu ya 10.
   ※Peza njila yopendelamo bwino na mwamusanga elo uza banzanko mwamene wapendela.

   ☐ Na ichita!

2－4

1. Konza tu pendelo tuli 20.
   Tantika tu pendelo mwamene uganizila tunga nkhalile pa ma frame of 10.
   ※Uza banzanko motufakila.

   ☐ Na ichita!

2. Konza tu pendelo tuli 14.
   Tantika tu pendelo mwamene uganizila tunga nkhalile pa ma frame of 10.
   ※Uza banzanko motufakila.

   ☐ Na ichita!

3. Konza tu pendelo tuli 18.
   Tantika tu pendelo mwamene uganizila tunga nkhalile pa ma frame of 10.
   ※Uza banzanko motufakila.

   ☐ Na ichita!

4. Konza tu pendelo tuli 16.
   Tantika tu pendelo mwamene uganizila tunga nkhalile pa ma frame of 10.
   ※Uza banzanko motufakila.

   ☐ Na ichita!

5. Ganiza tuma frame of 10 tubili. Pasala ma spaces yangati, ngati pali tu pendelo tuli 13?
   ※Uza banzanko motufakila.

   ☐ Na ichita!

6. Ganiza tuma frame of 10 tubili. Pasala ma spaces yangati, ngati pali tu pendelo tuli 17?
   ※Uza banzanko motufakila.

   ☐ Na ichita!

3 – 1

1. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tutatu, ku side kwinangu ika tu pendelo tuli 9.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 4, ku side kwinangu ika tu pendelo tuli 7.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 5, ku side kwinangu ika tu pendelo tuli 8.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 7, ku side kwinangu ika tu pendelo tuli 6.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 8, ku side kwinangu ika tu pendelo tuli 7.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

6. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 6, ku side kwinangu ika tu pendelo tuli 9.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

3 – 2

1. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo tuli 13, ku side kwinangu ika tu pendelo tuli 19.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

2. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 14, ku side kwinangu ika tu pendelo tuli 17.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

3. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 15, ku side kwinangu ika tu pendelo tuli 18.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

4. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 16, ku side kwinangu ika tu pendelo tuli 12.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

5. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 17, ku side kwinangu ika tu pendelo tuli 16.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

6. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

3 – 3

1. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 12.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 14.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 16.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 11.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 17.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

6. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 13.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

7. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

3 – 4

1. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 27.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 24.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 28.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 18.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 13.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

6. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

4－1

1. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 49.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

2. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 38.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

3. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 26.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

4. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 32.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

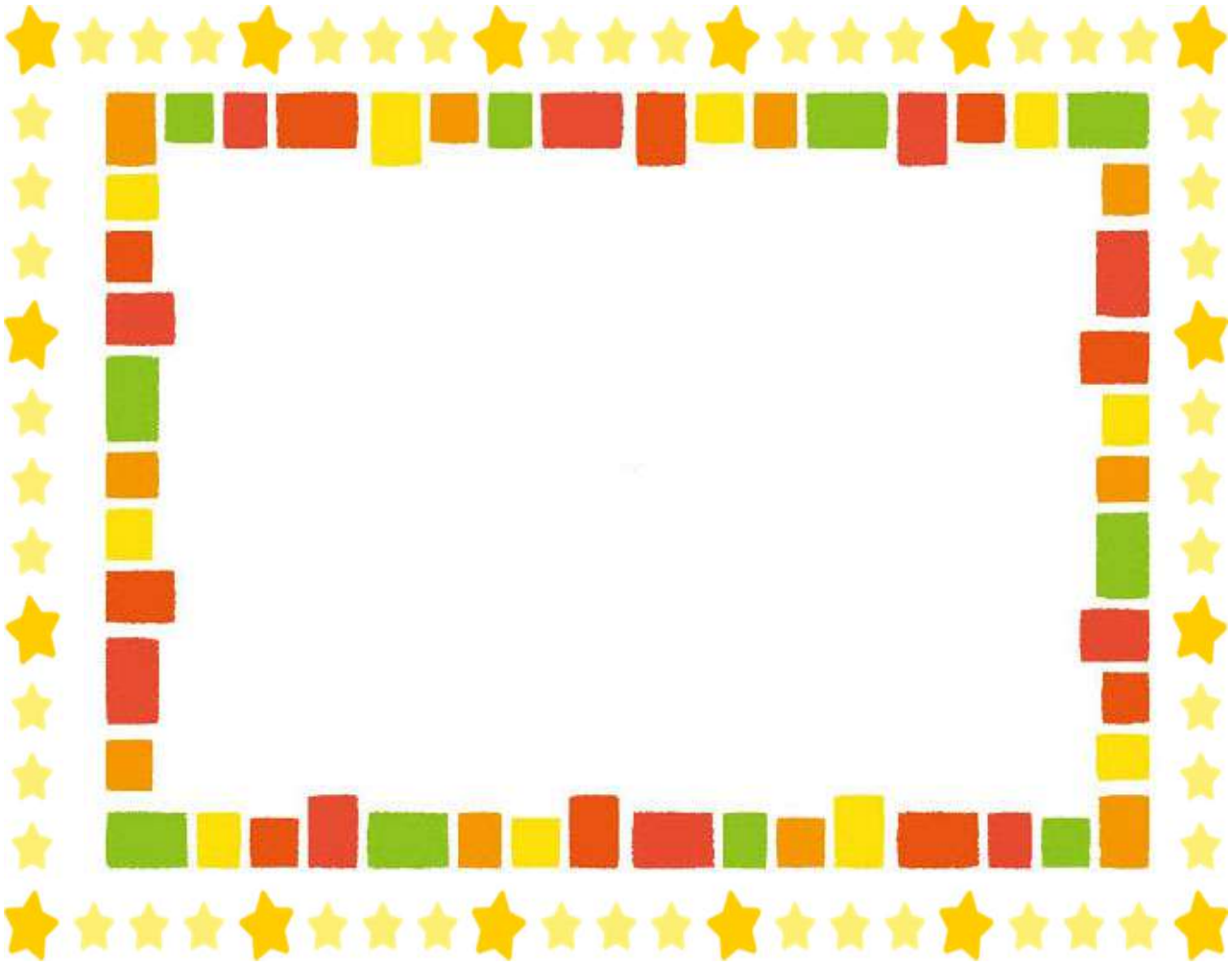
Appendix 4-3

Pupil's Workbook

Grade 3

Buku la bana ba sikulu yosebenzela mu masamu

(Grade 3)



Sukulu:_____ Dzina:_____

Title: Buku la bana ba sikulu yosebenzela mu masamu

Author: ARTHUR, Mungalu
BABA, Takuya
BARBARA, Mudenda
CHIKOLA, Doye
EMMANUEL, Kaabo
KOSAKA, Masato,
KUSAKA, Satoshi
MAMBWE, Bareford
MINAGOSHI, Kanae
NAKAWA, Nagisa,
NKHALAMO, Chimwemwe Joy
NKHATA, Bentry,
SPIWE, Tafeni
WATANABE, Koji

Pepala yolangiza pamene muyendela

Dzina: _____

Siku	Zamkati
Chisanzo Makumi Atatu	1-1

Siku	Zamkati

Vili Mu Book

3 – 1

1. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tutatu, ku side kwinangu ika tu pendelo tuli 9.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 4, ku side kwinangu ika tu pendelo tuli 7.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 5, ku side kwinangu ika tu pendelo tuli 8.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 7, ku side kwinangu ika tu pendelo tuli 6.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 8, ku side kwinangu ika tu pendelo tuli 7.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

6. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 6, ku side kwinangu ika tu pendelo tuli 9.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

3 – 2

1. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo tuli 13, ku side kwinangu ika tu pendelo tuli 19.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

2. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 14, ku side kwinangu ika tu pendelo tuli 17.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

3. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 15, ku side kwinangu ika tu pendelo tuli 18.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

4. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 16, ku side kwinangu ika tu pendelo tuli 12.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

5. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 17, ku side kwinangu ika tu pendelo tuli 16.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

6. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

3 – 3

1. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 12.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 14.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 16.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 11.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 17.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

6. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 13.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

7. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

3 – 4

1. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 27.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 24.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 28.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 18.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 13.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

6. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

4－1

1. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 49.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

2. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 38.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

3. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 26.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

4. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 32.
   Penda tu pendelo mu njila yamusanga musanga.

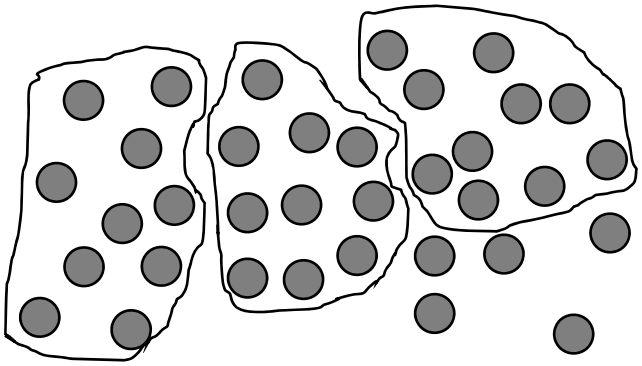
   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

Extra activity1 (Counting numbers using group of 10)

(Chisanzo)

Yali yangati ma dot?



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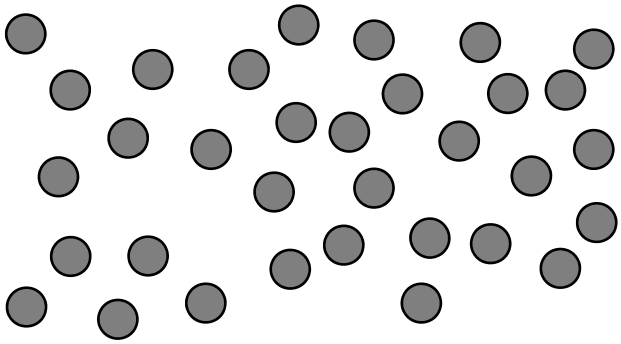

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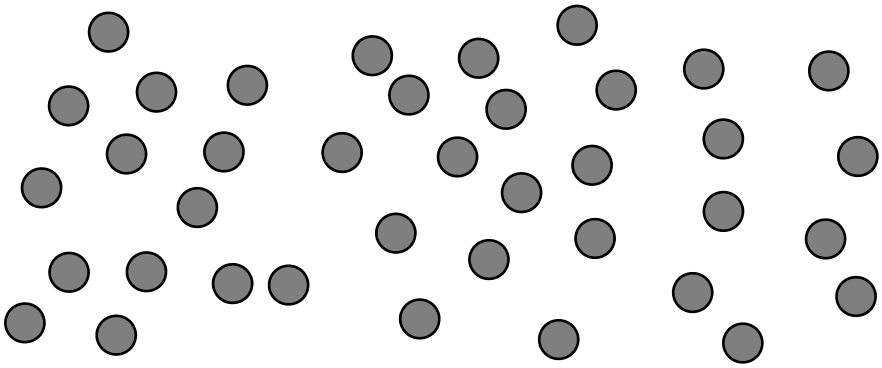
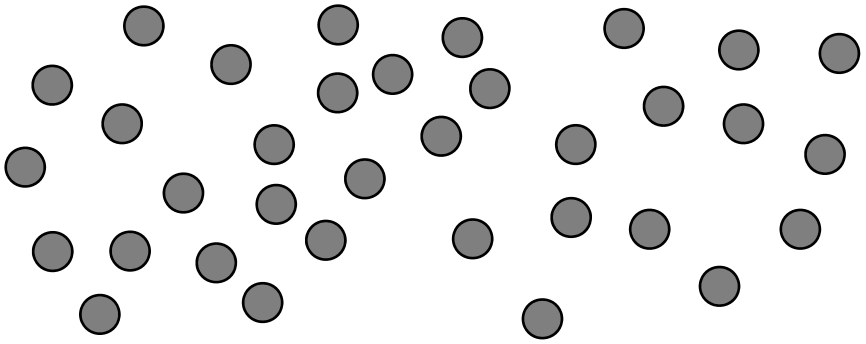


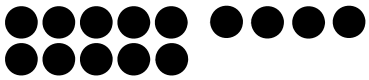
(3)



5－1

Tuli tungati tuma dot utu? Uza banzako mwamene wapendela bwino.

(1)



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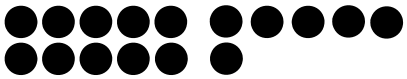
(2)



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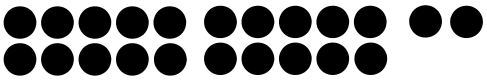
(3)



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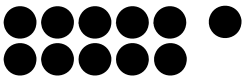
(4)



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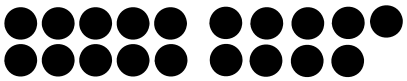
(5)



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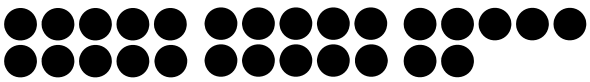
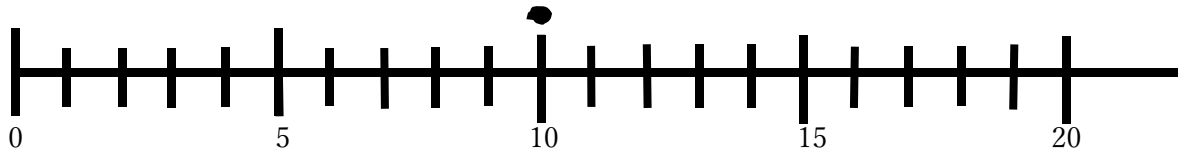


_____

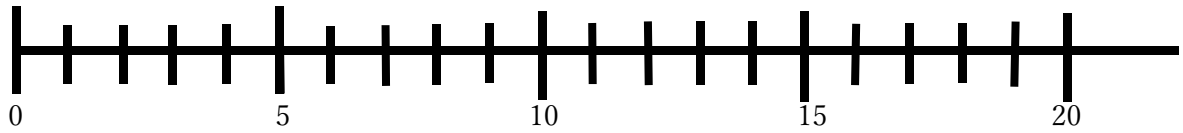
5 – 2a

Langiza ma aya namba pa namba line.

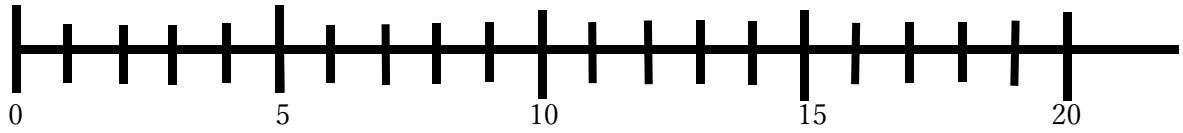
(Chisanzo) 10



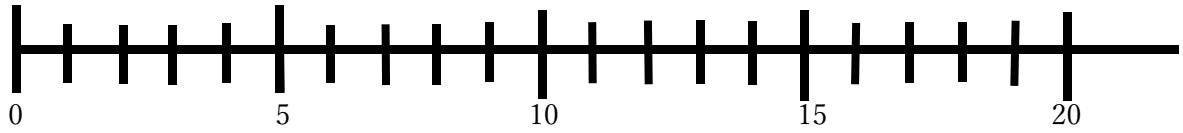
(1) 12



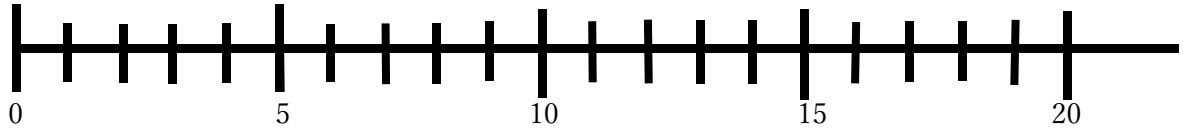
(2) 14



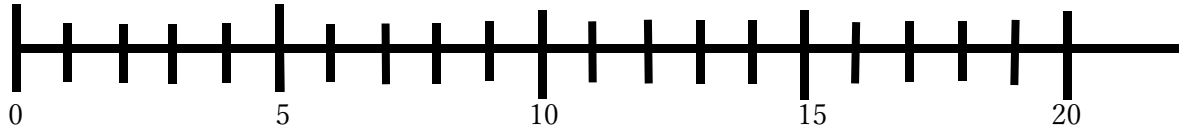
(3) 11



(4) 16



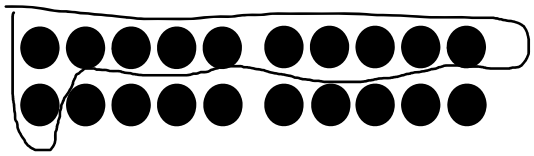
(5) 19



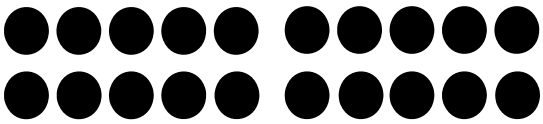
5 – 2b

Circling'a aya ma number yama dots. Fakila nzelu kumagulu ya 10.

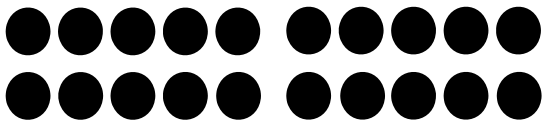
(Chisanzo) 11



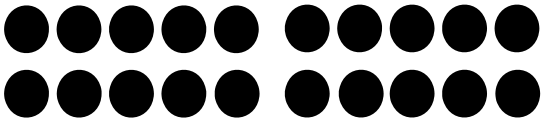
(1) 12



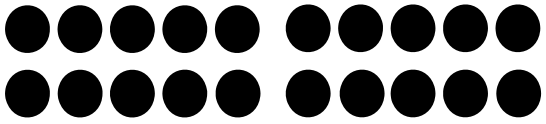
(2) 15



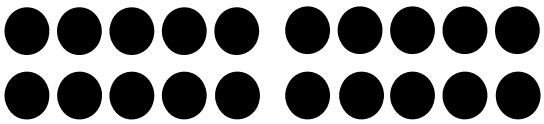
(3) 14



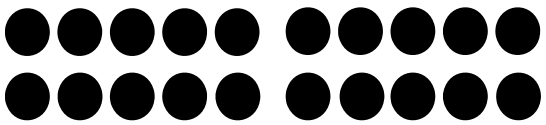
(4) 18



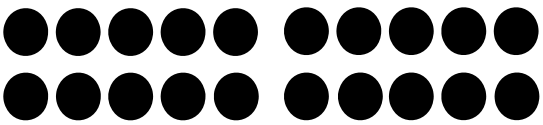
(5) 11



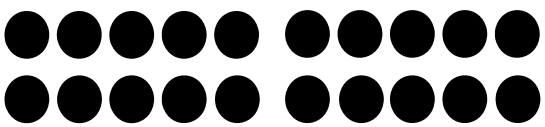
(6) 19



(7) 13



(8) 17

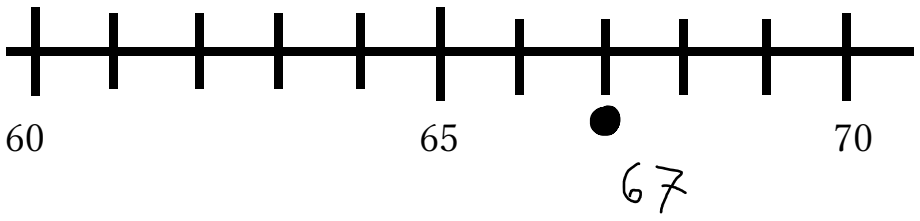


5 – 3a

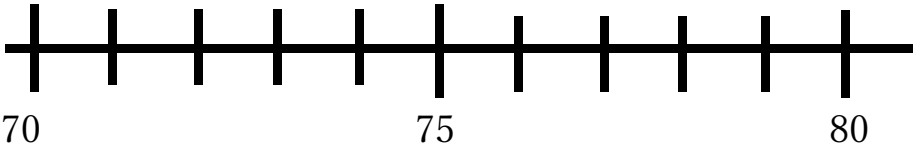
Langiza ma aya namba pa namba line.

(Chisanzo)

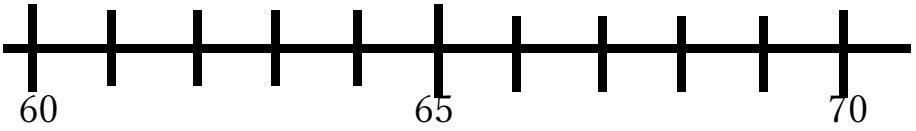
67



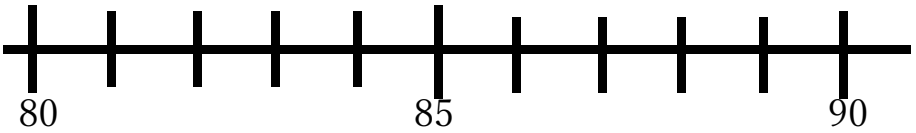
(1) 77



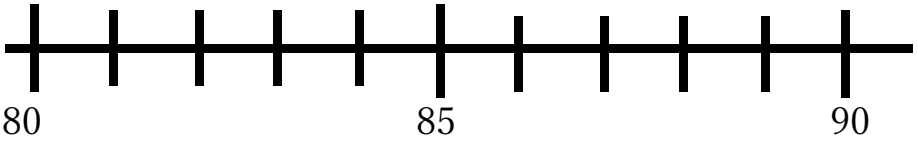
(2) 68



(3) 89



(4) 83

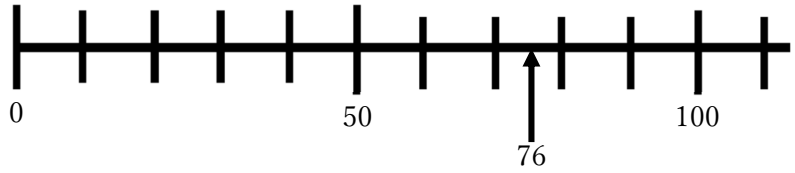


5 – 3b

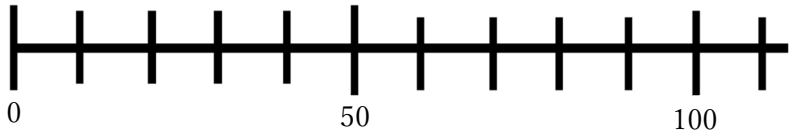
Langiza ma aya namba pa namba line.

