





I don't know how to do that using mathematics.

CIES 2018



## Early Grade Reading and Mathematics Initiative (RAMP)

- RAMP is a nationwide initiative of the Jordanian Ministry of Education (MoE) designed to improve the reading and mathematics skills of students in kindergarten 2 through grade 3 (K2–G3).
- RAMP, which is being carried out over five years (2015 to 2019), expects to deliver improved reading and mathematics instruction to all public school students in Jordan in grades K2–G3—about 400,000 students.

# Early Grade Reading and Mathematics Initiative (RAMP)

Central to the RAMP approach to improving mathematics performance is supporting a shift from mathematics as:

*the memorization of facts, rules and procedures to produce an answer*

to mathematics as:

*a meaningful, sense-making problem solving activity*

This panel explores the impact of the mathematics component of the RAMP initiative by reporting on a research study that examined the classroom implementation of the problem solving component of the mathematics program.

## Panel overview

- The role of mathematical problem solving in the RAMP initiative.

Sabreen Salman, Mathematics Specialist, Queen Rania Teacher Academy, Jordan

- How problem solving is being implemented by RAMP trained teachers.

Aarnout Brombacher, Senior Education Program Specialist, RTI International

- How can the ministry support teachers to implement the RAMP problem solving methodologies more successfully?

Zainab Al-Shawabkeh, Director: Education Management, Ministry of Education, Jordan





# The role of mathematical problem solving in the RAMP initiative.

Sabreen Salman

Mathematics Specialist, Queen Rania Teacher Academy,  
Jordan



# The role of mathematical problem solving

- In RAMP, problem situations support the learning of mathematics.
- Problem situations are used to reveal to children the mathematics that we want them to learn.
- Problems are both the reason for developing mathematical knowledge and skills as well as a vehicle for doing so.

# The role of mathematical problem solving

- Children are typically presented with problem situations that they are capable of making sense of, using solutions strategies appropriate to their age, their grade, and the number range.
- The organic solutions of the problem by the children reveals the mathematics or a computational method that we want the children to learn in a more formal way.

*The problem or situation provokes a natural response, and that natural response is the mathematics or computational strategy that we want to teach and develop*



# The role of mathematical problem solving

- This approach is not limited to the basic operations; it can also be applied throughout school mathematics. In RAMP, the approach is used to develop an understanding of the basic operations and the fraction concept.

# The role of mathematical problem solving

- Problems are both the reason for developing mathematical knowledge and skills as well as a vehicle for doing so.
- Three key purposes are given in the RAMP teacher guide for using problems to develop mathematical knowledge and skills:
  1. *Problems are be used to introduce children to the so-called basic operations (and fractions);*
  2. *Problems contribute to the development of computational methods; and*
  3. *Problems make the mathematical experiences of the child meaningful and relevant.*

# The role of mathematical problem solving

## *1. Problems are be used to introduce children to the so-called basic operations (and fractions)*

- Problems that support the development of addition and subtraction:
  - Change, combine, and compare problems
- Problems that support the development of the division concept:
  - Sharing, and grouping problems
- Problems that support the development of the multiplication concept:
  - Repeated addition, and situations with a grid or array type structure
- Problems that support the development of the following concepts:
  - Fractions, ratio, rate and proportion including sharing in a ratio

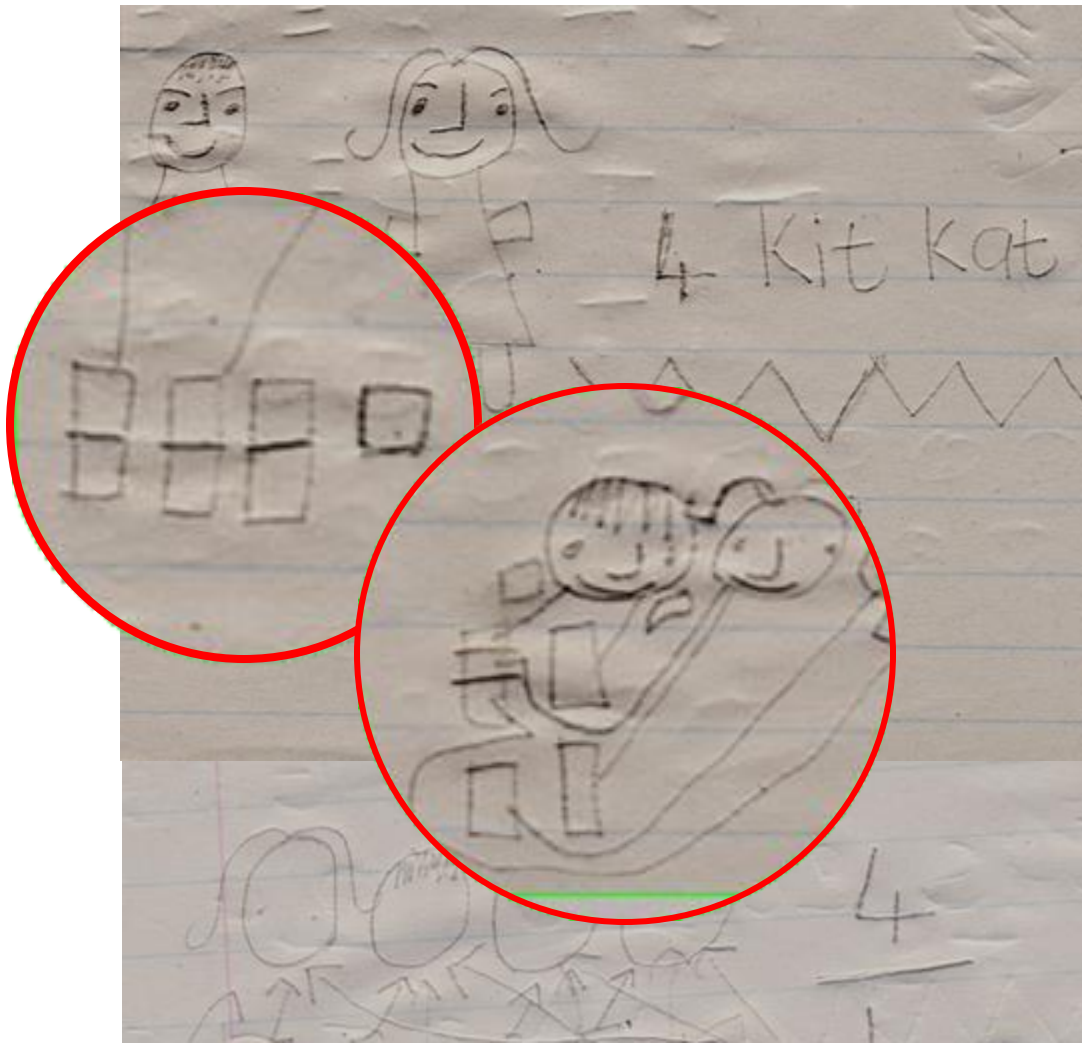
# The role of mathematical problem solving