(Chisanzo)

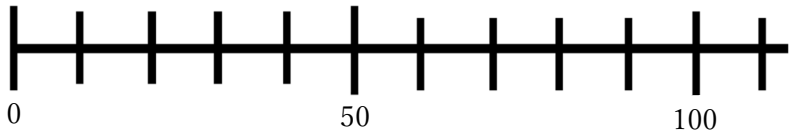
76



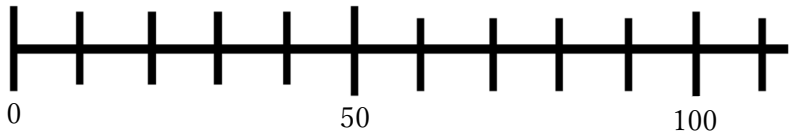
(1) 58



(2) 64



(3) 87



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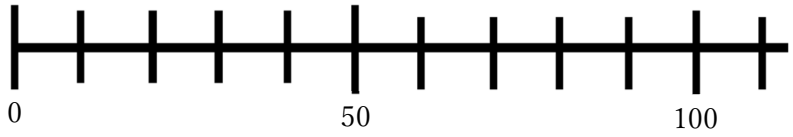
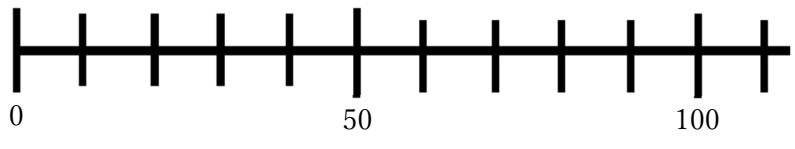
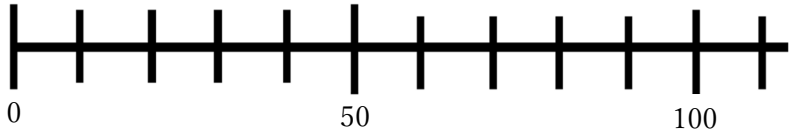


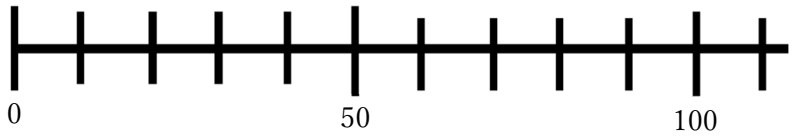
(5) 74



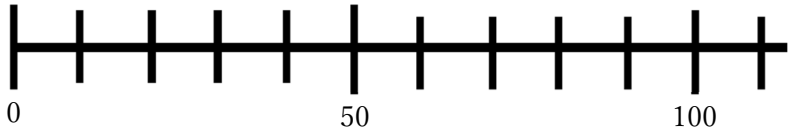
(6) 83



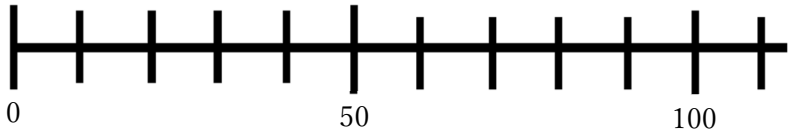
(7) 77



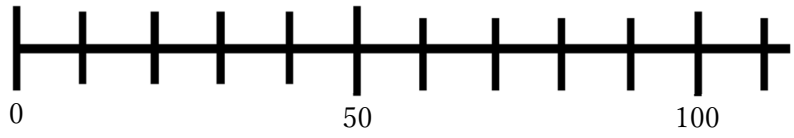
(8) 93



(9) 103



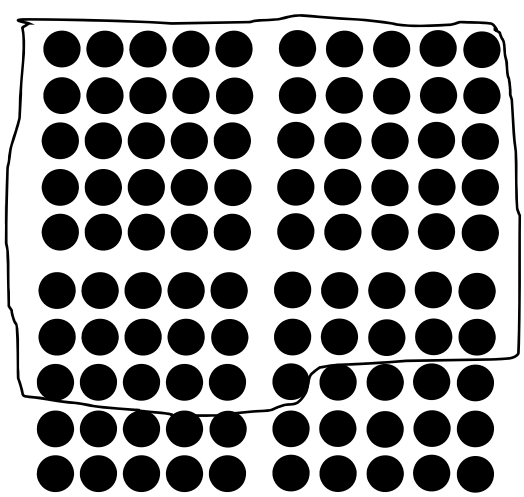
(10) 120

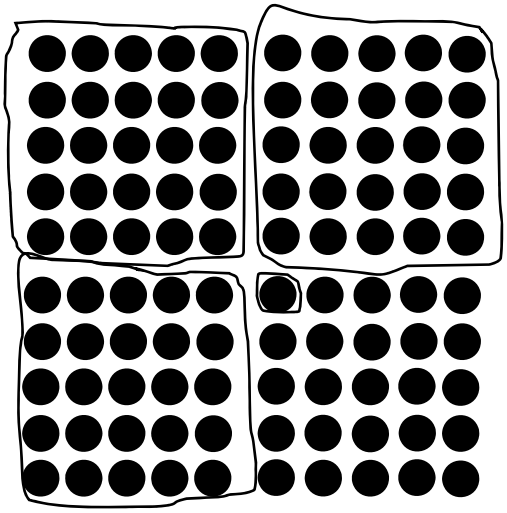


5 – 3c

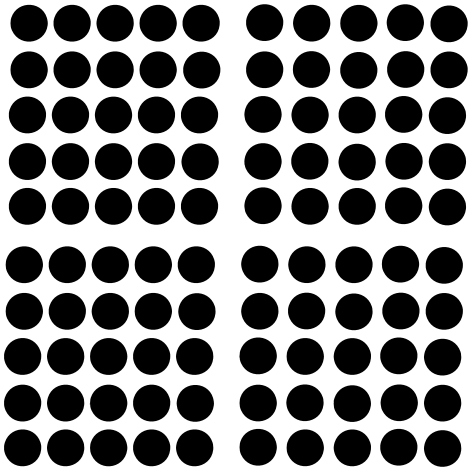
Circling'a aya ma number yama dots. Uza banzako mwamene waganizila.

Chisanzo: 76

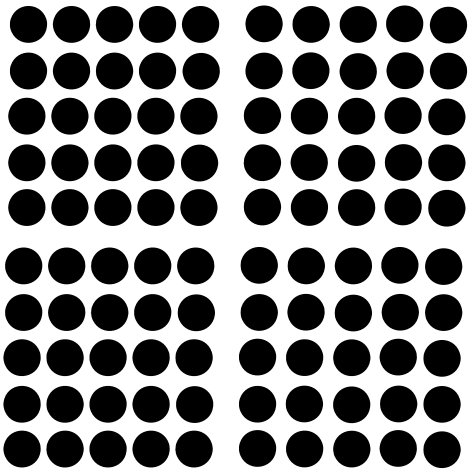




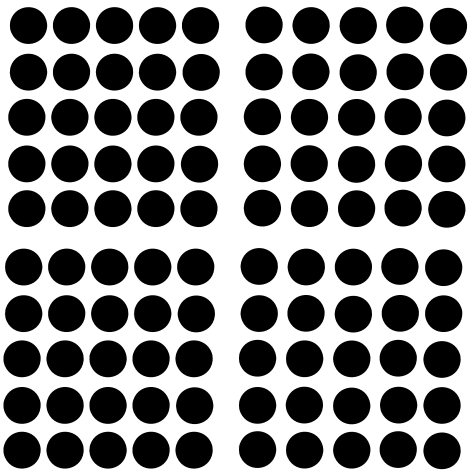
(1) 54



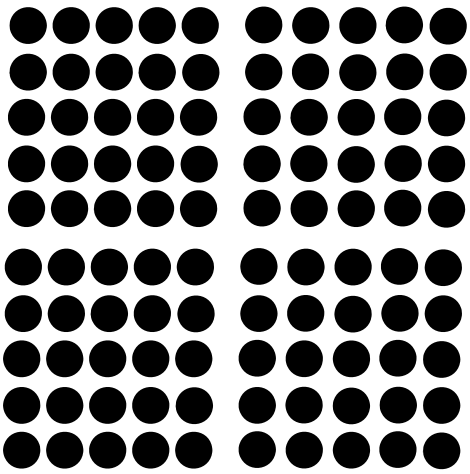
(2) 80



(3) 98



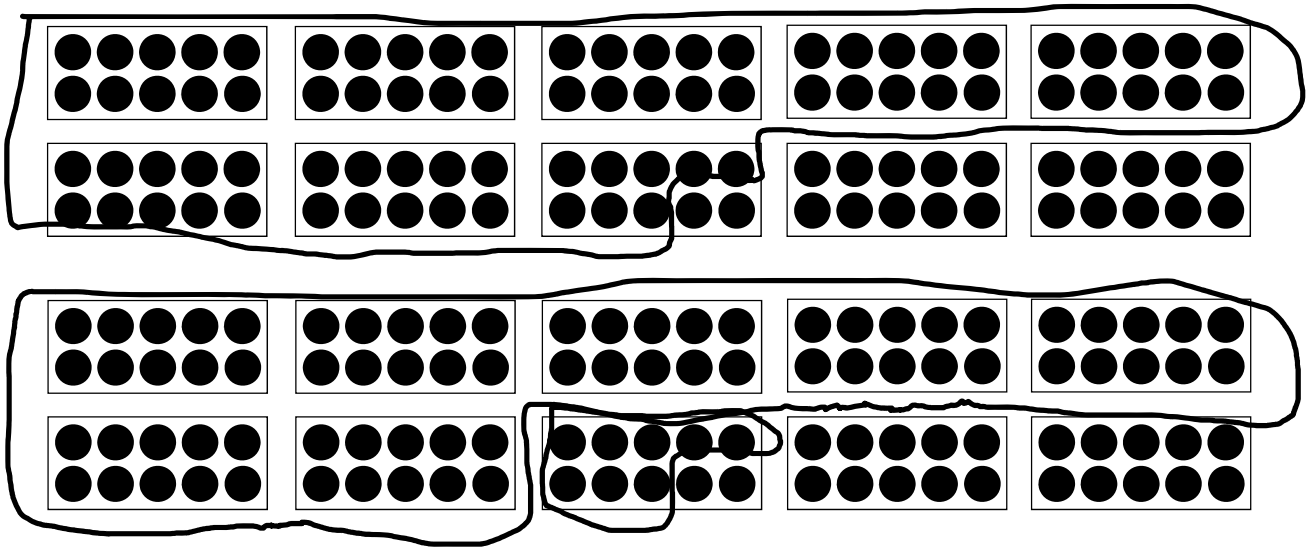
(4) 79



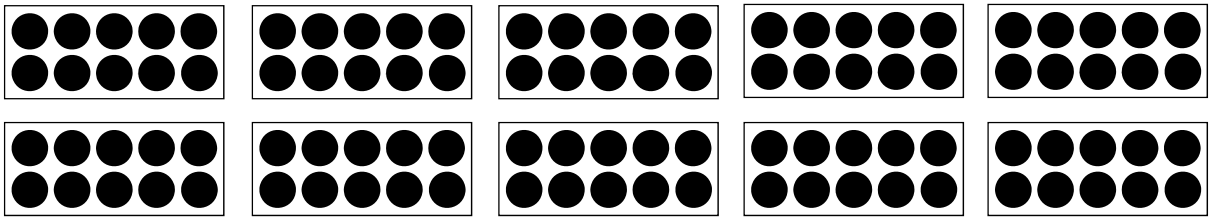
5 – 3d

Circling'a aya ma number yama dots. Uza banzako mwamene waganizila.

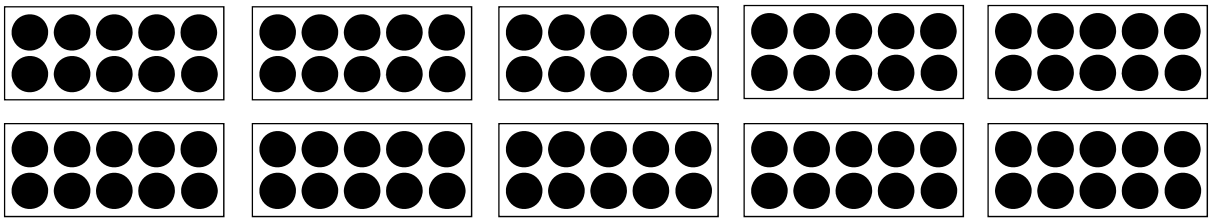
Chisanzo: 78



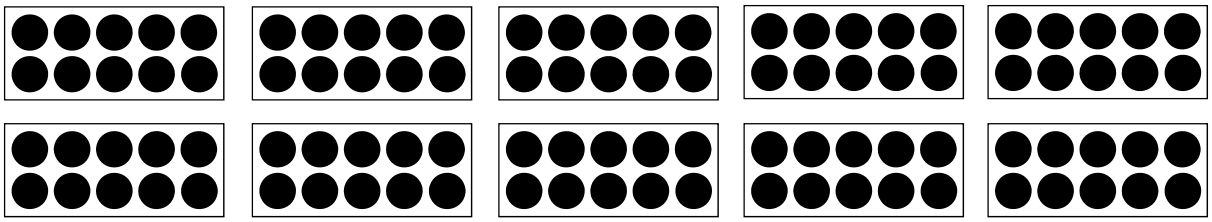
(1) 55



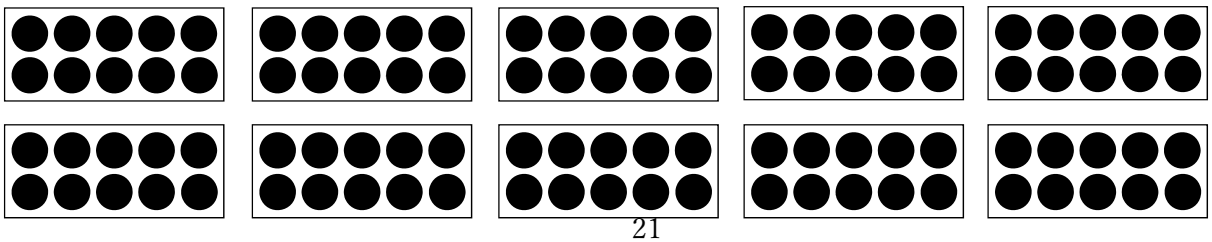
(2) 73



(3) 89



(4) 102

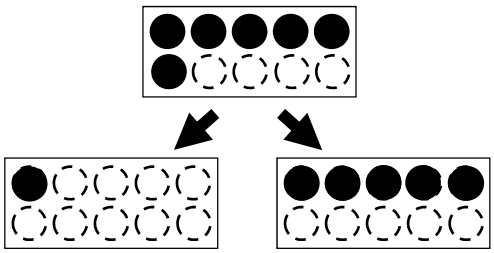


Extra activity 2 (Number bond with dots)

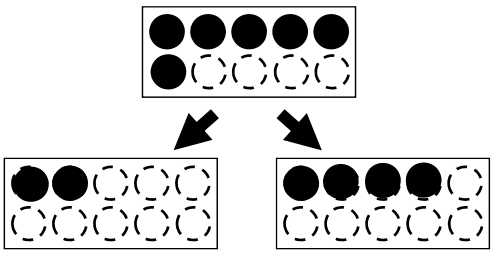
Drawinga tuma dot ku patula number.

(Chisanzo)

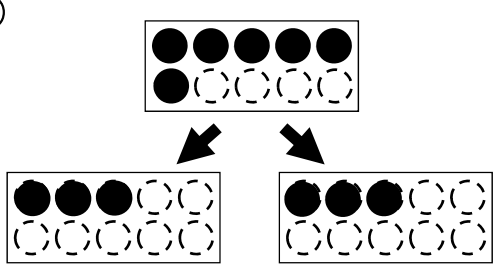
①



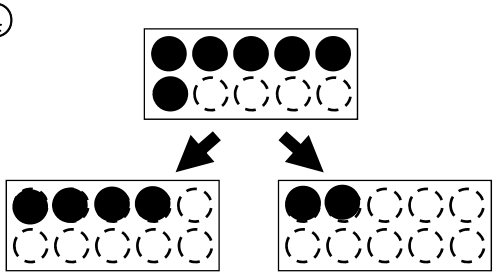
②



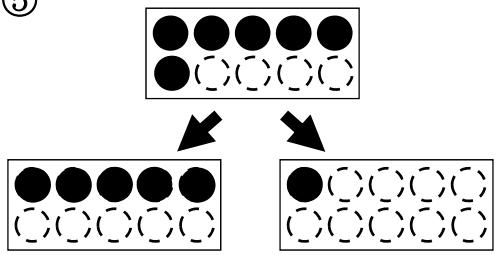
③



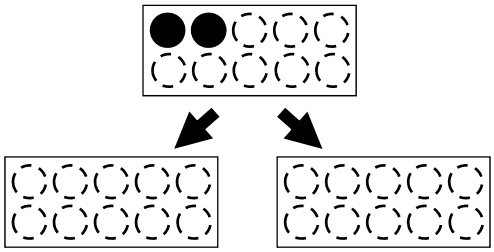
④



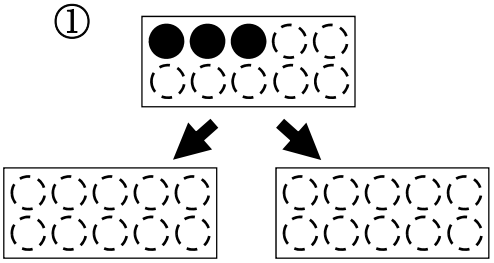
⑤



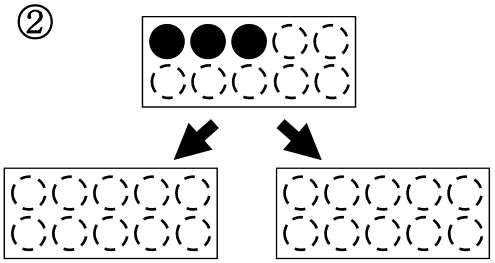
(1) ①



(2) ①

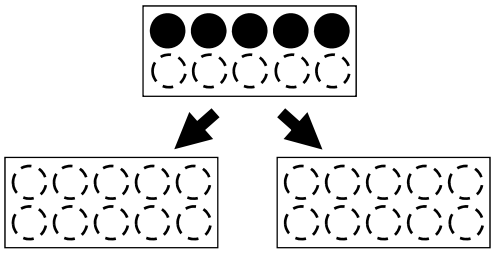


②



(3)

①



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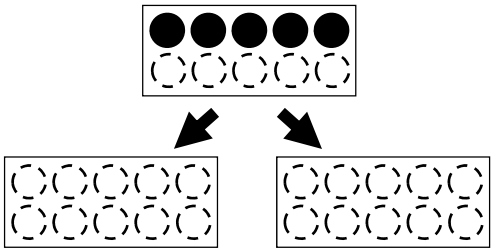
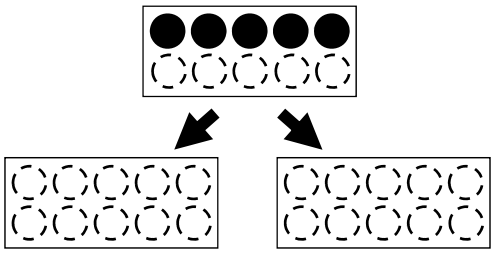


④



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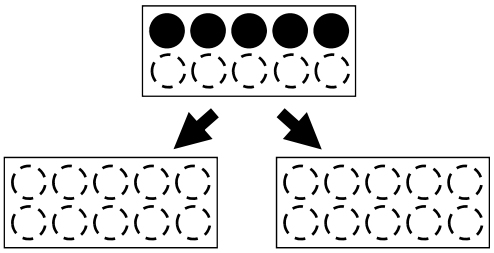
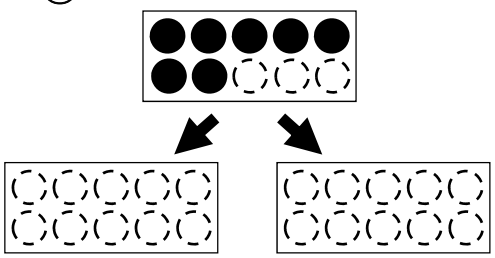


(4)

②



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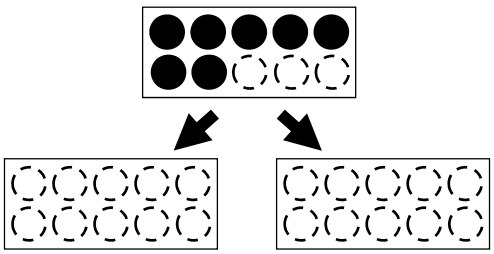

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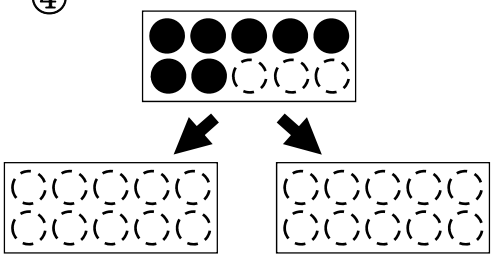

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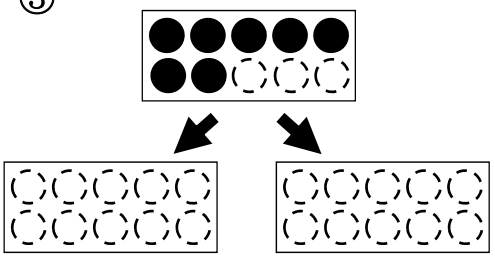

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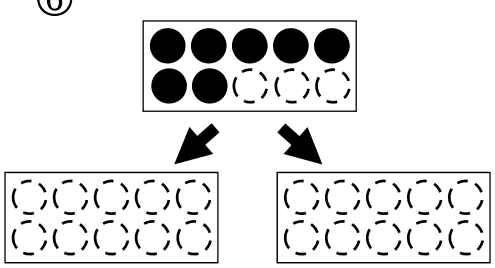

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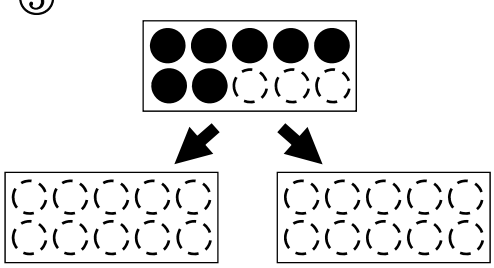
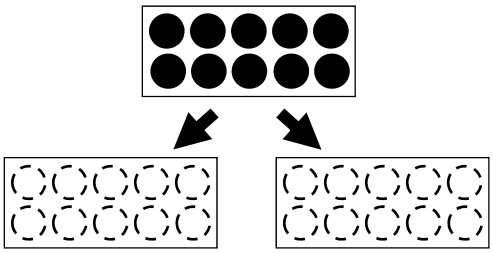


(6)

①



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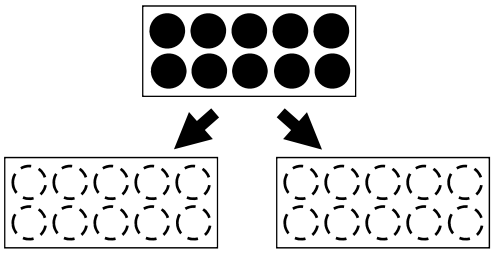

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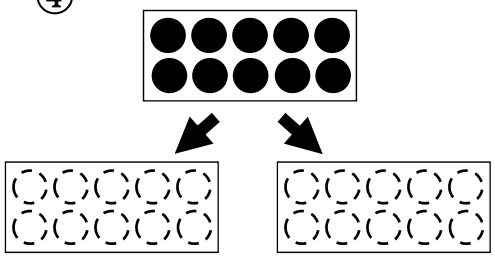

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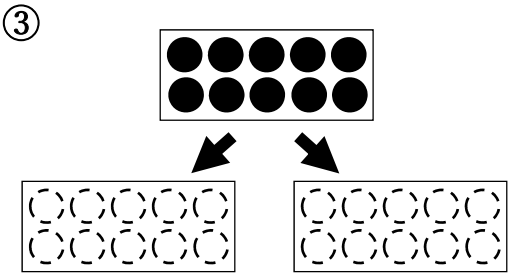

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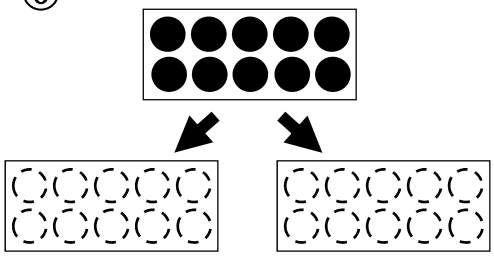

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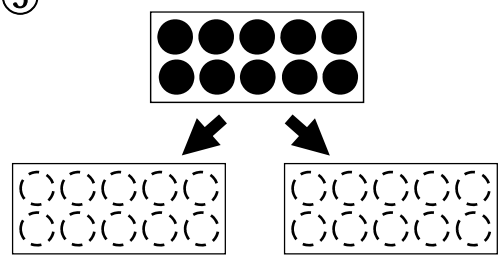

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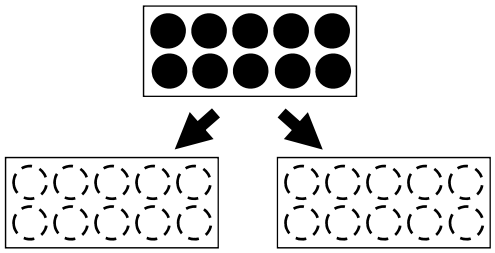

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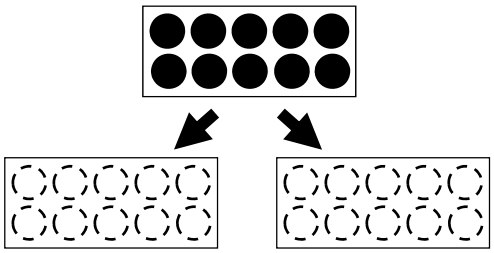

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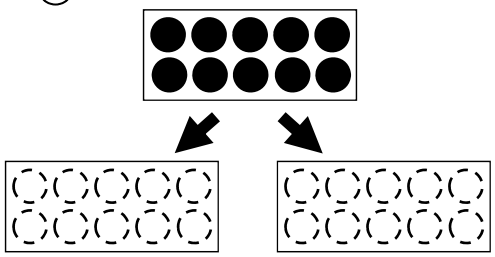
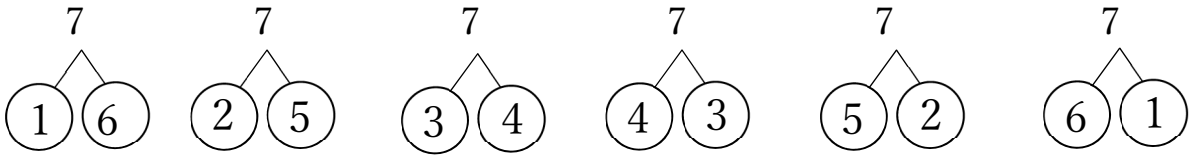
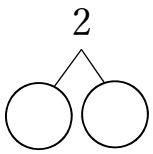


Extra activity 3 (Number bond)

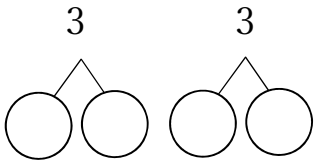
Gabanisa ma number yali pa mwamba.
(Chisanzo)



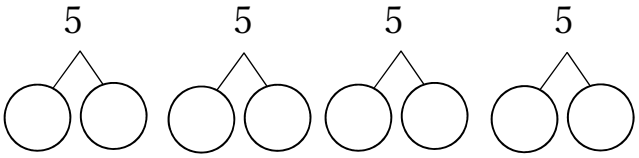
(1)



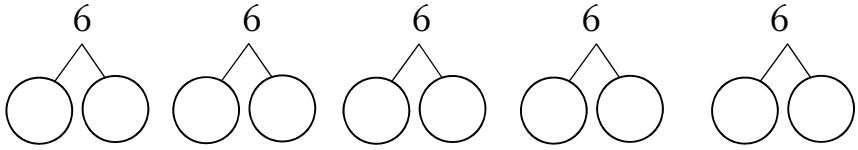
(2)



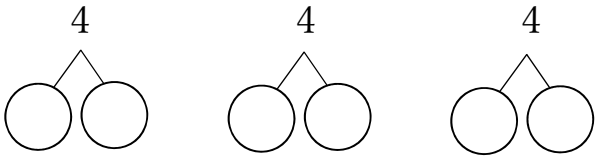
(3)



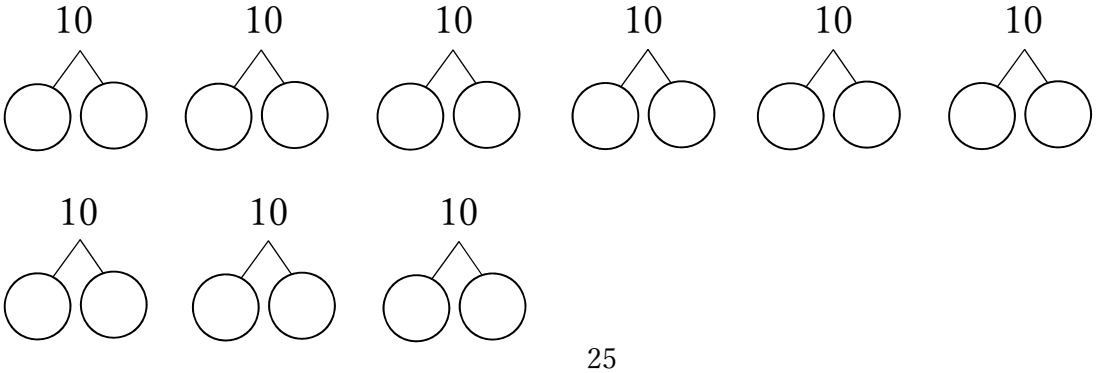
(4)



(5)

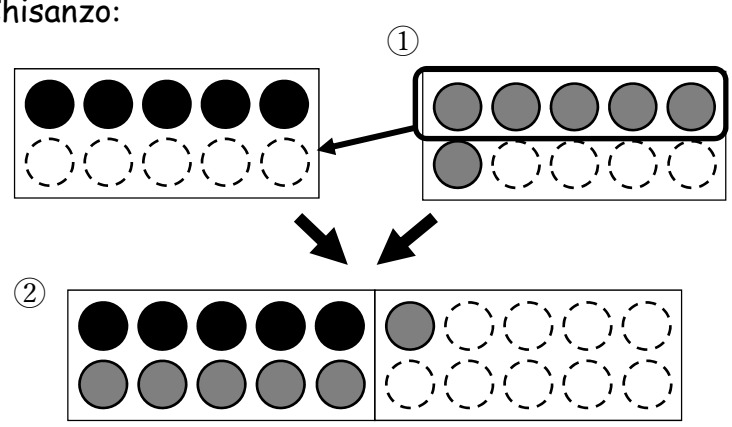


(6)



6 – a, A

Chisanzo:



③ $5 + 6 = 11$

Mochitila/Vokonka:

① Ganiza number tupendelo twamene finika ku fendeza kuti ti pange 10.

② Shadinga tupendelo tuli 10 na twamene twasalila, upeze na answer.

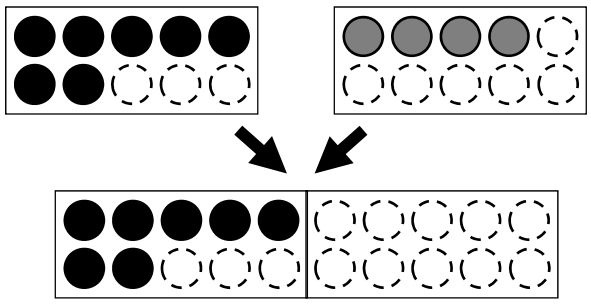
③ Lemba ma sum ku onesa vamene wa chita.

[Chizibiso/Zindikira]

Ungasebenzese tupendelo ngati ufuna.

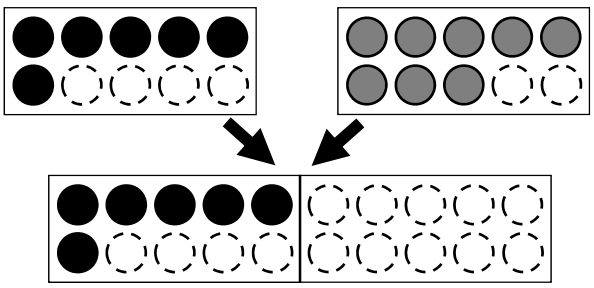
Drawinga ma marble elo lemba ansa yama sum.

1)



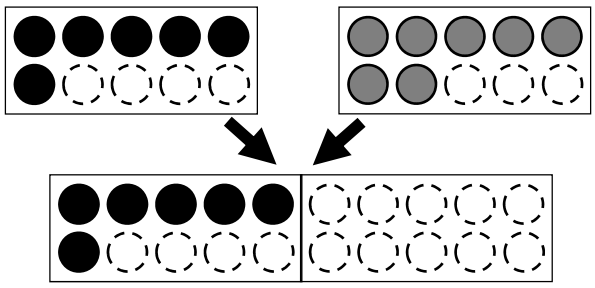
$7 + 4 = \_\_\_$

2)



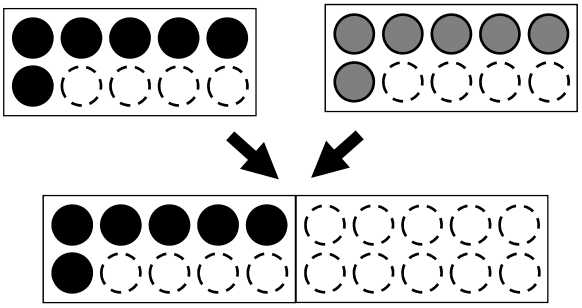
$6 + 8 = \_\_\_$

3)



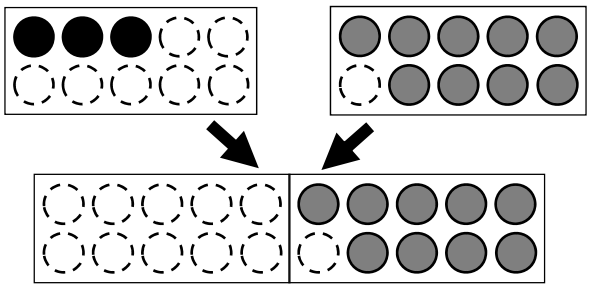
$6 + 7 = \_\_\_$

4)



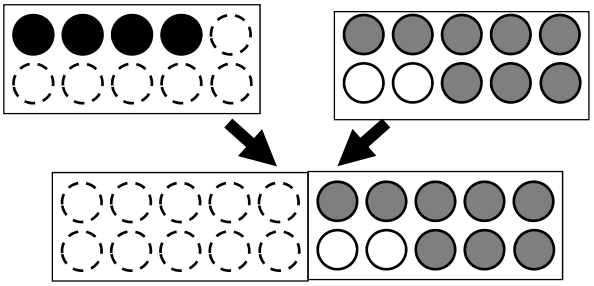
$6 + 6 = \_\_\_$

5)



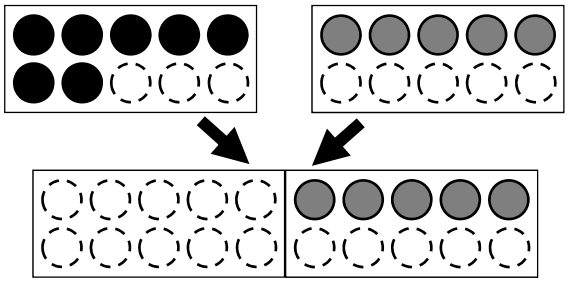
$3 + 9 =$

6)



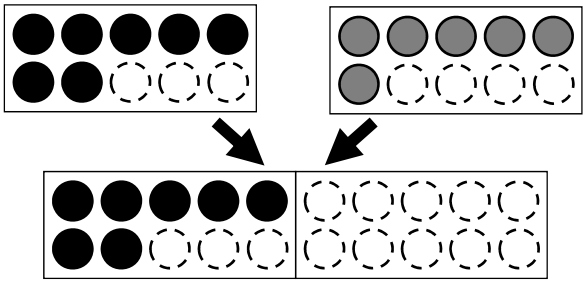
$4 + 8 =$

7)



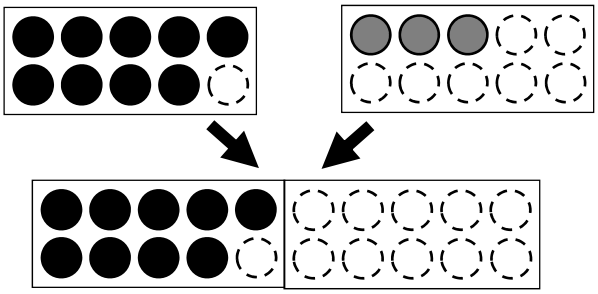
___ + ___ = ___

8)



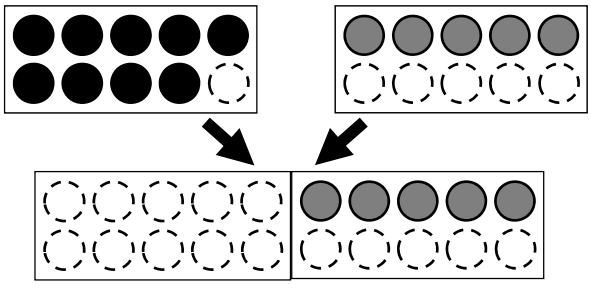
___ + ___ = ___

9)



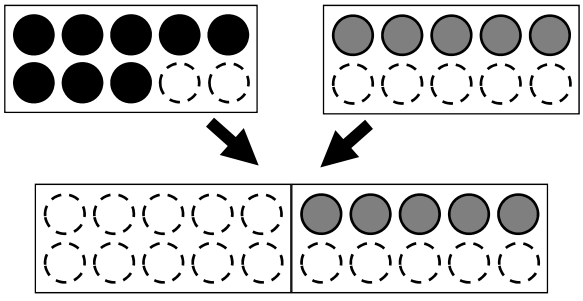
___ + ___ = ___

10)



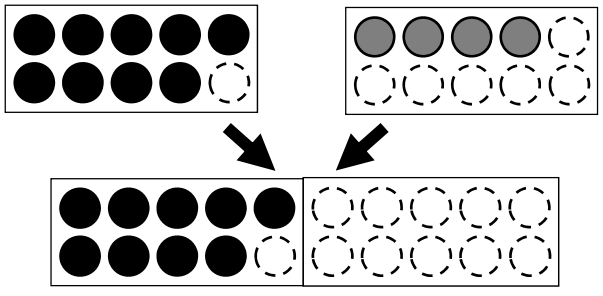
___ + ___ = ___

11)



___ + ___ = ___

12)

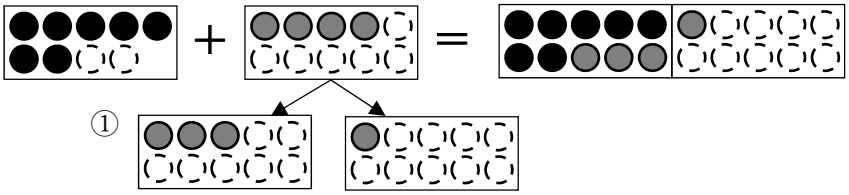


___ + ___ = ___

6 – a, B

Chisanzo:

$$7 + 4 = 11$$



Mochitila/Vokonka:

① Ganiza number tupendelo twamene finika ku fendeza kuti ti pange 10.

② 10 na number wa gabanisa ndiye answer. Shadinga tupendelo ku onesa answer.

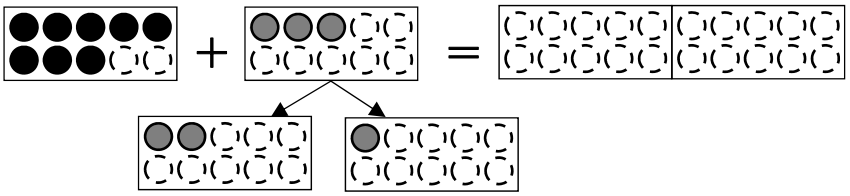
③ Lemba ansa ya masamu aya.

[Chizibiso/Zindikira]

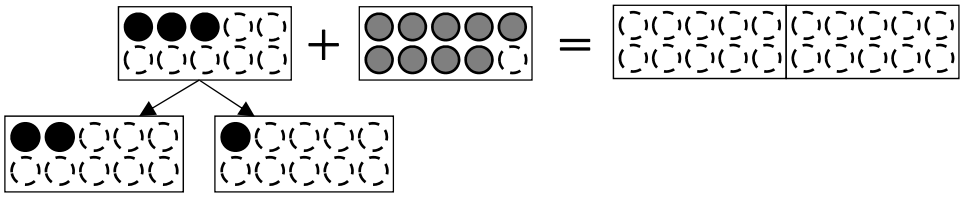
Ungasebenzese tupendelo ngati ufuna

Drawinga ma marble elo lemba ansa yama sum.

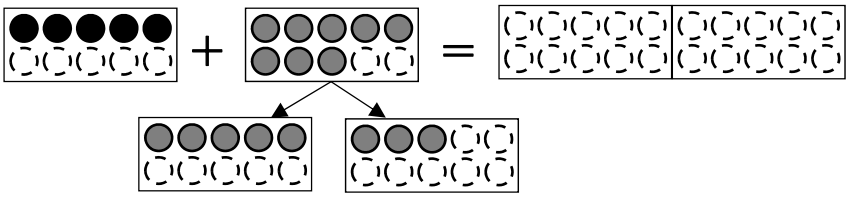
(1) $8 + 3 =$



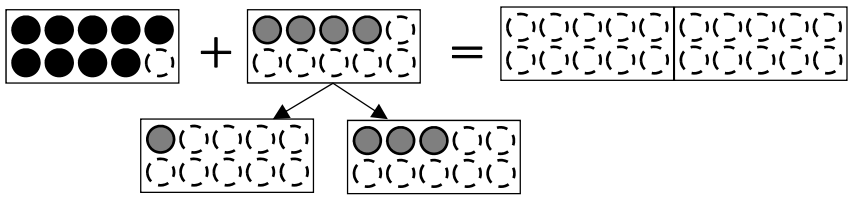
(2) $3 + 9 =$



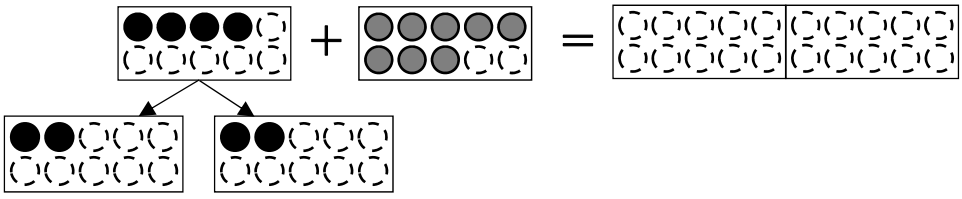
(3) $5 + 8 =$



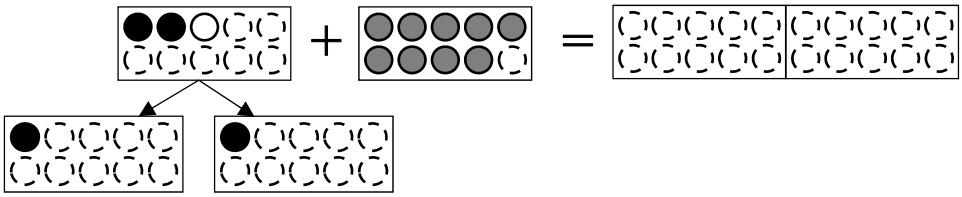
(4) $9 + 4 =$



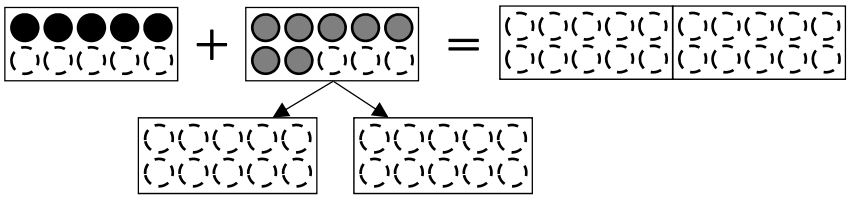
(5) $4 + 8 =$



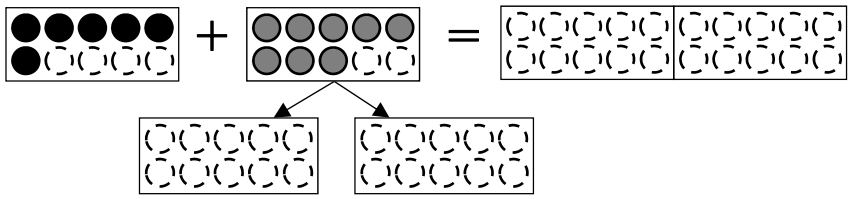
(6) $2 + 9 =$



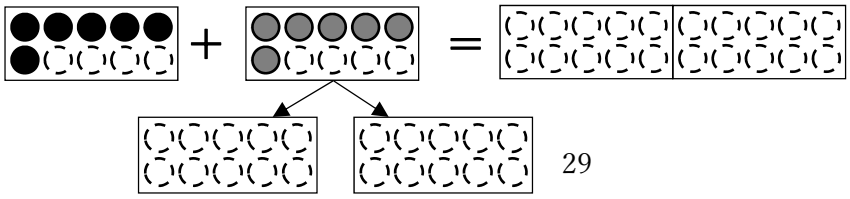
(7) $5 + 7 =$



(8) $6 + 8 =$



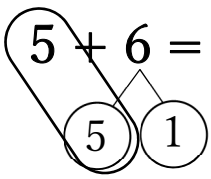
(9) $6 + 6 =$



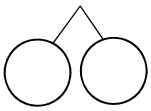
6 – a, C

Peza masamu aya, ugabanise namba imozi kuti ipange 10.

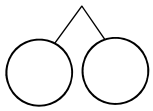
1) $5 + 6 = 11$



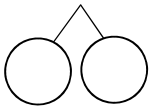
2) $9 + 6 =$



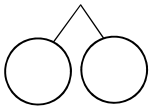
3) $8 + 8 =$



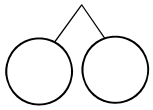
4) $9 + 2 =$



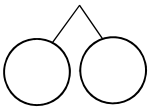
5) $9 + 5 =$



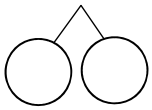
6) $7 + 7 =$



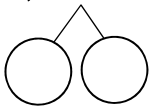
7) $8 + 4 =$



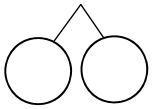
8) $9 + 8 =$



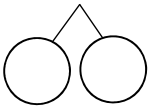
9) $4 + 9 =$



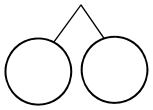
10) $8 + 9 =$



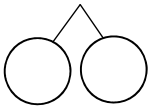
11) $9 + 7 =$



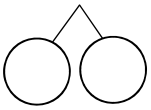
12) $6 + 5 =$



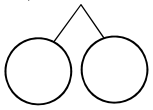
13) $7 + 8 =$



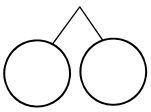
14) $6 + 9 =$



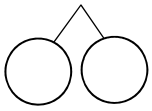
15) $7 + 9 =$



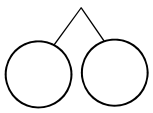
16) $5 + 9 =$



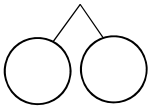
17) $8 + 6 =$



18) $9 + 4 =$

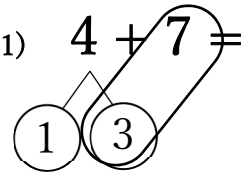


19) $8 + 7 =$



Peza masamu aya, ugabanise namba imozi kuti ipange 10.

1) $4 + 7 = 11$



2) $6 + 7 =$

3) $7 + 9 =$

4) $9 + 7 =$

5) $9 + 8 =$

6) $4 + 8 =$

7) $8 + 9 =$

8) $7 + 8 =$

9) $6 + 5 =$

10) $7 + 5 =$

11) $6 + 9 =$

12) $7 + 6 =$

13) $5 + 6 =$

14) $9 + 6 =$

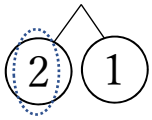
15) $3 + 8 =$

Unga sanke ilionse number yosenbenzesa mu ma sum.

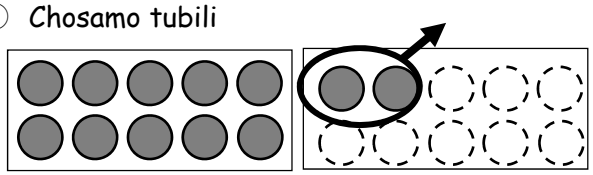
6 – s, A

Chisanzo:

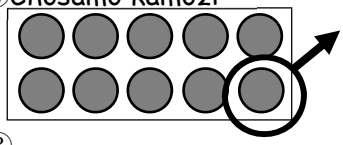
$12 - 3 = 9$



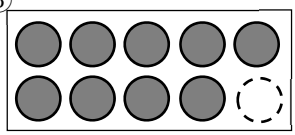
① Chosamo tubili



②Chosamo kamozi



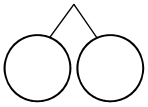
③



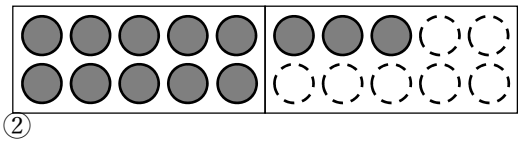
Iyi ndiye ansa!

Peza masamu aya yochesela.

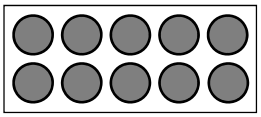
1) $13 - 4 =$



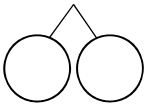
①



②



2) $15 - 6 =$



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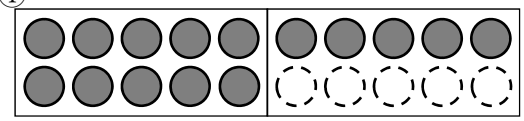

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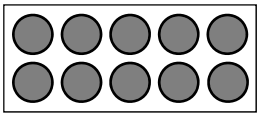
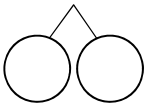
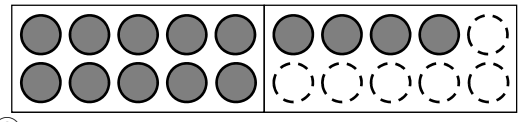


3) $14 - 5 =$



①



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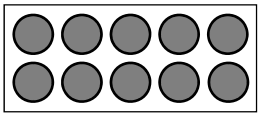
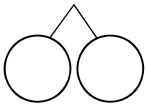


4) $12 - 4 =$



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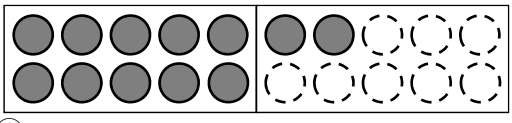

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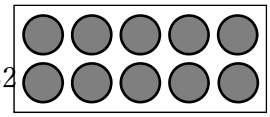
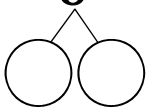


5) 11 − 3 =



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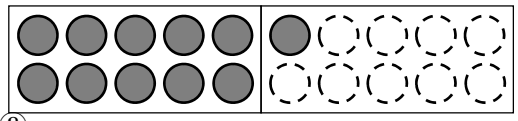

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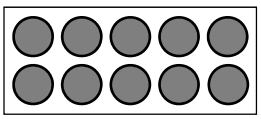
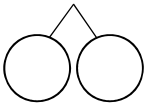


6) 16 − 7 =



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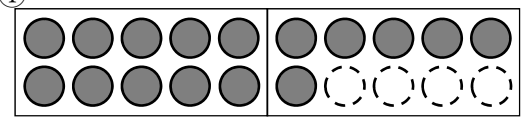

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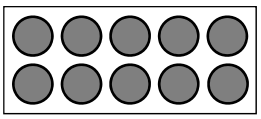
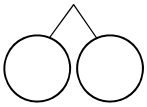


7) 17 − 8 =



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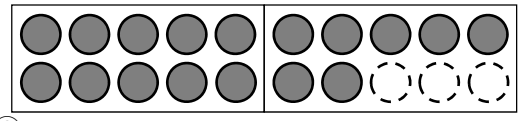

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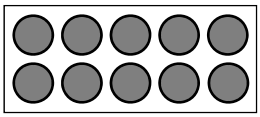
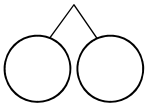


8) 11 − 2 =



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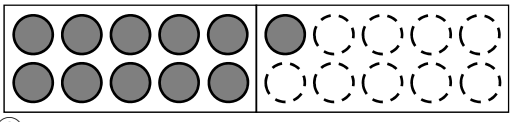

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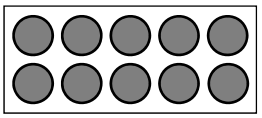
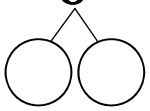


9) 12 − 3 =



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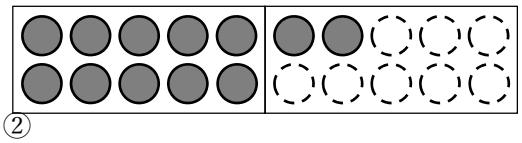

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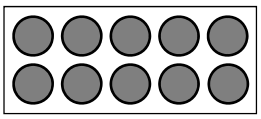
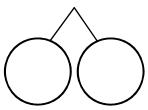
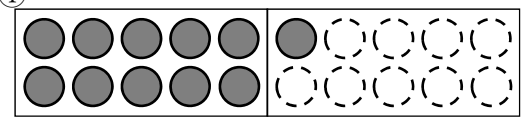


10) 11 − 4 =



①



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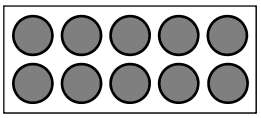
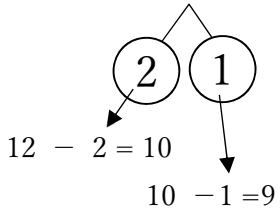


6 – s, B

Chisanzo:

$12 - 3 = 8$



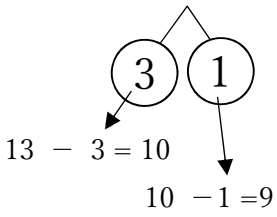
Steps:

① 3 niyogabanisiwa muma number yabili, imozi niyolembewa yoyambilila(number 2), elo yasala(number 1).

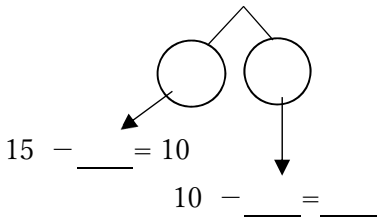
② Ku 12 ta chosako 2 ku peza 10, ku 10 tachosako 1 ku peza 9.

Peza ma sum aya, ku lemba ma number mu malo mwamene mulibe.

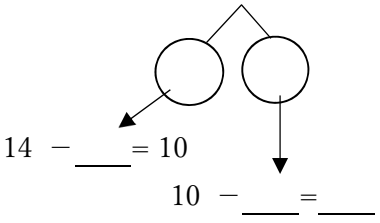
1) $13 - 4 =$



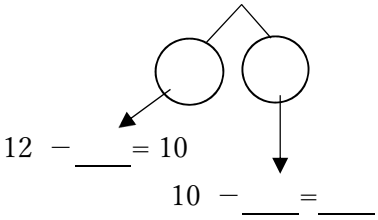
2) $15 - 6 =$



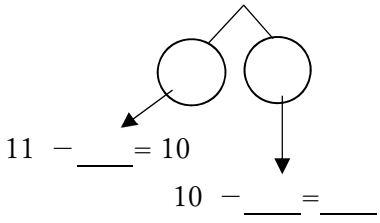
3) $14 - 5 =$



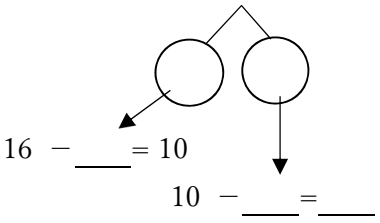
4) $12 - 4 =$



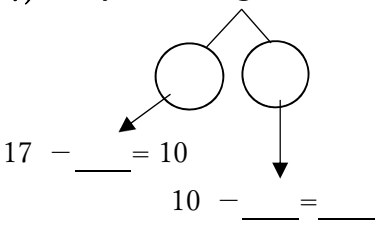
5) $11 - 3 =$



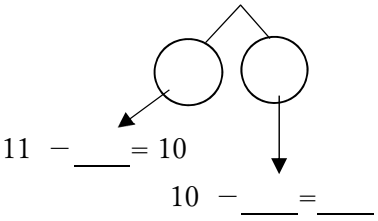
6) $16 - 7 =$



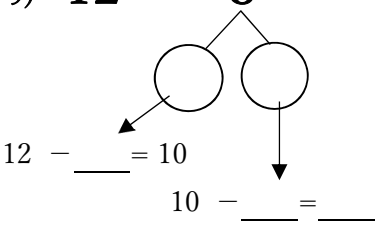
7) $17 - 8 =$



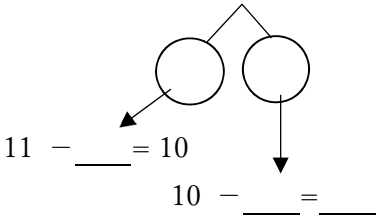
8) $11 - 2 =$



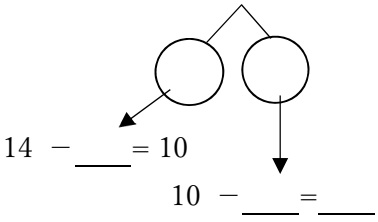
9) $12 - 3 =$



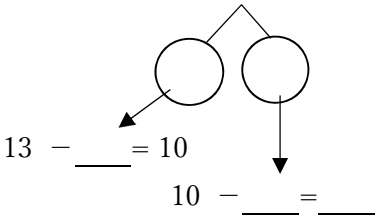
10) $11 - 4 =$



11) $14 - 6 =$



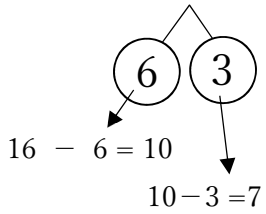
12) $13 - 6 =$



6 – s, C

Peza masamu aya yochosela, na kulembe mwamene wayipezela weka

1) $16 - 9 = 7$



2) $15 - 8 =$

3) $15 - 9 =$

4) $14 - 9 =$

5) $15 - 6 =$

6) $14 - 8 =$

7) $18 - 9 =$

8) $13 - 8 =$

9) $17 - 9 =$

13) $15 - 7 =$

14) $14 - 7 =$

15) $13 - 8 =$

16) $17 - 9 =$

17) $18 - 9 =$

18) $16 - 8 =$

19) $12 - 4 =$

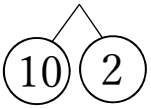
20) $11 - 3 =$

21) $16 - 7 =$

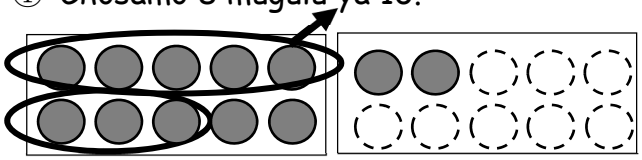
6 – s, D

Chisanzo:

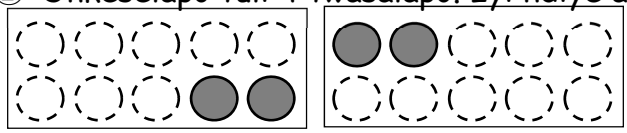
$12 - 8 = 4$



① Chosamo 8 mugulu ya 10.

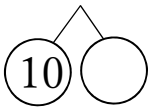


② Onkeselapo tuli 4 twasalapo. Iyi ndiye ansa!

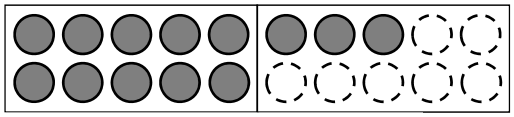


Lemba ma numba elo drawinga diagram kwati ili monga pamwamba

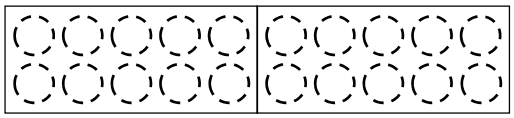
1) $13 - 5 =$ ____



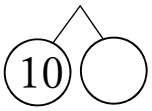
① Chosamo 5 mu gulu ya 10.



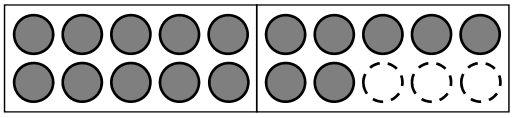
② Onjeza yasalako: ____



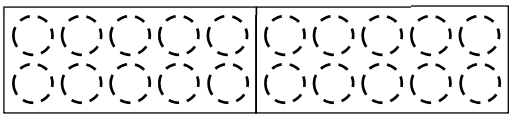
2) $17 - 9 =$



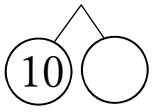
① Chosamo 9 mu gulu ya 10.



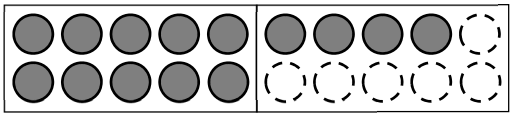
② Onkesa yasalako: ____



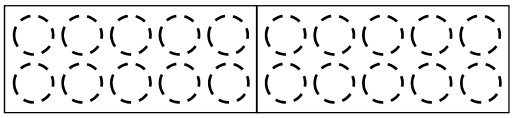
3) $14 - 7 =$



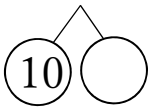
① Chosamo 7 mu gulu ya 10.



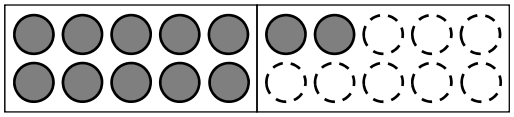
② Onkesa yasalako: ___



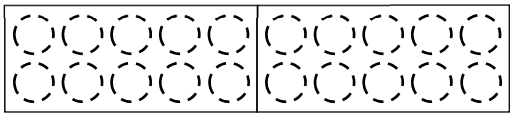
4) $12 - 6 = \_\_\_\_$



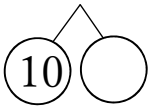
① Chosamo 6 mu gulu ya 10.



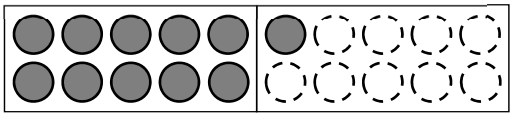
② Onkesa yasalako: ____



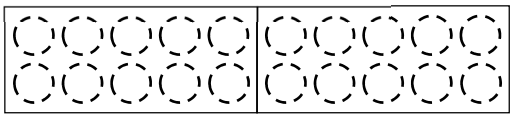
5) $11 - 8 =$



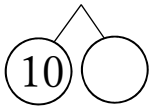
① Chosamo 8 mu gulu ya 10.



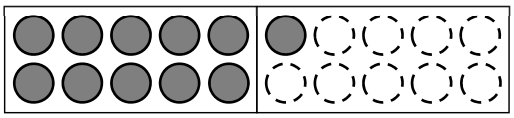
② Onkesa yasalako: ____



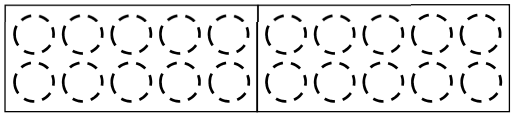
6) $11 - 6 =$



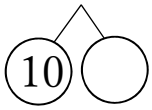
① Chosamo 6 mu gulu ya 10.



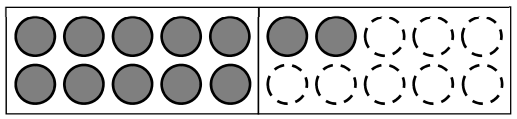
② Onkesa yasalako: ____



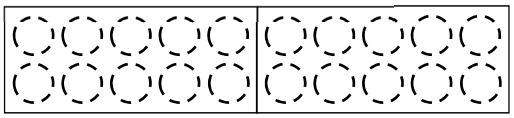
7) $12 - 9 =$



① Chosamo 9 mu gulu ya 10.



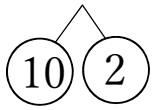
②Onkesa yasalako: ____



6 – s, E

Chisanzo:

$$12-9=3$$

① 

② $10 - 9 = 1$

$1 + 2 = 3$

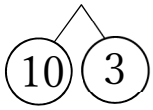
Mochitila/Vokonka:

① 12 niyogabanisiwa muli 10 na 2.

② 9 niyochosewa muli 10(10-9=1)
2 niyo onkesewa kuli 1(1+2=3)

Peza masamu aya, kulemba mulibe volembewa.

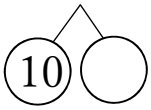
1) $13 - 5 =$



$10 - 5 = 5$

$5 + 3 = 8$

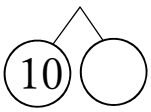
2) $17 - 9 =$



10 − ___ = ___

___+___ = ___

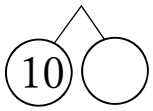
3) $14 - 7 =$



10 − ___ = ___

___+___ = ___

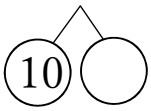
4) $12 - 6 =$



10 − ___ = ___

___+___ = ___

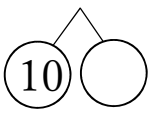
5) $11 - 8 =$



10 − ___ = ___

___+___ = ___

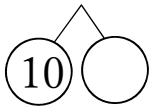
6) $11 - 6 =$



10 − ___ = ___

___+___ = ___

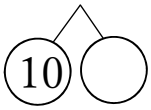
7) $12 - 9 =$



10 − ___ = ___

___+___ = ___

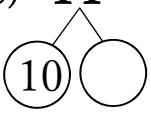
8) $16 - 9 =$



10 − ___ = ___

___+___ = ___

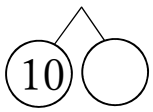
9) $11 - 5 =$



10 − ___ = ___

___+___ = ___

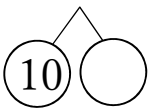
10) $13 - 9 =$



10 − ___ = ___

___+___ = ___

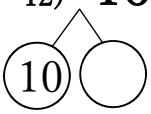
11) $12 - 8 =$



10 − ___ = ___

___+___ = ___

12) $16 - 8 =$



10 − ___ = ___

___+___ = ___

6 – s, F

Peza masamu aya yochosela, na kulemba mwamene wayipezela weka.

1) $14 - 6 =$ 2) $14 - 8 =$ 3) $14 - 5 =$

4) $15 - 7 =$ 5) $13 - 6 =$ 6) $15 - 8 =$

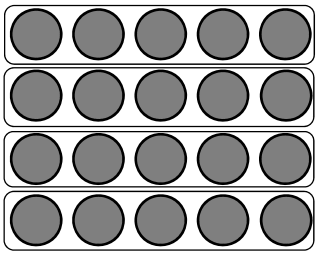
7) $12 - 5 =$ 8) $15 - 9 =$ 9) $11 - 9 =$

10) $18 - 9 =$ 11) $13 - 7 =$ 12) $12 - 7 =$

13) $14 - 9 =$ 14) $11 - 7 =$ 15) $13 - 8 =$

6－m1

Chisanzo:



$4 \times 5 = 20$

Mochitila/Vokonka:

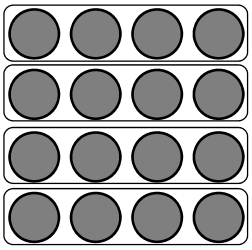
① Circolinga ma gulu yama dot ya same.
Pali apa magulu yali 4 yama 5

② Lemba masamu.
4 × 5 = 20

［Chizibiso/Zindikira］ Osa yangana ma dot muma line yo choka pamwamba kubwela pansi.Osa yangana ma dot muma line yo choka pamwamba kubwela pansi.

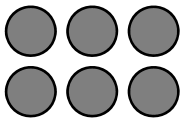
Lemba masamu.

(1)



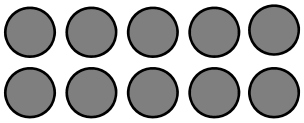
$4 \times 4 = 16$

(2)



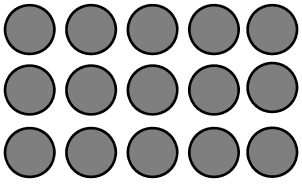
＿＿×＿＿＝＿＿

(3)



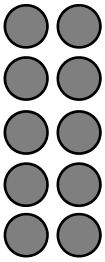
＿＿×＿＿＝＿＿

(4)



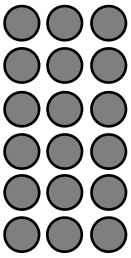
＿＿×＿＿＝＿＿

(5)



＿＿×＿＿＝＿＿

(6)



＿＿×＿＿＝＿＿

Drawinga ma marble kulangisa masamu aya.

(1)

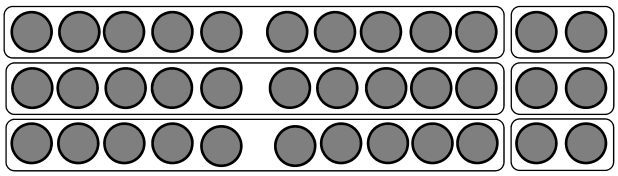
$4 \times 2 =$

(2)

$3 \times 4 =$

6－m2

Chisanzo:



$12 \times 3 = 36$

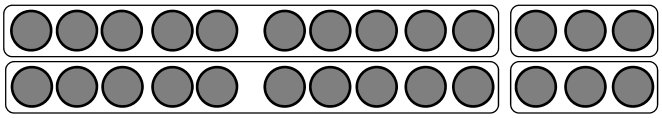
Mochitila/Vokonka:

① Circolinga magulu yama dot ya same, kuganizila ma place value(ma tens nama ones)

② Lemba masamu: "ma gulu yatatu yama 2 ni 6" elo na "magulu yatatu yama 10 ni 30. Pamodzi 36, ansa ni 36

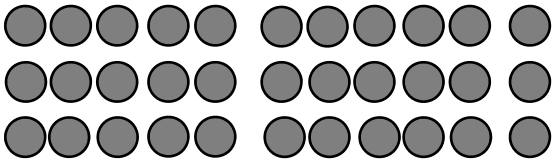
Lemba masamu.

(1)



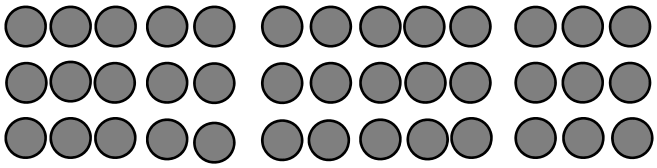
$13 \times 2 = 26$

(2)



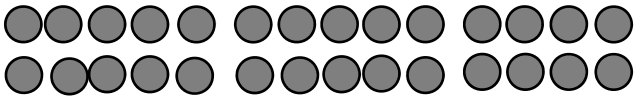
＿ × ＿ = ＿

(3)



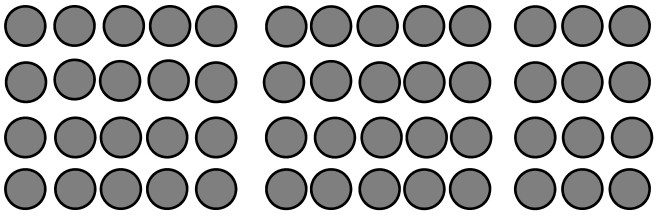
＿ × ＿ = ＿

(4)



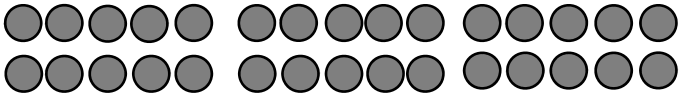
＿ × ＿ = ＿

(5)



＿ × ＿ = ＿

(6)



＿ × ＿ = ＿

Drawinga tupendelo kulangiza ma nsamu aya.

(1) $14 \times 2 =$

(2) $12 \times 2 =$

6－d1

Chisanzo:

$12 \div 2 = 6$

Mochitila/Vokonka:

① Lemba masamu

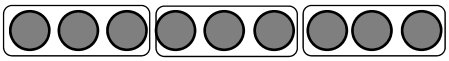
② Ma dot yali 12 niyogabanisiwa muma gulu yabili elo group imozi ili na ma dot yali 6. Mwaicho, 12÷2=6

Lemba masamu.

(1)

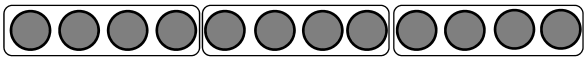
$10 \div 2 = 5$

(2)



＿＿÷＿＿＝＿＿

(3)



＿＿÷＿＿＝＿＿

(4)

＿＿÷＿＿＝＿＿

(5)

＿＿÷＿＿＝＿＿

(6)

＿＿÷＿＿＝＿＿

Drawinga tupendelo kulangiza masamu aya.

(1)

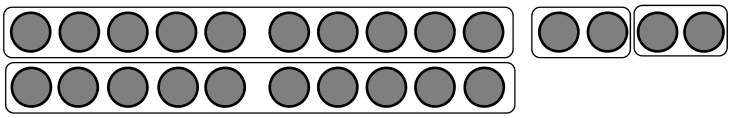
$8 \div 2 =$

(2)

$10 \div 5 =$

6 – d2

Chisanzo:



$20 \div 2 = 10$ $4 \div 2 = 2$

$$24 \div 2 = 12$$

Mochitilia/ Vokonka:

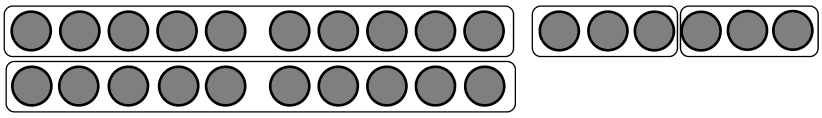
① Lemba ma nsamu, elo yapeze kuganizila ma place values(ma tens nama ones).

② Ma dot yali 24 niyogabanisiwa muma gulu yabili.
- peza ma tens: 20/2=10
- peza ma ones 4/2=2

Mwaicho,ansa ni 12.

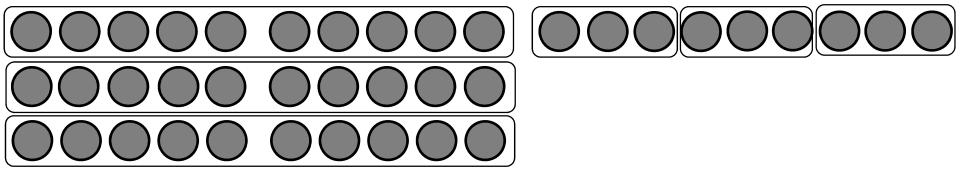
Lemba masamu.

(1)



___ ÷ ___ = ___

(2)



___ ÷ ___ = ___

Drawinga tupendelo kulangiza masamu aya.

$$28 \div 2 =$$

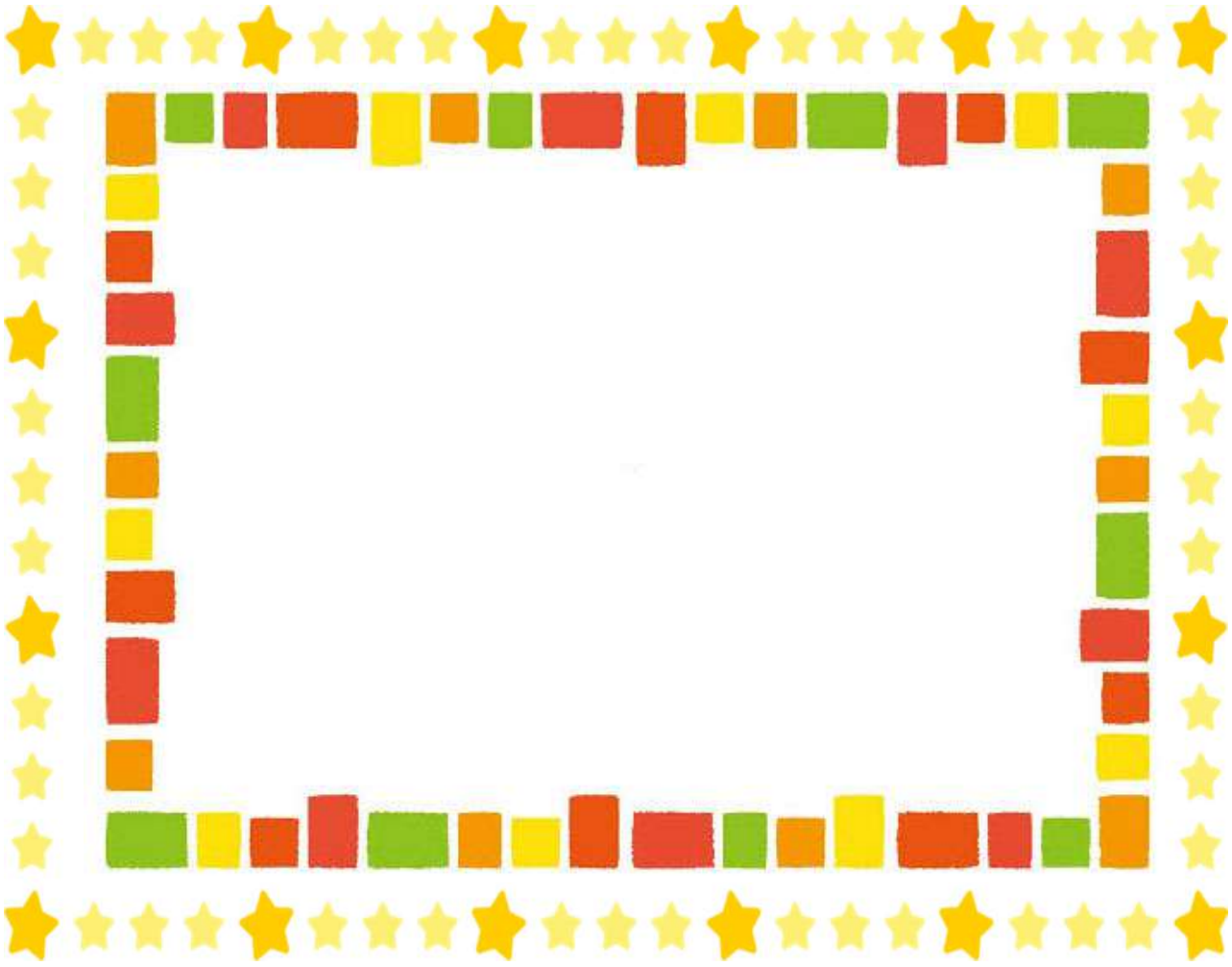
Appendix 4-4

Pupil's Workbook

Grade 4

Buku la bana ba sikulu yosebenzela mu masamu

(Grade 4)



Sukulu: _____ Dzina: _____

Title: Buku la bana ba sikulu yosebenzela mu masamu

Author: ARTHUR, Mungalu
BABA, Takuya
BARBARA, Mudenda
CHIKOLA, Doye
EMMANUEL, Kaabo
KOSAKA, Masato,
KUSAKA, Satoshi
MAMBWE, Bareford
MINAGOSHI, Kanae
NAKAWA, Nagisa,
NKHALAMO, Chimwemwe Joy
NKHATA, Bentry,
SPIWE, Tafeni
WATANABE, Koji

Pepala yolangiza pamene muyendela

Dzina: _____

Siku	Zamkati
Chisanzo Makumi Atatu	1 - 1

Siku	Zamkati

Vili Mu Book

3 – 1

1. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tutatu, ku side kwinangu ika tu pendelo tuli 9.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 4, ku side kwinangu ika tu pendelo tuli 7.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 5, ku side kwinangu ika tu pendelo tuli 8.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 7, ku side kwinangu ika tu pendelo tuli 6.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 8, ku side kwinangu ika tu pendelo tuli 7.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

6. Konza tuma frame of 10 tubili. Ku side ku mozi ika tu pendelo tuli 6, ku side kwinangu ika tu pendelo tuli 9.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   Lemba ansa: _____

   ☐ Na ichita!

3 – 2

1. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo tuli 13, ku side kwinangu ika tu pendelo tuli 19.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

2. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 14, ku side kwinangu ika tu pendelo tuli 17.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

3. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 15, ku side kwinangu ika tu pendelo tuli 18.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

4. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 16, ku side kwinangu ika tu pendelo tuli 12.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

5. Konza tuma frame of 10 tuli 4. Ku side ku mozi ika tu pendelo 17, ku side kwinangu ika tu pendelo tuli 16.
   Ganiza ngati tuli tungati tu pendelo pamozi muma gulu ya 10.

   ☐ Na ichita!

   Lemba ansa: _____

6. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

3 – 3

1. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 12.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 14.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 16.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 11.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 17.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

6. Konza tuma frame of 10 tubili. Ika tu pendelo tuli 13.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 20.

   Lemba ansa: _____ ☐ Na ichita!

7. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

3 – 4

1. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 27.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

2. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 24.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

3. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 28.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

4. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 18.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

5. Konza tuma frame of 10 tuli 4. Ika tu pendelo tuli 13.
   Ganiza ngati ufunika tu pendelo tungati kuti tu kwane 40 muma gulu ya 10.

   Lemba ansa: _____ ☐ Na ichita!

6. Nkhalani babili babili.
   Panga funso ili monga yapamwaba yo funsa munzako.

4－1

1. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 49.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

2. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 38.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

3. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 26.
   Penda tu pendelo mu njila yamusanga musanga.

   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

4. Konza tuma frame of 10 tuli 5. Ika tu pendelo kuti tu kwane 32.
   Penda tu pendelo mu njila yamusanga musanga.

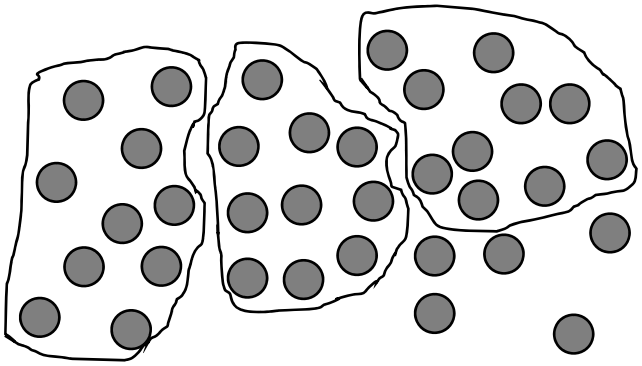
   ※ Uza banzanko mu class mwamene wa ganizila.

   ☐ Na ichita!

Extra activity1 (Counting numbers using group of 10)

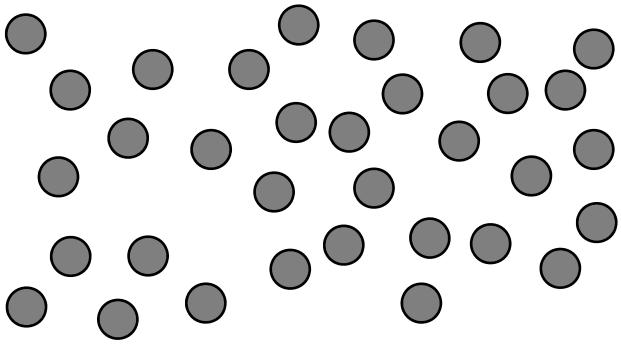
(Chisanzo)

Yali yangati ma dot?



35

(1)



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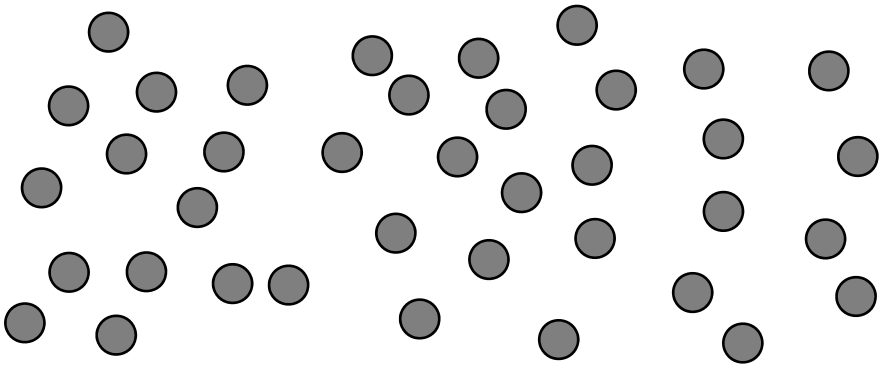
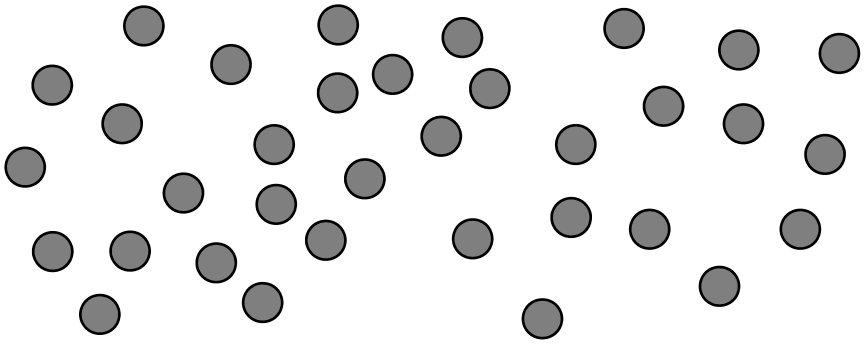


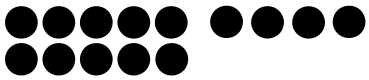
(3)



5－1

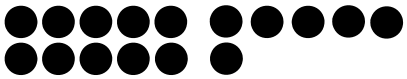
Tuli tungati tuma dot utu? Uza banzako mwamene wapendela bwino.

(1)



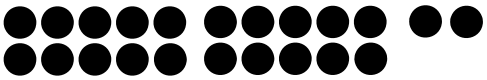
_____

(2)



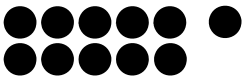
_____

(3)



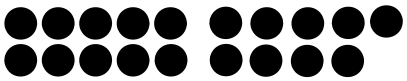
_____

(4)



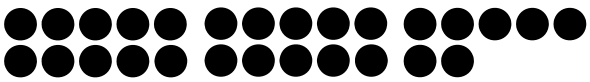
_____

(5)



_____

(6)

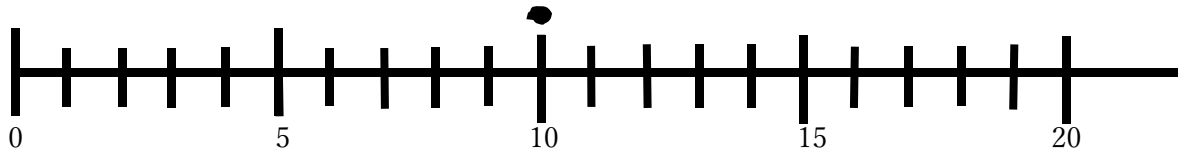


_____

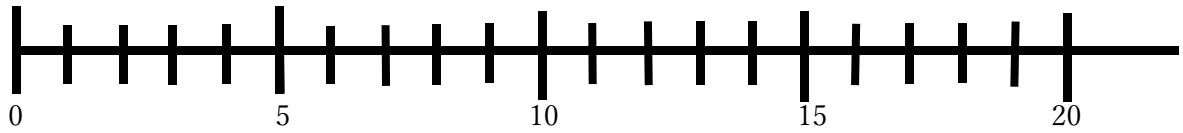
5 – 2a

Langiza ma aya namba pa namba line.

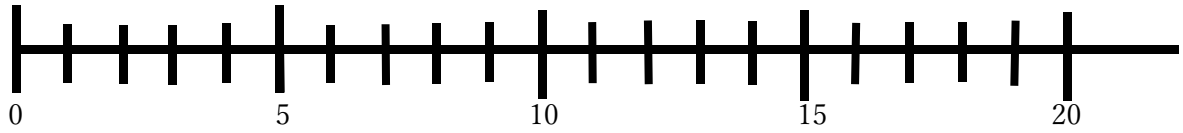
(Chisanzo) 10



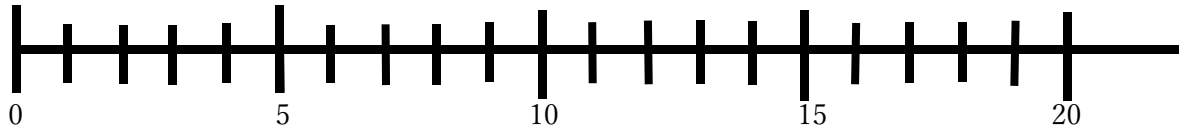
(1) 12



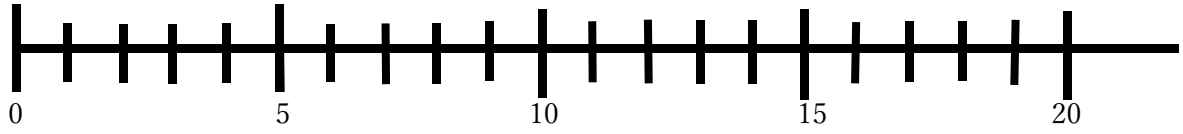
(2) 14



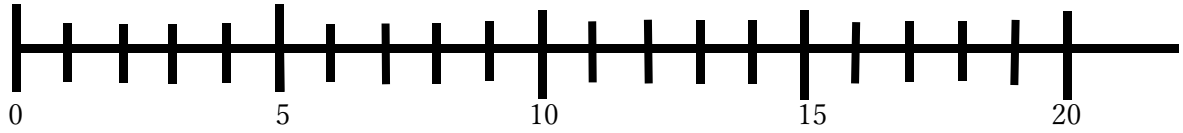
(3) 11



(4) 16



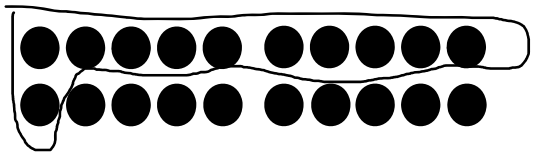
(5) 19



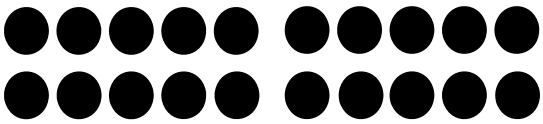
5 – 2b

Circling'a aya ma number yama dots. Fakila nzelu kumagulu ya 10.

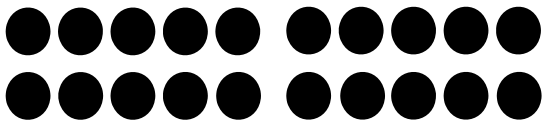
(Chisanzo) 11



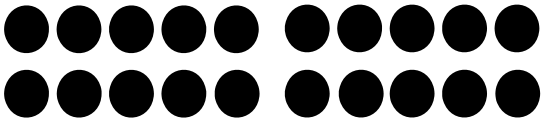
(1) 12



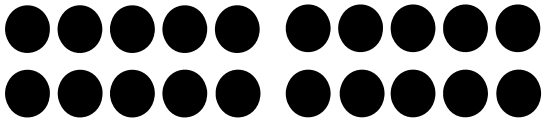
(2) 15



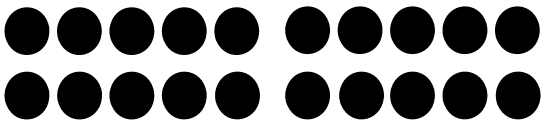
(3) 14



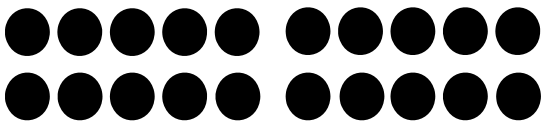
(4) 18



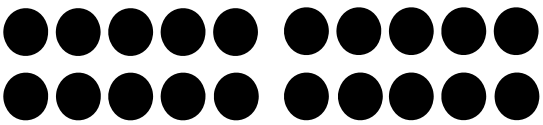
(5) 11



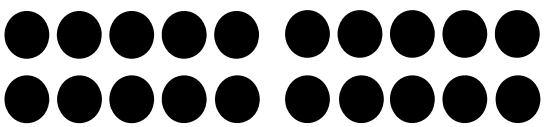
(6) 19



(7) 13



(8) 17

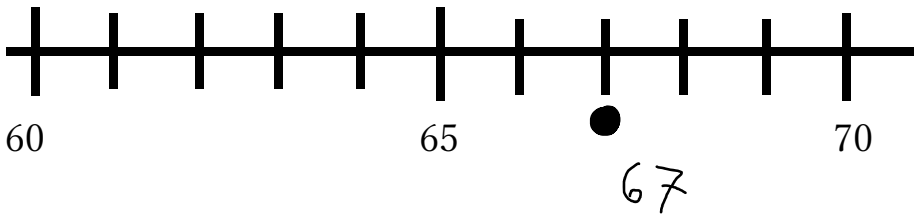


5 – 3a

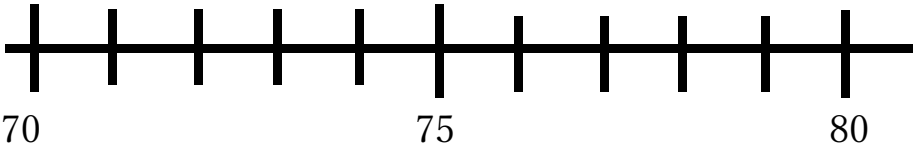
Langiza ma aya namba pa namba line.

(Chisanzo)

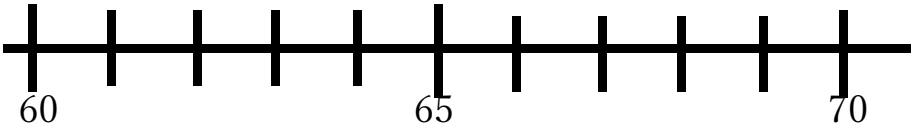
67



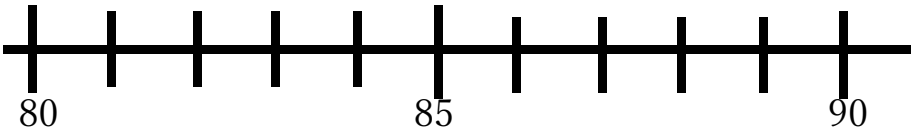
(1) 77



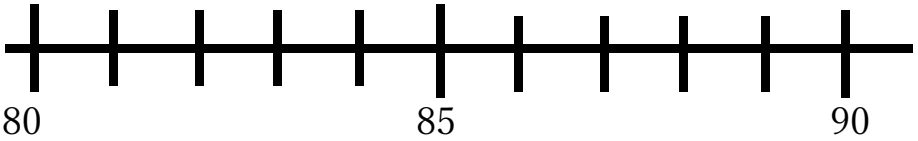
(2) 68



(3) 89



(4) 83

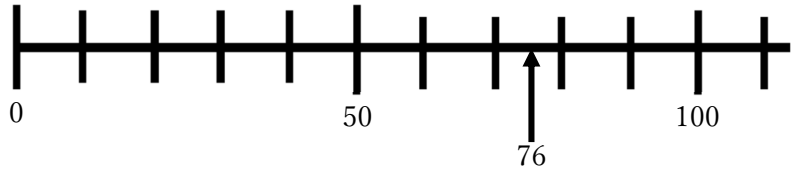


5 – 3b

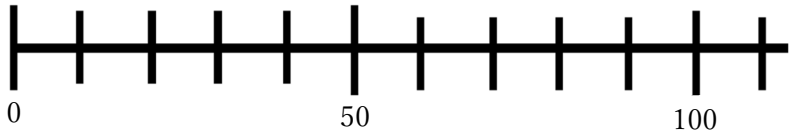
Langiza ma aya namba pa namba line.

(Chisanzo)

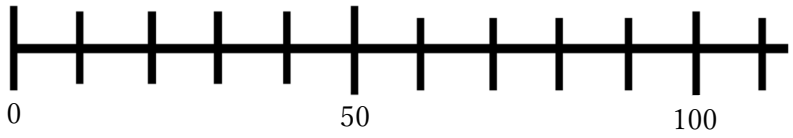
76



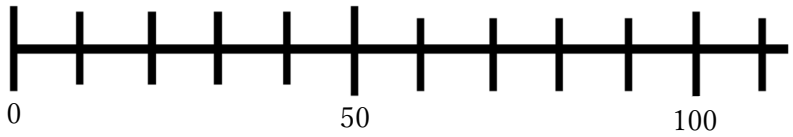
(1) 58



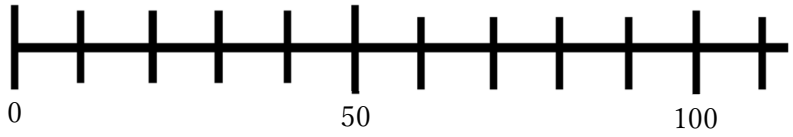
(2) 64



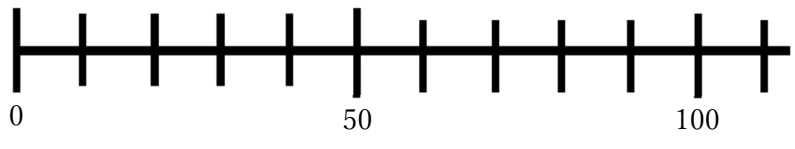
(3) 87



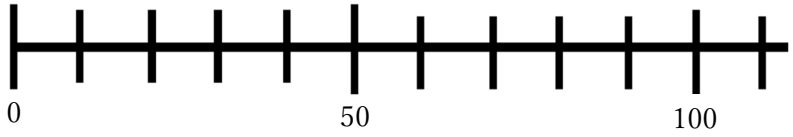
(4) 92



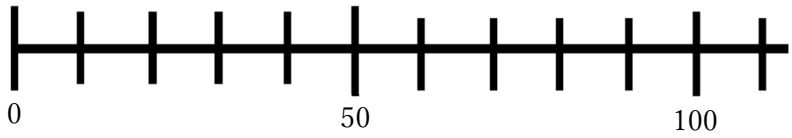
(5) 74



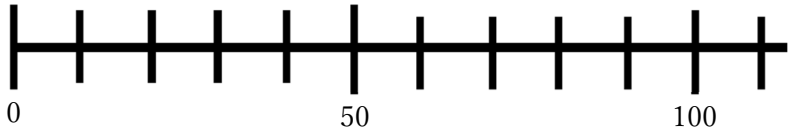
(6) 83



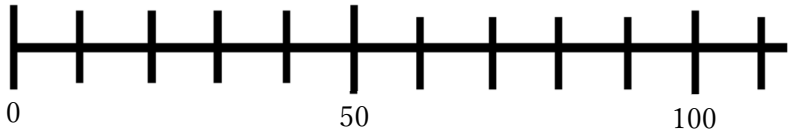
(7) 77



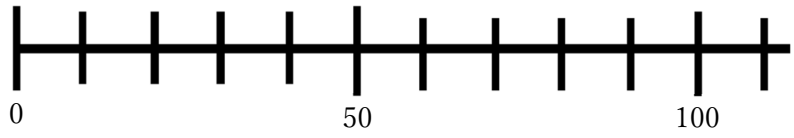
(8) 103



(9) 98



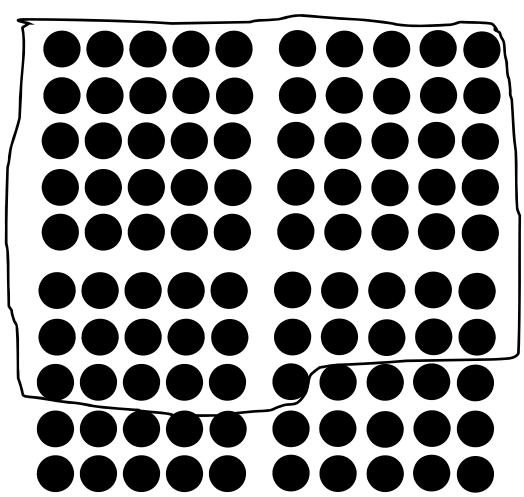
(10) 120

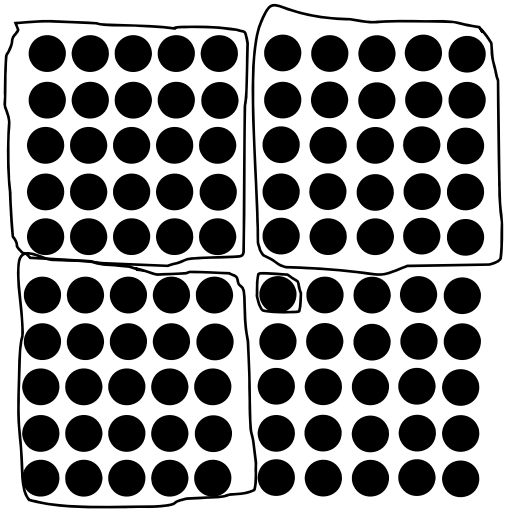


5 – 3c

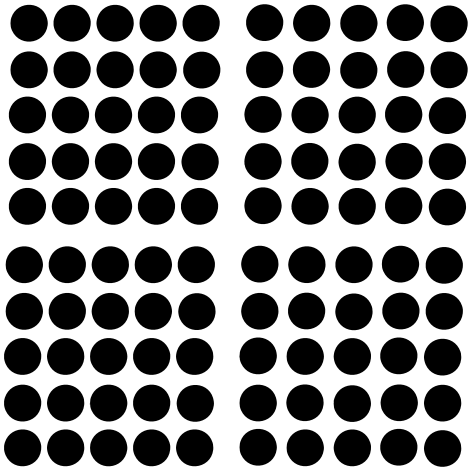
Circling'a aya ma number yama dots. Uza banzako mwamene waganizila.

Chisanzo: 76

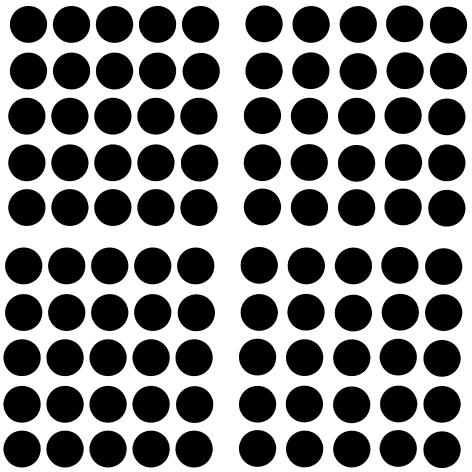




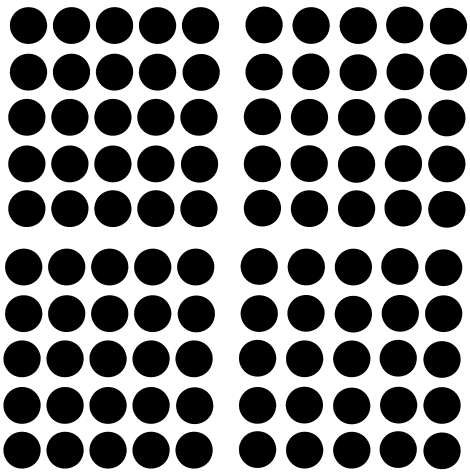
(1) 54



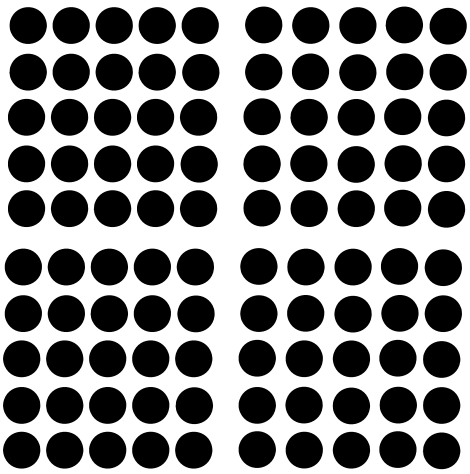
(2) 80



(3) 98



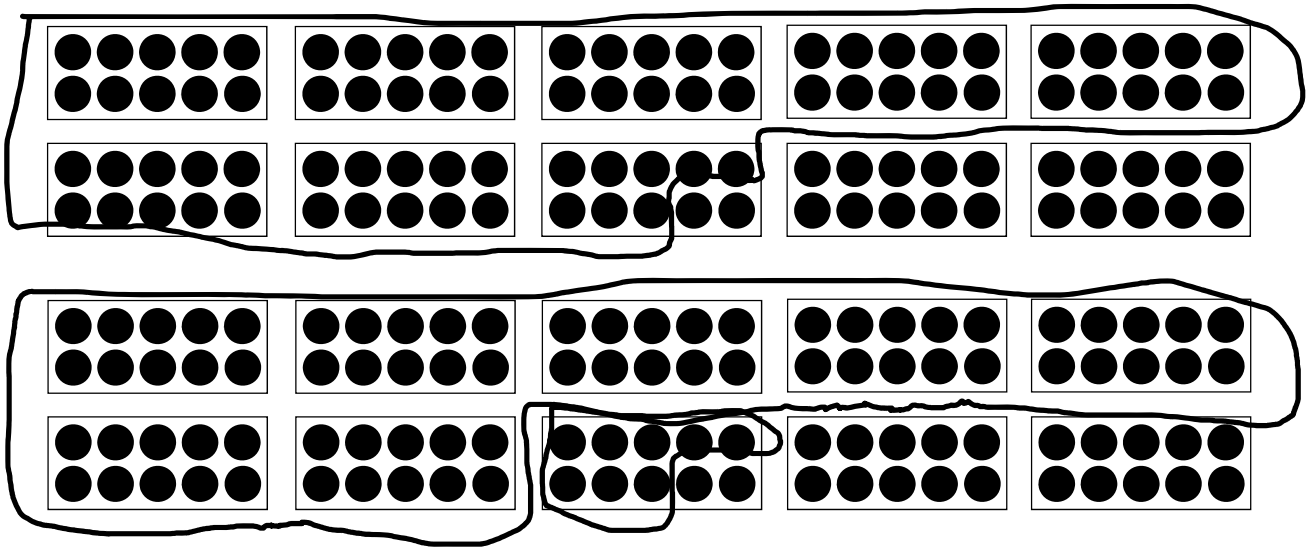
(4) 79



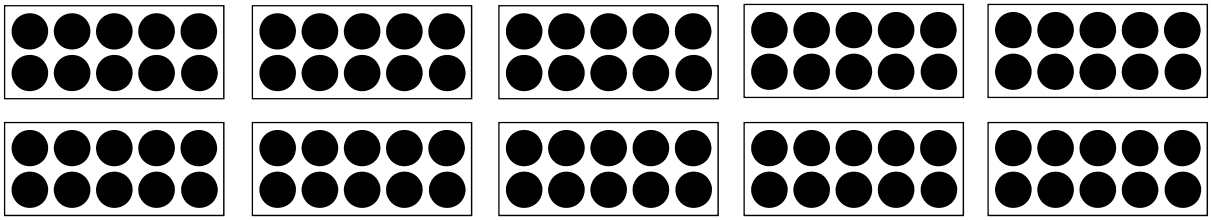
5 – 3d

Circling'a aya ma number yama dots. Uza banzako mwamene waganizila.

Chisanzo: 78



(1) 55



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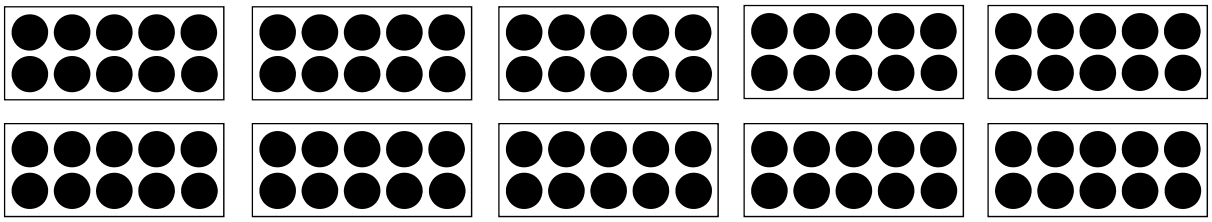
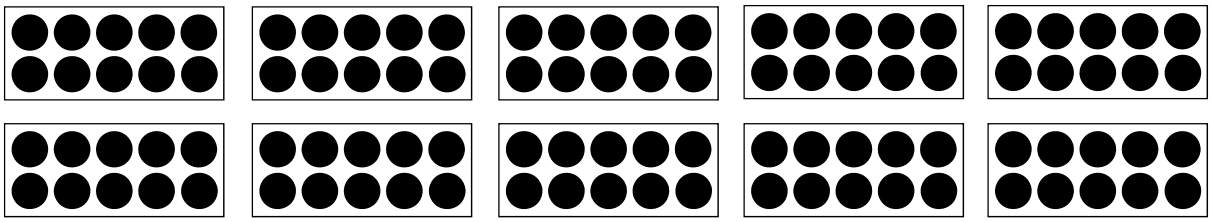
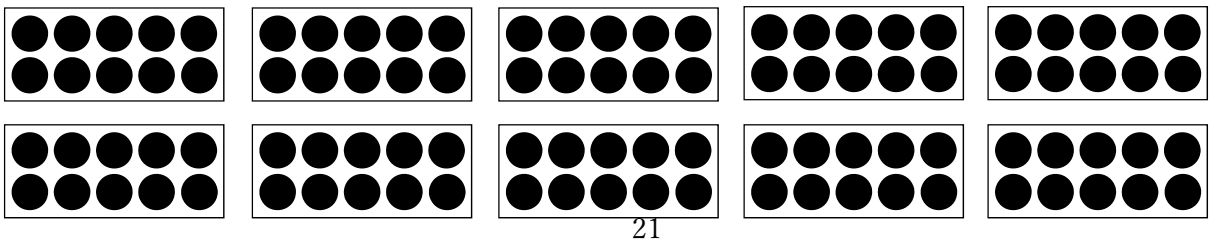


(3) 89



(4) 102

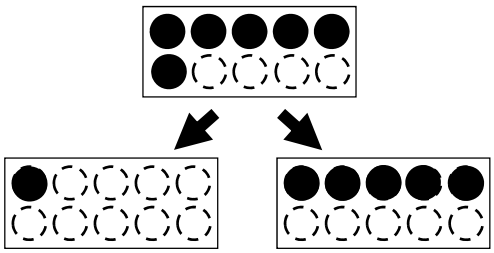


Extra activity 2 (Number bond with dots)

Drawinga tuma dot ku patula number.

(Chisanzo)

①



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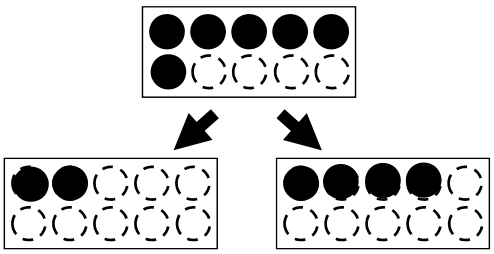
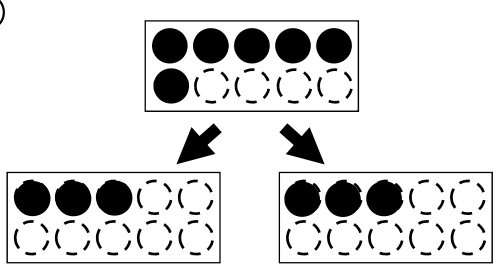


③



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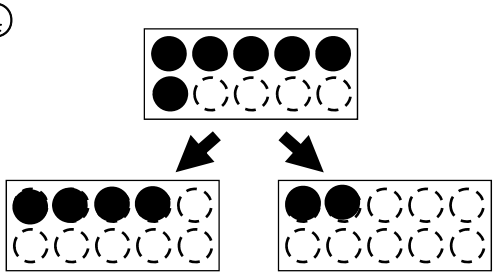
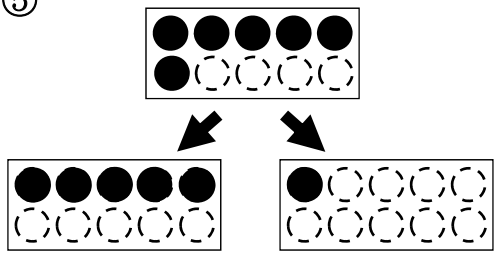
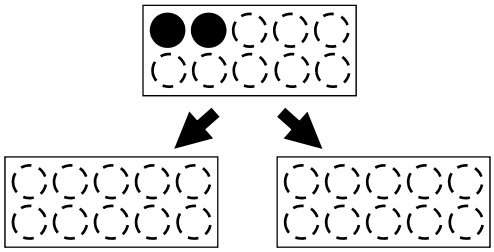


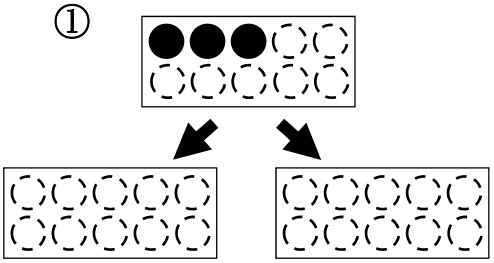
⑤



(1) ①



(2) ①



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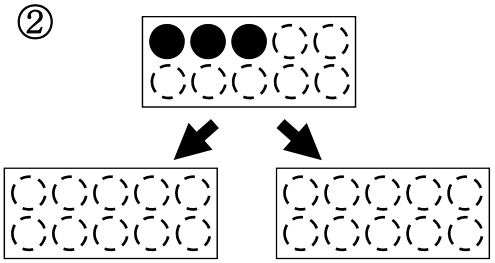
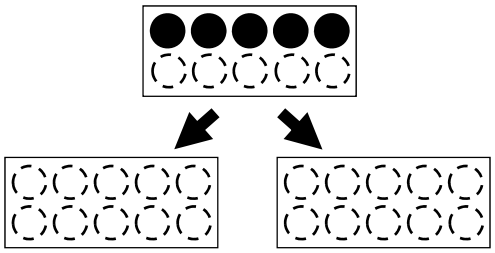


(3)

①



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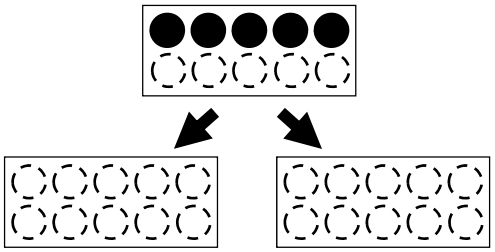

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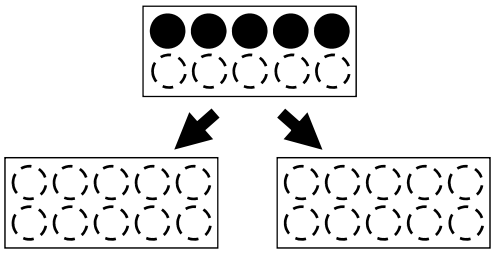

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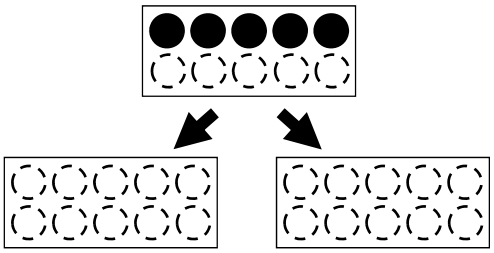

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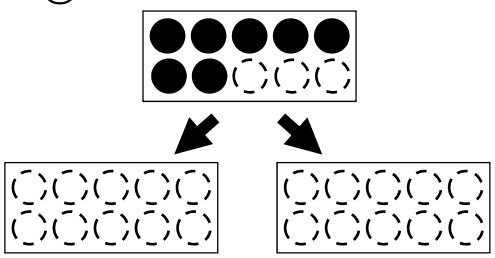

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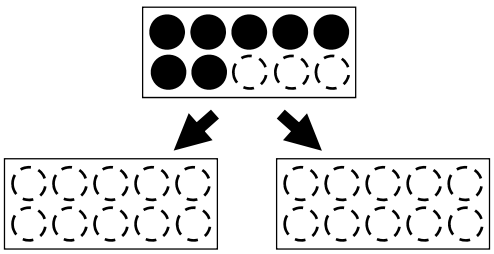

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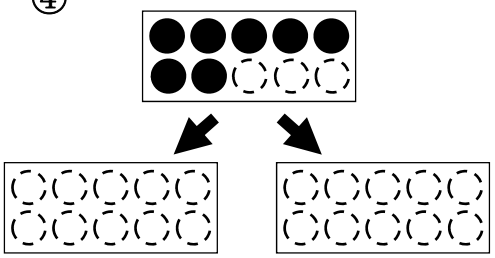

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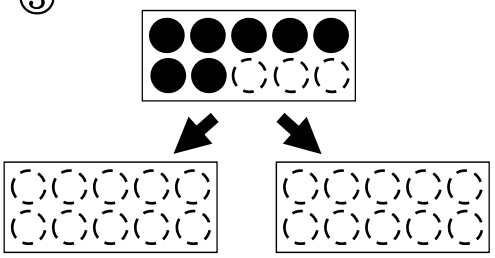

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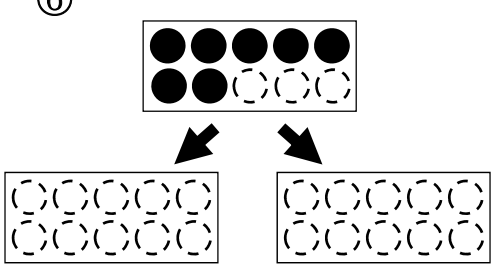

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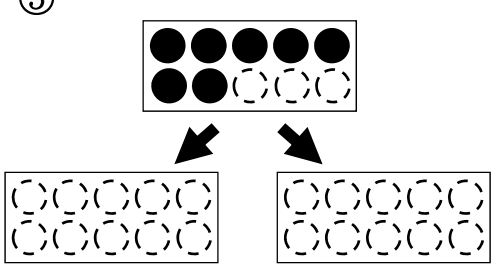
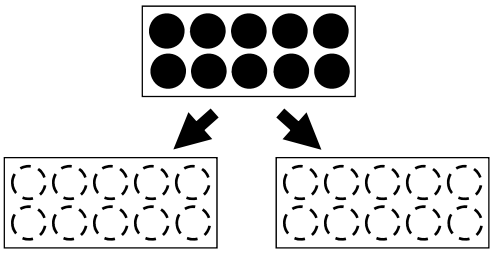


(6)

①



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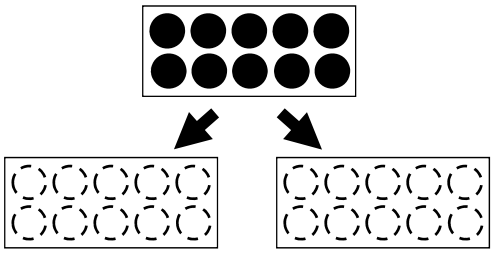

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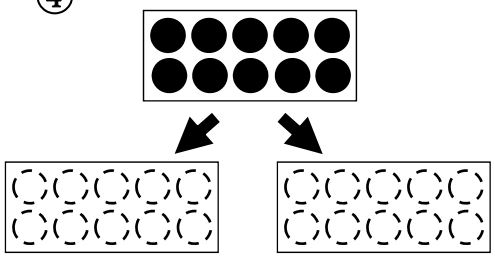

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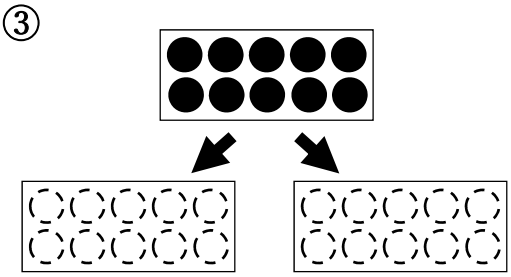

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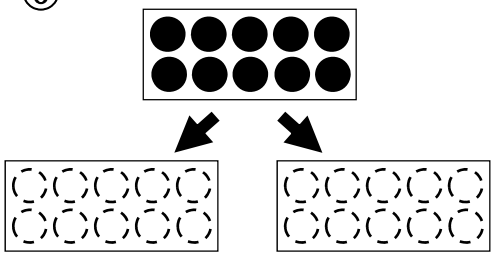

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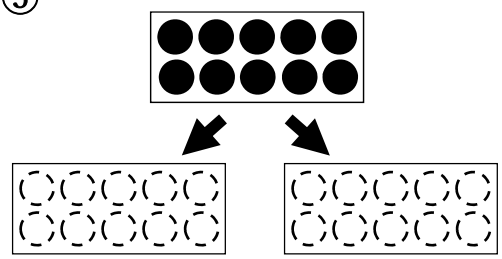

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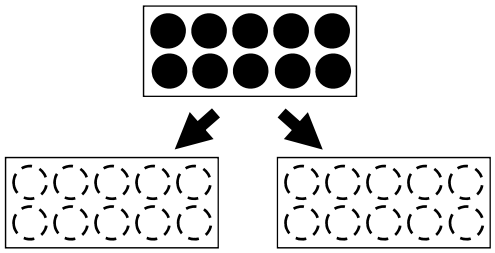

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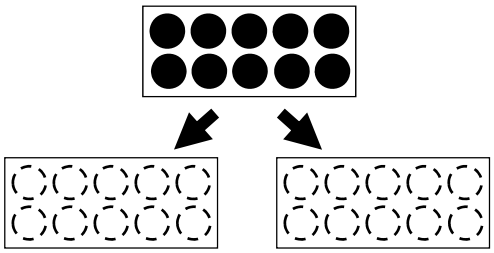

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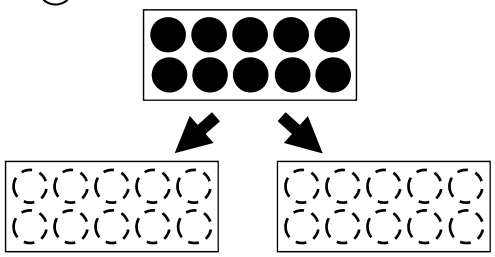
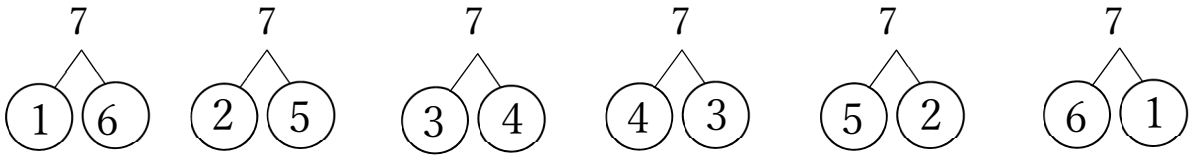
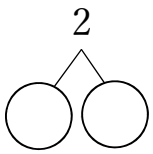


Extra activity 3 (Number bond)

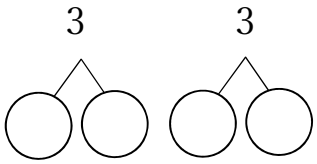
Gabanisa ma number yali pa mwamba.
(Chisanzo)



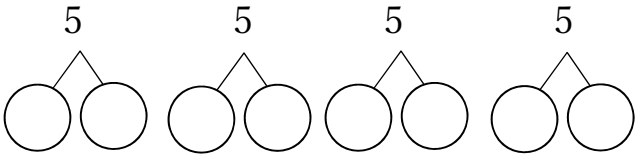
(1)



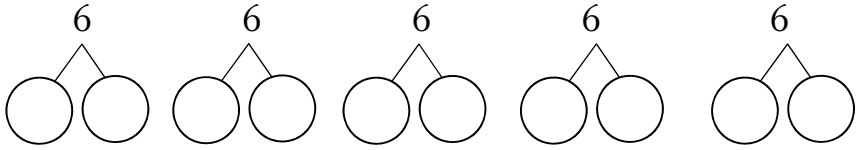
(2)



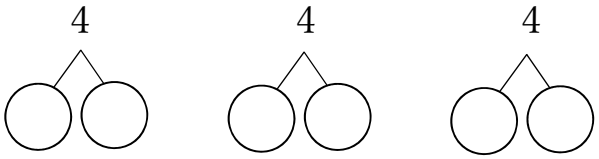
(3)



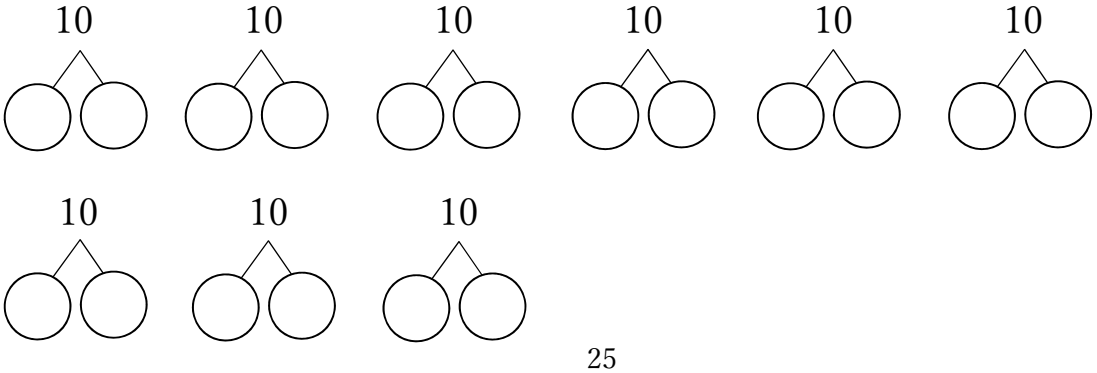
(4)



(5)

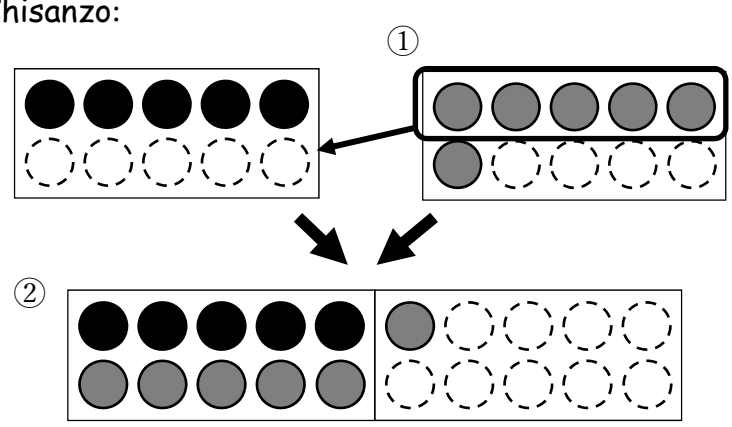


(6)



6 – a, A

Chisanzo:



③ $5 + 6 = 11$

Mochitila/Vokonka:

① Ganiza number tupendelo twamene finika ku fendeza kuti ti pange 10.

② Shadinga tupendelo tuli 10 na twamene twasalila, upeze na answer.

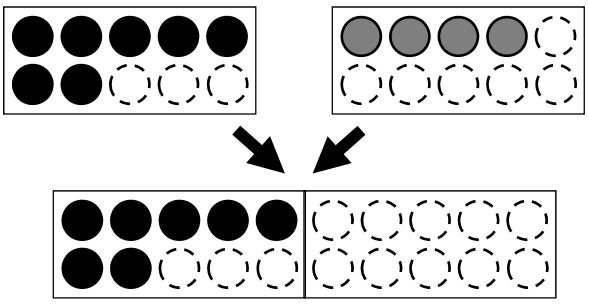
③ Lemba ma sum ku onesa vamene wa chita.

[Chizibiso/Zindikira]

Ungasebenzese tupendelo ngati ufuna.

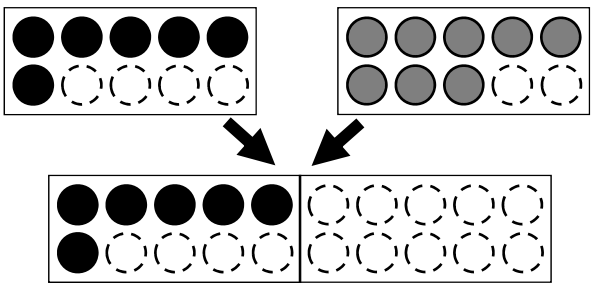
Drawinga ma marble elo lemba ansa yama sum.

1)



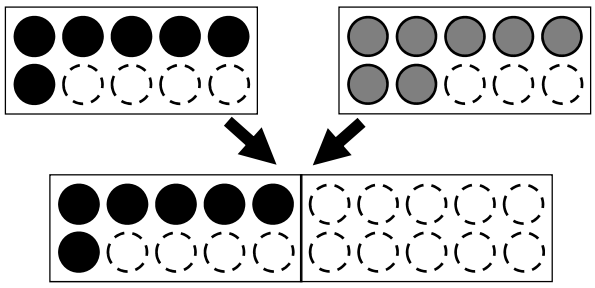
$7 + 4 = \_\_\_$

2)



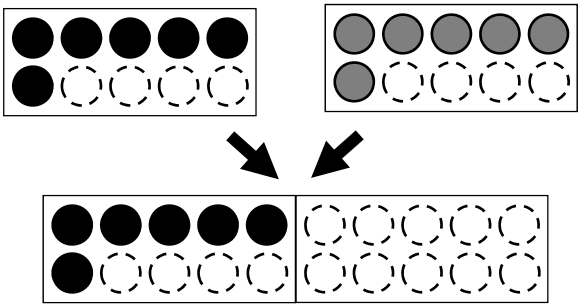
$6 + 8 = \_\_\_$

3)



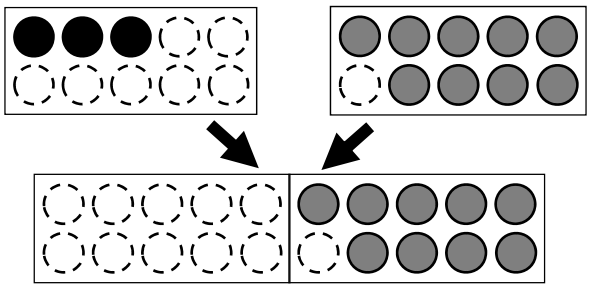
$6 + 7 = \_\_\_$

4)



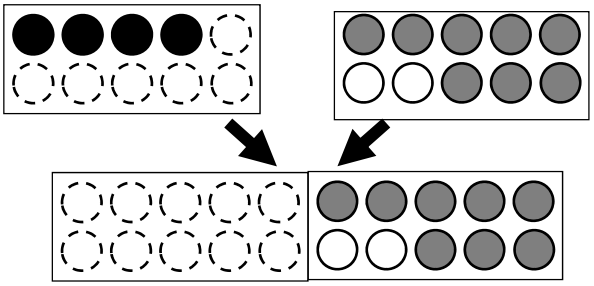
$6 + 6 = \_\_\_$

5)



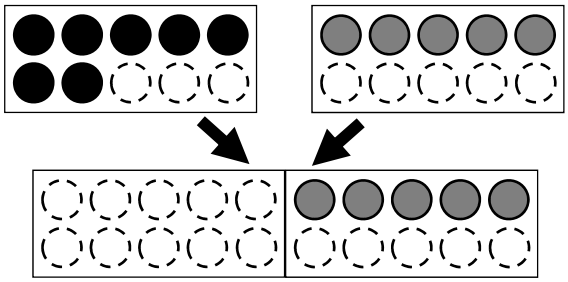
$3 + 9 =$

6)



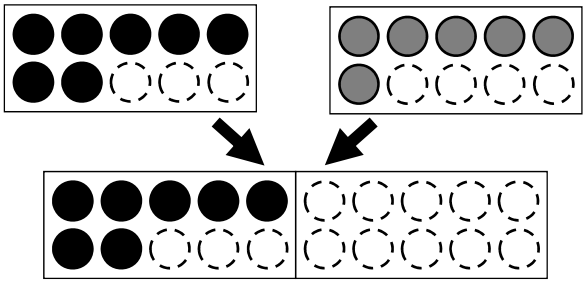
$4 + 8 =$

7)



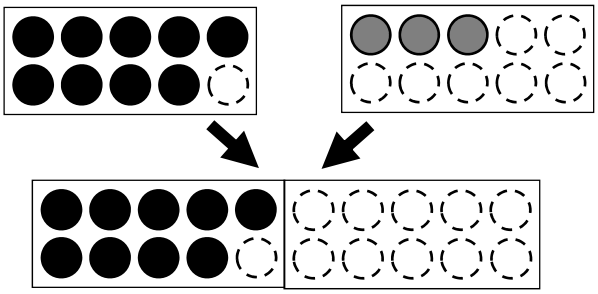
___ + ___ = ___

8)



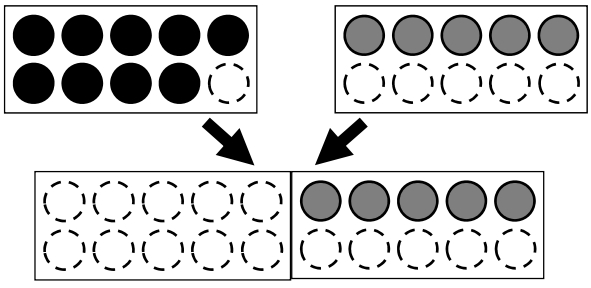
___ + ___ = ___

9)



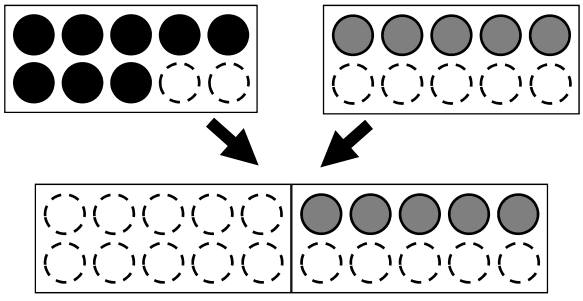
___ + ___ = ___

10)



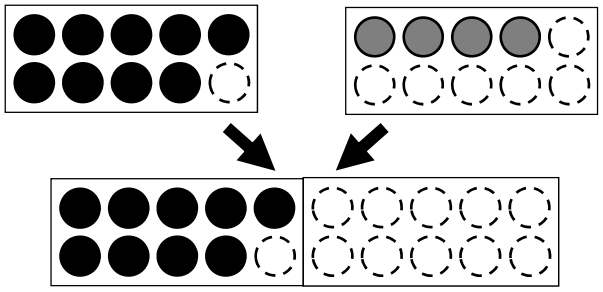
___ + ___ = ___

11)



___ + ___ = ___

12)

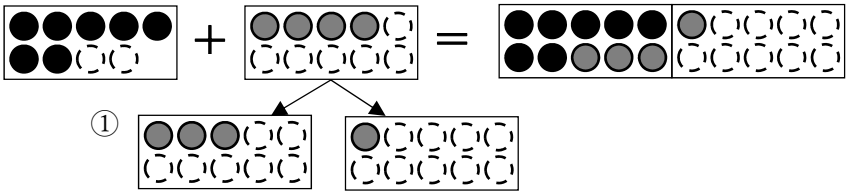


___ + ___ = ___

6 – a, B

Chisanzo:

$$7 + 4 = 11$$



Mochitila/Vokonka:

① Ganiza number tupendelo twamene finika ku fendeza kuti ti pange 10.

② 10 na number wa gabanisa ndiye answer. Shadinga tupendelo ku onesa answer.

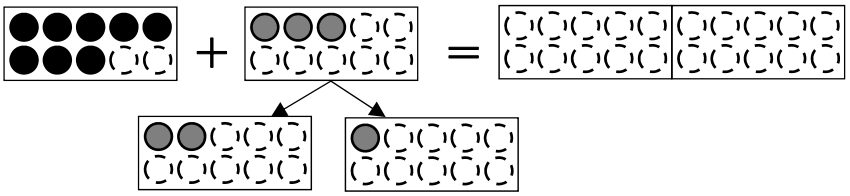
③ Lemba ansa ya masamu aya.

[Chizibiso/Zindikira]

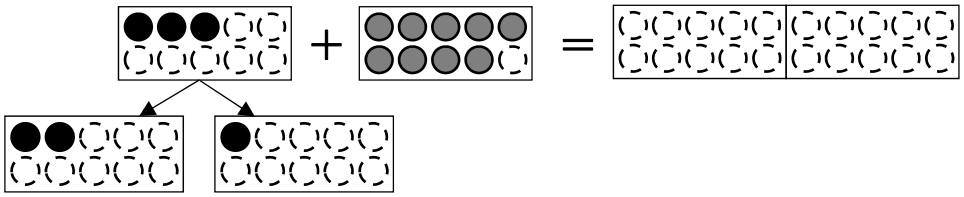
Ungasebenzese tupendelo ngati ufuna

Drawinga ma marble elo lemba ansa yama sum.

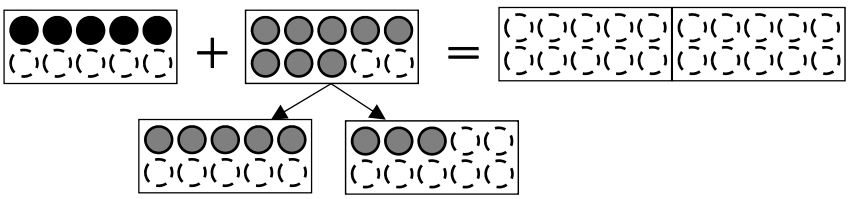
(1) $8 + 3 =$



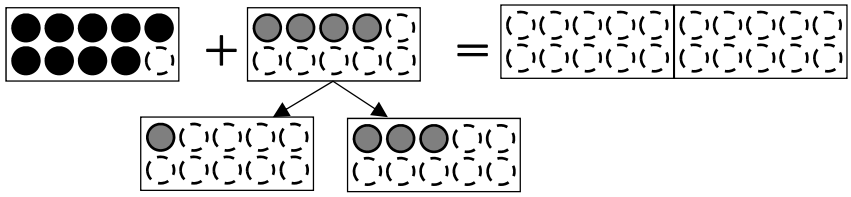
(2) $3 + 9 =$



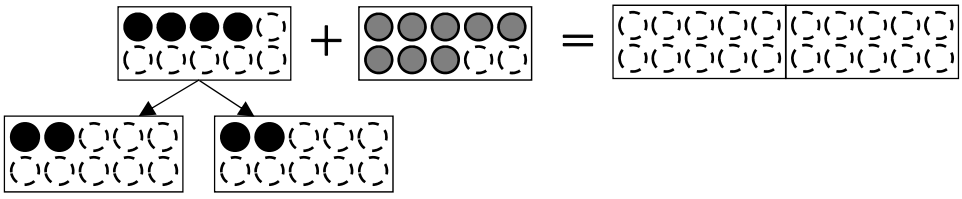
(3) $5 + 8 =$



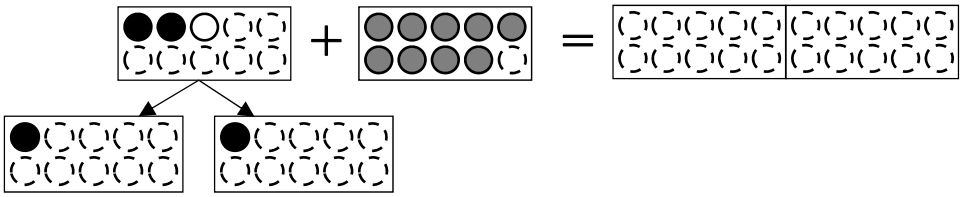
(4) $9 + 4 =$



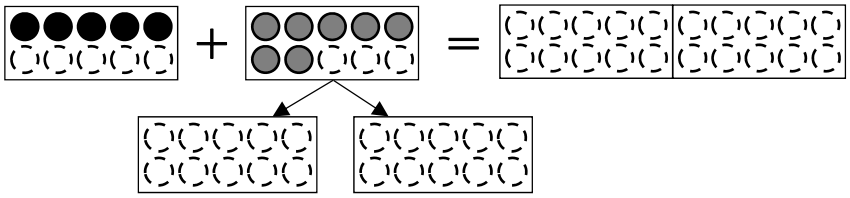
(5) $4 + 8 =$



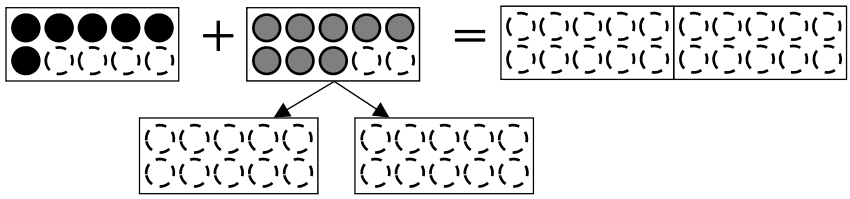
(6) $2 + 9 =$



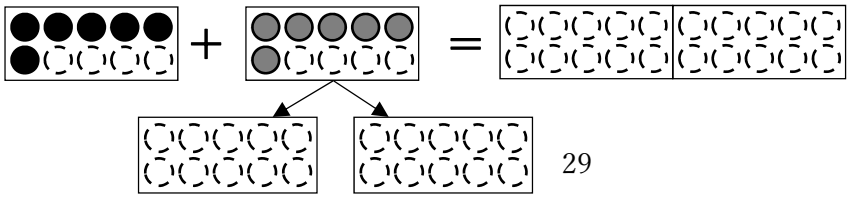
(7) $5 + 7 =$



(8) $6 + 8 =$



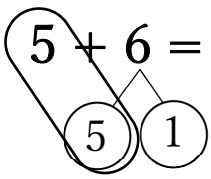
(9) $6 + 6 =$



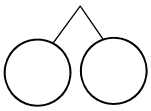
6 – a, C

Peza masamu aya, ugabanise namba imozi kuti ipange 10.

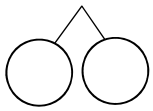
1) $5 + 6 = 11$



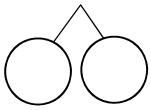
2) $9 + 6 =$



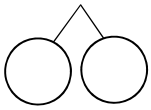
3) $8 + 8 =$



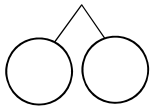
4) $9 + 2 =$



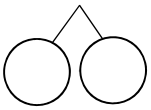
5) $9 + 5 =$



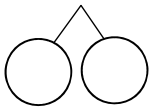
6) $7 + 7 =$



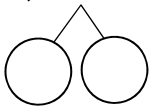
7) $8 + 4 =$



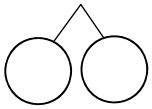
8) $9 + 8 =$



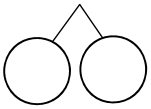
9) $4 + 9 =$



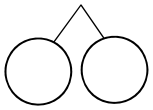
10) $8 + 9 =$



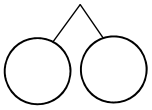
11) $9 + 7 =$



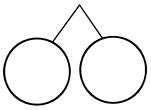
12) $6 + 5 =$



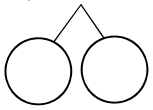
13) $7 + 8 =$



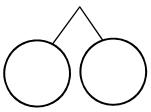
14) $6 + 9 =$



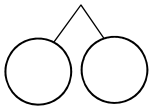
15) $7 + 9 =$



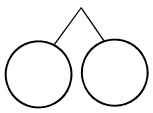
16) $5 + 9 =$



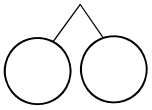
17) $8 + 6 =$



18) $9 + 4 =$

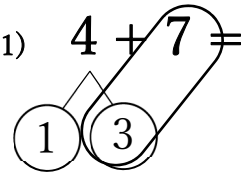


19) $8 + 7 =$



Peza masamu aya, ugabanise namba imozi kuti ipange 10.

1) $4 + 7 = 11$



2) $6 + 7 =$

3) $7 + 9 =$

4) $9 + 7 =$

5) $9 + 8 =$

6) $4 + 8 =$

7) $8 + 9 =$

8) $7 + 8 =$

9) $6 + 5 =$

10) $7 + 5 =$

11) $6 + 9 =$

12) $7 + 6 =$

13) $5 + 6 =$

14) $9 + 6 =$

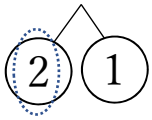
15) $3 + 8 =$

Unga sanke ilionse number yosenbenzesa mu ma sum.

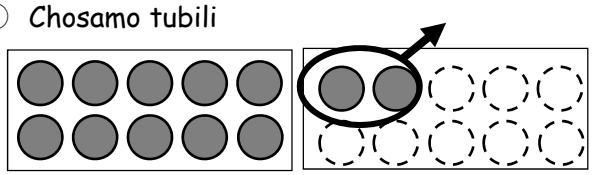
6 – s, A

Chisanzo:

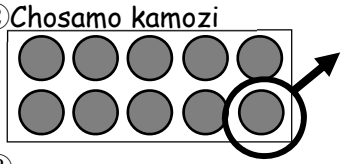
$12 - 3 = 9$



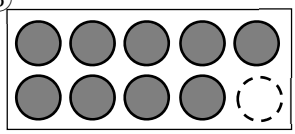
① Chosamo tubili



②Chosamo kamozi



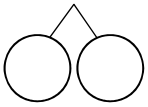
③



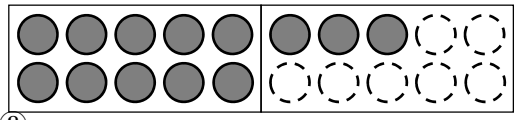
Iyi ndiye ansa!

Peza masamu aya yochesela.

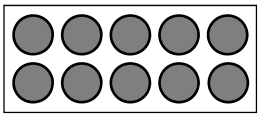
1) $13 - 4 =$



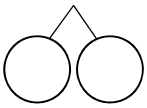
①



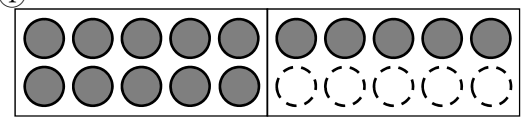
②



2) $15 - 6 =$



①



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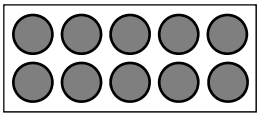
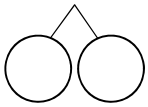
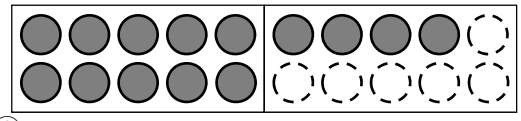


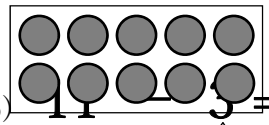
3) $14 - 5 =$



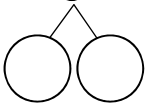
①



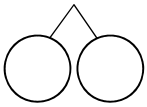
②



5) $11 - 3 =$



4) $12 - 4 =$



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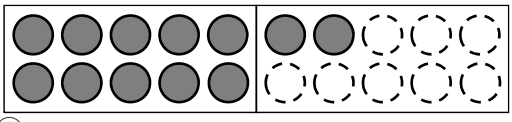

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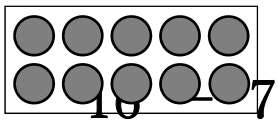
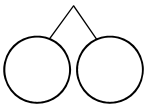
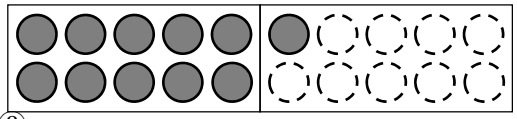


6) $16 - 7 =$



①



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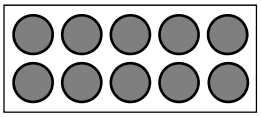

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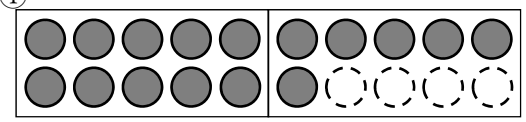

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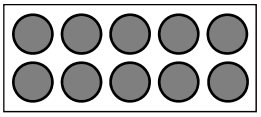
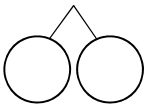


7) $17 - 8 =$



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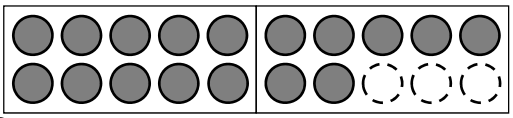
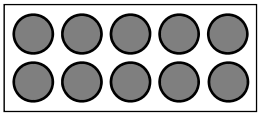
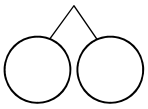


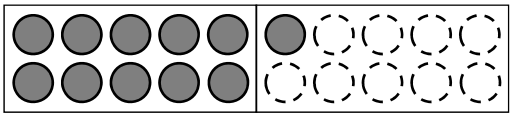
②



8) $11 - 2 =$



①



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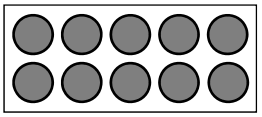
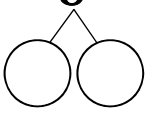


9) $12 - 3 =$



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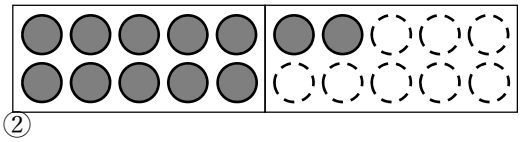

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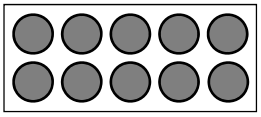
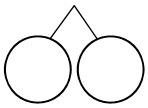
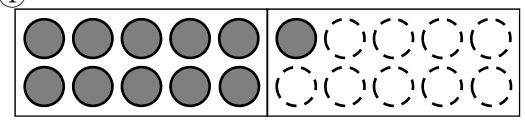


10) $11 - 4 =$



①



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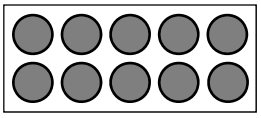
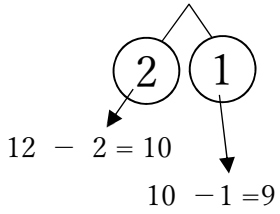


6 – s, B

Chisanzo:

$12 - 3 = 8$



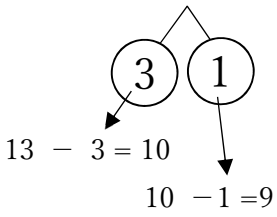
Steps:

① 3 niyogabanisiwa muma number yabili, imozi niyolembewa yoyambilila(number 2), elo yasala(number 1).

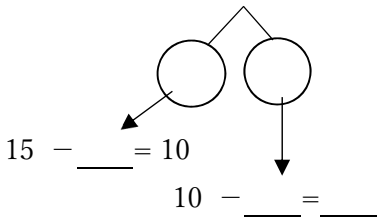
② Ku 12 ta chosako 2 ku peza 10, ku 10 tachosako 1 ku peza 9.

Peza ma sum aya, ku lemba ma number mu malo mwamene mulibe.

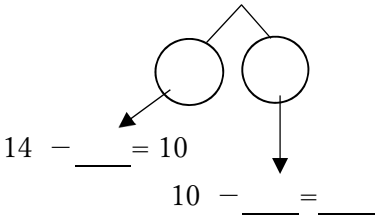
1) $13 - 4 =$



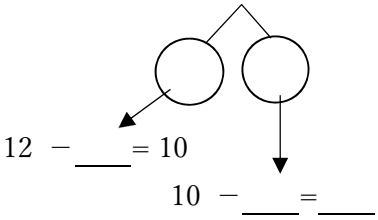
2) $15 - 6 =$



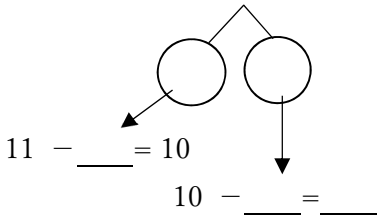
3) $14 - 5 =$



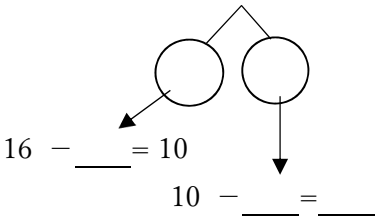
4) $12 - 4 =$



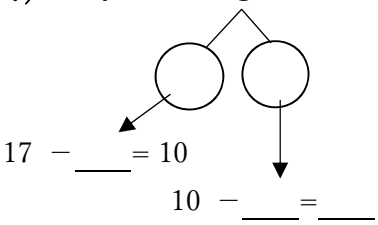
5) $11 - 3 =$



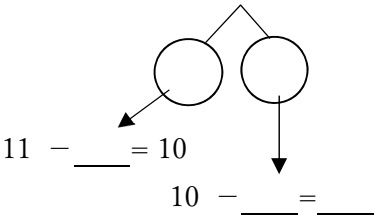
6) $16 - 7 =$



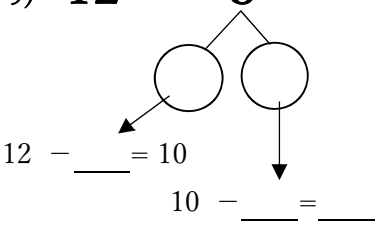
7) $17 - 8 =$



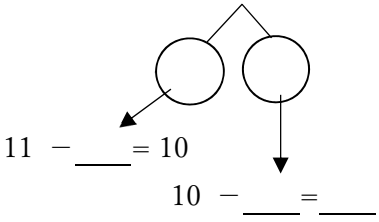
8) $11 - 2 =$



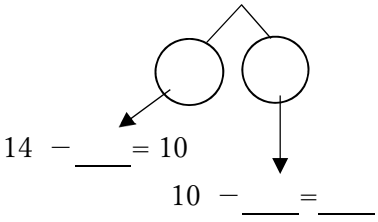
9) $12 - 3 =$



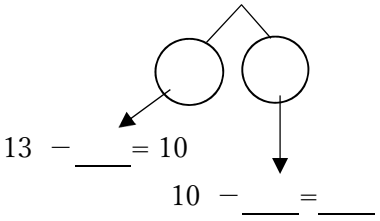
10) $11 - 4 =$



11) $14 - 6 =$



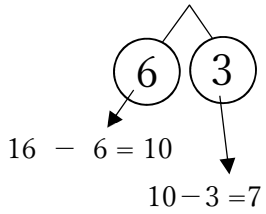
12) $13 - 6 =$



6 – s, C

Peza masamu aya yochosela, na kulembe mwamene wayipezela weka

1) $16 - 9 = 7$



2) $15 - 8 =$

3) $15 - 9 =$

4) $14 - 9 =$

5) $15 - 6 =$

6) $14 - 8 =$

7) $18 - 9 =$

8) $13 - 8 =$

9) $17 - 9 =$

13) $15 - 7 =$

14) $14 - 7 =$

15) $13 - 8 =$

16) $17 - 9 =$

17) $18 - 9 =$

18) $16 - 8 =$

19) $12 - 4 =$

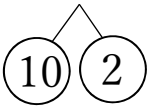
20) $11 - 3 =$

21) $16 - 7 =$

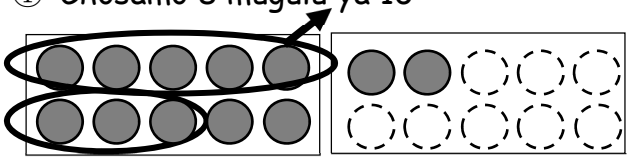
6 – s, D

Chisanzo:

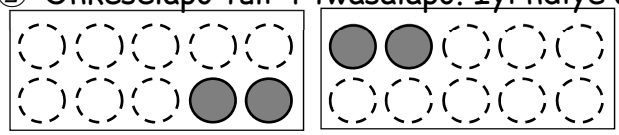
$12 - 8 = 4$



① Chosamo 8 mugulu ya 10

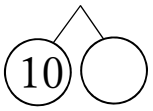


② Onkeselapo tuli 4 twasalapo. Iyi ndiye ansa!

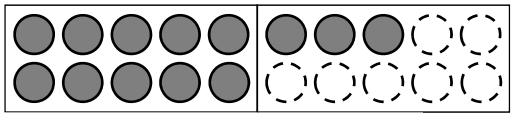


Lemba ma numba elo drawinga diagram kwati ili monga pamwamba

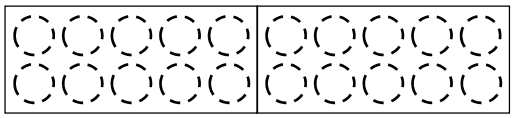
1) $13 - 5 = \_\_\_\_$



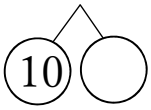
① Chosamo 5 mu gulu ya 10.



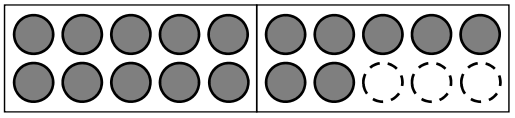
② Onjeza yasalako: ____



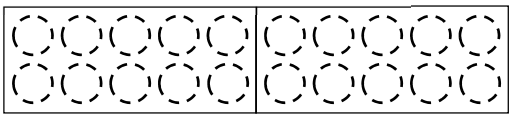
2) $17 - 9 =$



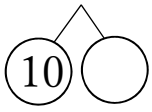
① Chosamo 9 mu gulu ya 10.



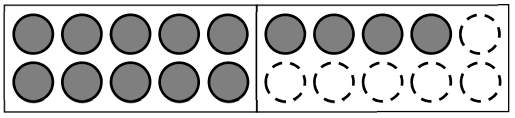
② Onkesa yasalako: ____



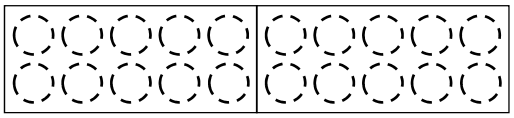
3) $14 - 7 =$



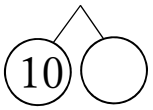
① Chosamo 7 mu gulu ya 10.



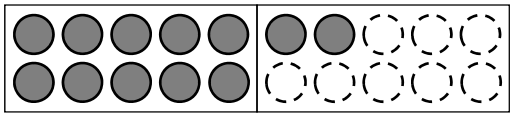
② Onkesa yasalako: ___



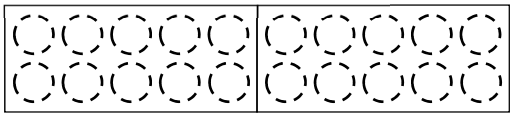
4) $12 - 6 = \_\_\_\_$



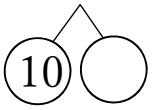
① Chosamo 6 mu gulu ya 10.



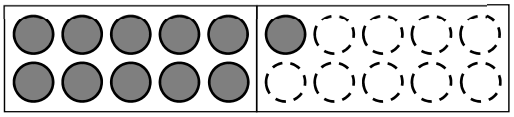
② Onkesa yasalako: ____



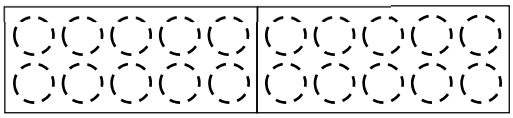
5) $11 - 8 =$



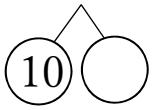
① Chosamo 8 mu gulu ya 10.



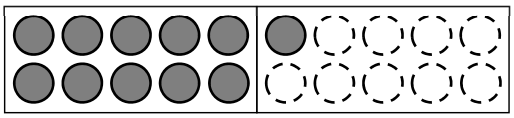
② Onkesa yasalako: ____



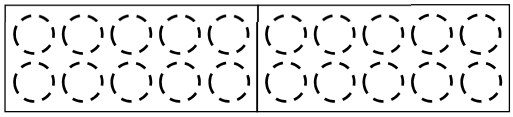
6) $11 - 6 =$



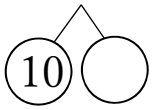
① Chosamo 6 mu gulu ya 10.



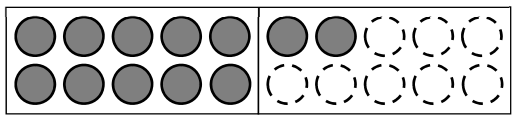
② Onkesa yasalako: ____



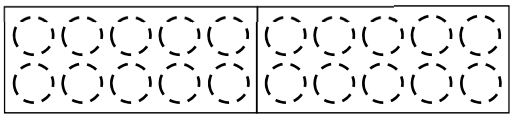
7) $12 - 9 =$



① Chosamo 9 mu gulu ya 10.



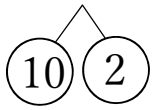
②Onkesa yasalako: ____



6 – s, E

Chisanzo:

$$12-9=3$$

① 

② $10 - 9 = 1$

$1 + 2 = 3$

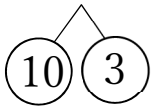
Mochitila/Vokonka:

① 12 niyogabanisiwa muli 10 na 2.

② 9 niyochosewa muli 10(10-9=1)
2 niyo onkesewa kuli 1(1+2=3)

Peza masamu aya, kulemba mulibe volembewa.

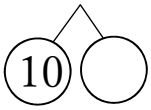
1) $13 - 5 =$



$10 - 5 = 5$

$5 + 3 = 8$

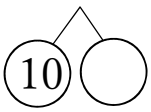
2) $17 - 9 =$



10 − ___ = ___

___+___ = ___

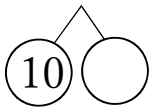
3) $14 - 7 =$



10 − ___ = ___

___+___ = ___

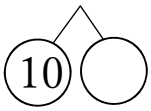
4) $12 - 6 =$



10 − ___ = ___

___+___ = ___

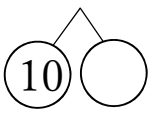
5) $11 - 8 =$



10 − ___ = ___

___+___ = ___

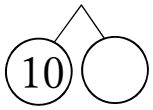
6) $11 - 6 =$



10 − ___ = ___

___+___ = ___

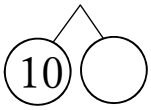
7) $12 - 9 =$



10 − ___ = ___

___+___ = ___

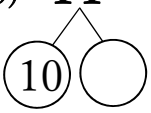
8) $16 - 9 =$



10 − ___ = ___

___+___ = ___

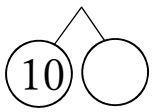
9) $11 - 5 =$



10 − ___ = ___

___+___ = ___

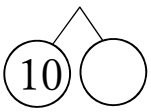
10) $13 - 9 =$



10 − ___ = ___

___+___ = ___

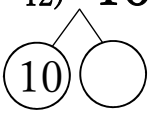
11) $12 - 8 =$



10 − ___ = ___

___+___ = ___

12) $16 - 8 =$



10 − ___ = ___

___+___ = ___

6 – s, F

Peza masamu aya yochosela, na kulemba mwamene wayipezela weka.

1) $14 - 6 =$ 2) $14 - 8 =$ 3) $14 - 5 =$

4) $15 - 7 =$ 5) $13 - 6 =$ 6) $15 - 8 =$

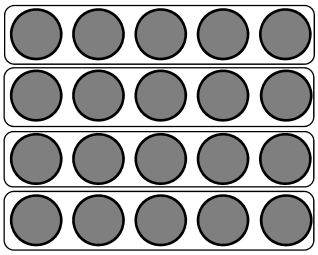
7) $12 - 5 =$ 8) $15 - 9 =$ 9) $11 - 9 =$

10) $18 - 9 =$ 11) $13 - 7 =$ 12) $12 - 7 =$

13) $14 - 9 =$ 14) $11 - 7 =$ 15) $13 - 8 =$

6－m1

Chisanzo:



$4 \times 5 = 20$

Mochitila/Vokonka:

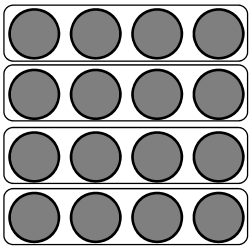
① Circolinga ma gulu yama dot ya same.
Pali apa magulu yali 4 yama 5

② Lemba masamu.
4 × 5 = 20

［Chizibiso/Zindikira］ Osa yangana ma dot muma line yo choka pamwamba kubwela pansi.Osa yangana ma dot muma line yo choka pamwamba kubwela pansi.

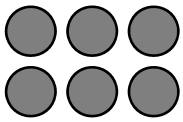
Lemba masamu.

(1)



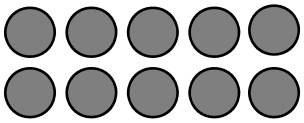
$4 \times 4 = 16$

(2)



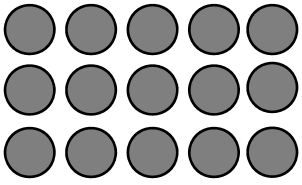
＿＿×＿＿＝＿＿

(3)



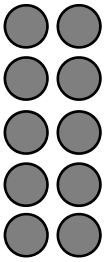
＿＿×＿＿＝＿＿

(4)



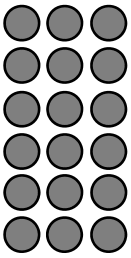
＿＿×＿＿＝＿＿

(5)



＿＿×＿＿＝＿＿

(6)



＿＿×＿＿＝＿＿

Drawinga ma marble kulangisa masamu aya.

(1)

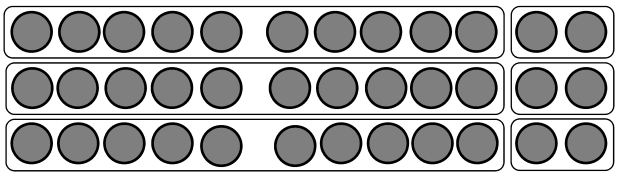
$4 \times 2 =$

(2)

$3 \times 4 =$

6－m2

Chisanzo:



$12 \times 3 = 36$

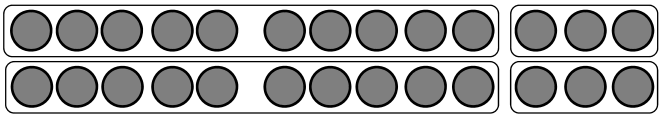
Mochitila/Vokonka:

① Circolinga magulu yama dot ya same, kuganizila ma place value(ma tens nama ones)

② Lemba masamu: "ma gulu yatatu yama 2 ni 6" elo na "magulu yatatu yama 10 ni 30. Pamodzi 36, ansa ni 36.

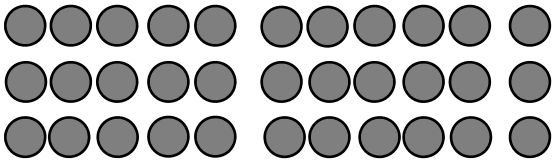
Lemba masamu.

(1)



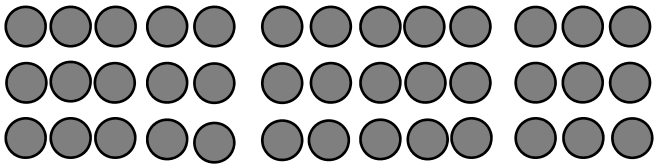
$13 \times 2 = 26$

(2)



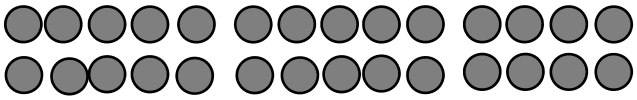
＿ × ＿ = ＿

(3)



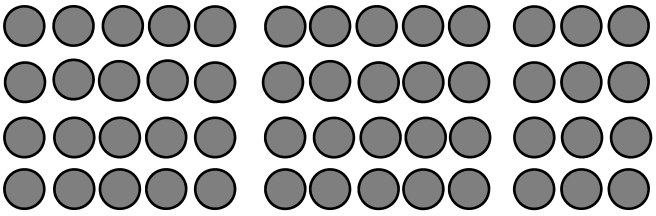
＿ × ＿ = ＿

(4)



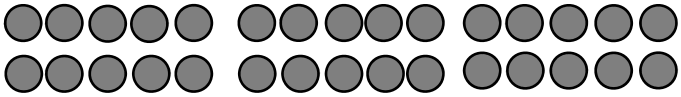
＿ × ＿ = ＿

(5)



＿ × ＿ = ＿

(6)



＿ × ＿ = ＿

Drawinga tupendelo kulangiza ma nsamu aya.

(1) $14 \times 2 =$

(2) $12 \times 2 =$

6－d1

Chisanzo:

$12 \div 2 = 6$

Mochitila/Vokonka:

① Lemba masamu

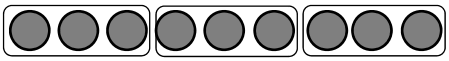
② Ma dot yali 12 niyogabanisiwa muma gulu yabili elo group imozi ili na ma dot yali 6. Mwaicho, 12÷2=6

Lemba masamu.

(1)

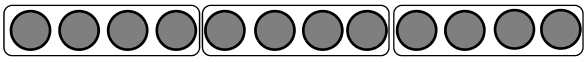
$10 \div 2 = 5$

(2)



＿＿÷＿＿＝＿＿

(3)



＿＿÷＿＿＝＿＿

(4)

＿＿÷＿＿＝＿＿

(5)

＿＿÷＿＿＝＿＿

(6)

＿＿÷＿＿＝＿＿

Drawinga tupendelo kulangiza masamu aya.

(1)

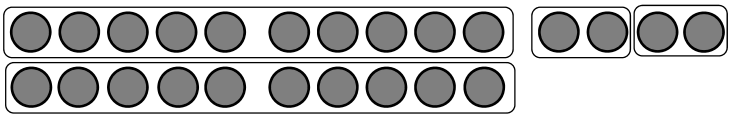
$8 \div 2 =$

(2)

$10 \div 5 =$

6 – d2

Chisanzo:



$20 \div 2 = 10$ $4 \div 2 = 2$

$$24 \div 2 = 12$$

Mochitilia/ Vokonka:

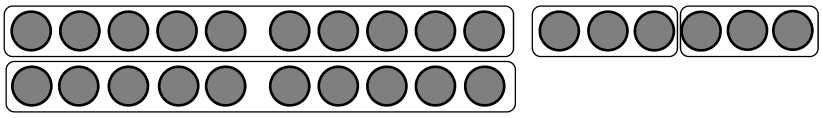
① Lemba ma nsamu, elo yapeze kuganizila ma place values(ma tens nama ones).

② Ma dot yali 24 niyogabanisiwa muma gulu yabili.
- peza ma tens: 20/2=10
- peza ma ones 4/2=2

Mwaicho,ansa ni 12.

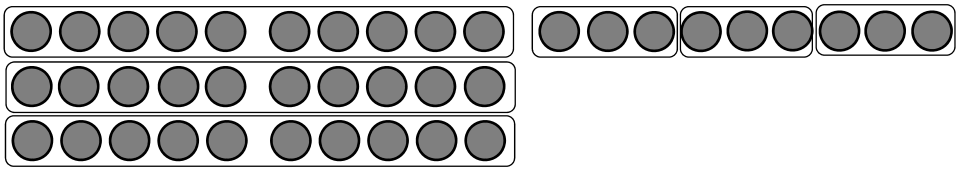
Lemba masamu.

(1)



___ ÷ ___ = ___

(2)



___ ÷ ___ = ___

Drawinga tupendelo kulangiza masamu aya.

$$28 \div 2 =$$