## Problems used to introduce the fraction concept:

- Two friends share three chocolate bars equally. Show them how to do it.
- Three friends share four chocolate bars equally. Show them how to do it.
- Four friends share five chocolate bars equally. Show them how to do it.

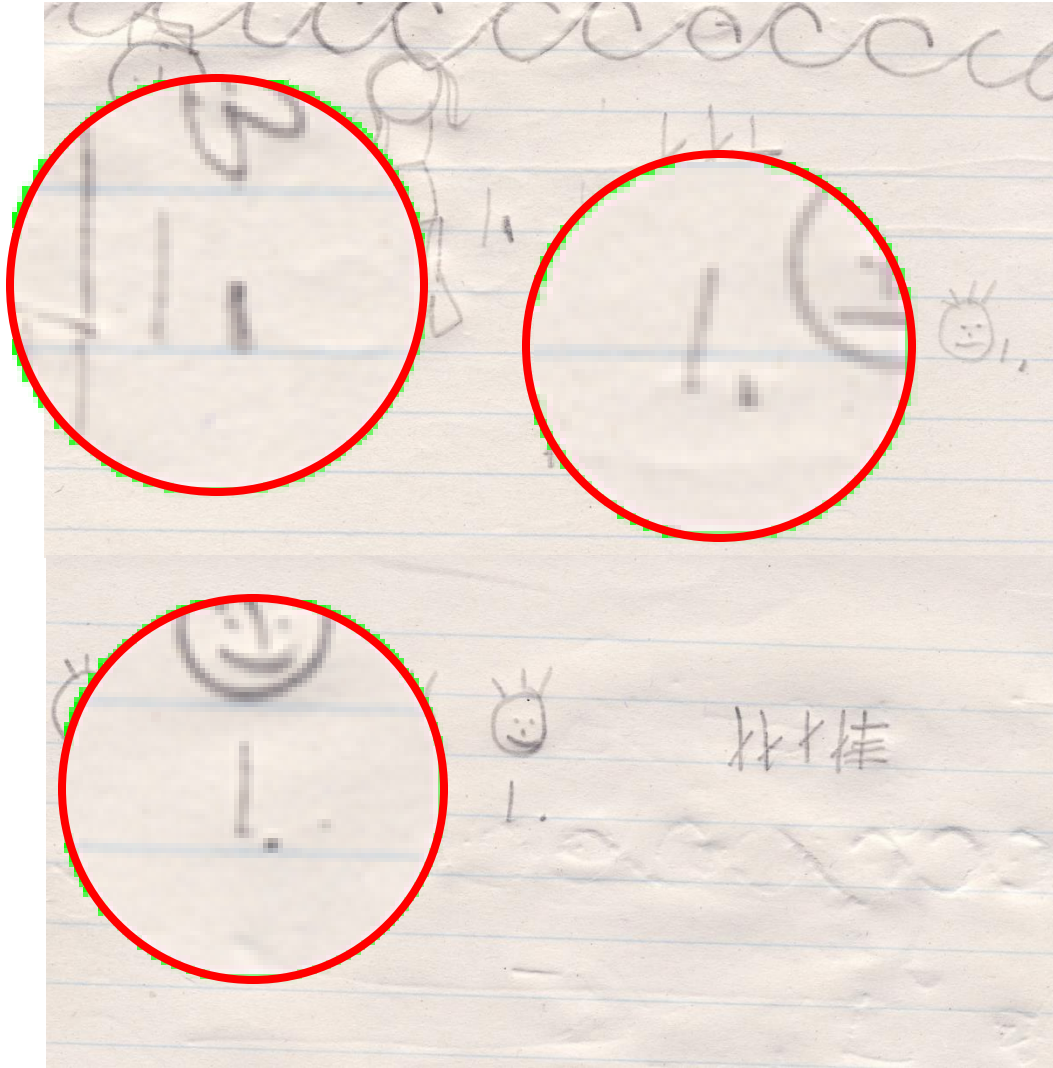
# The role of mathematical problem solving

Problems used to introduce the fraction concept:



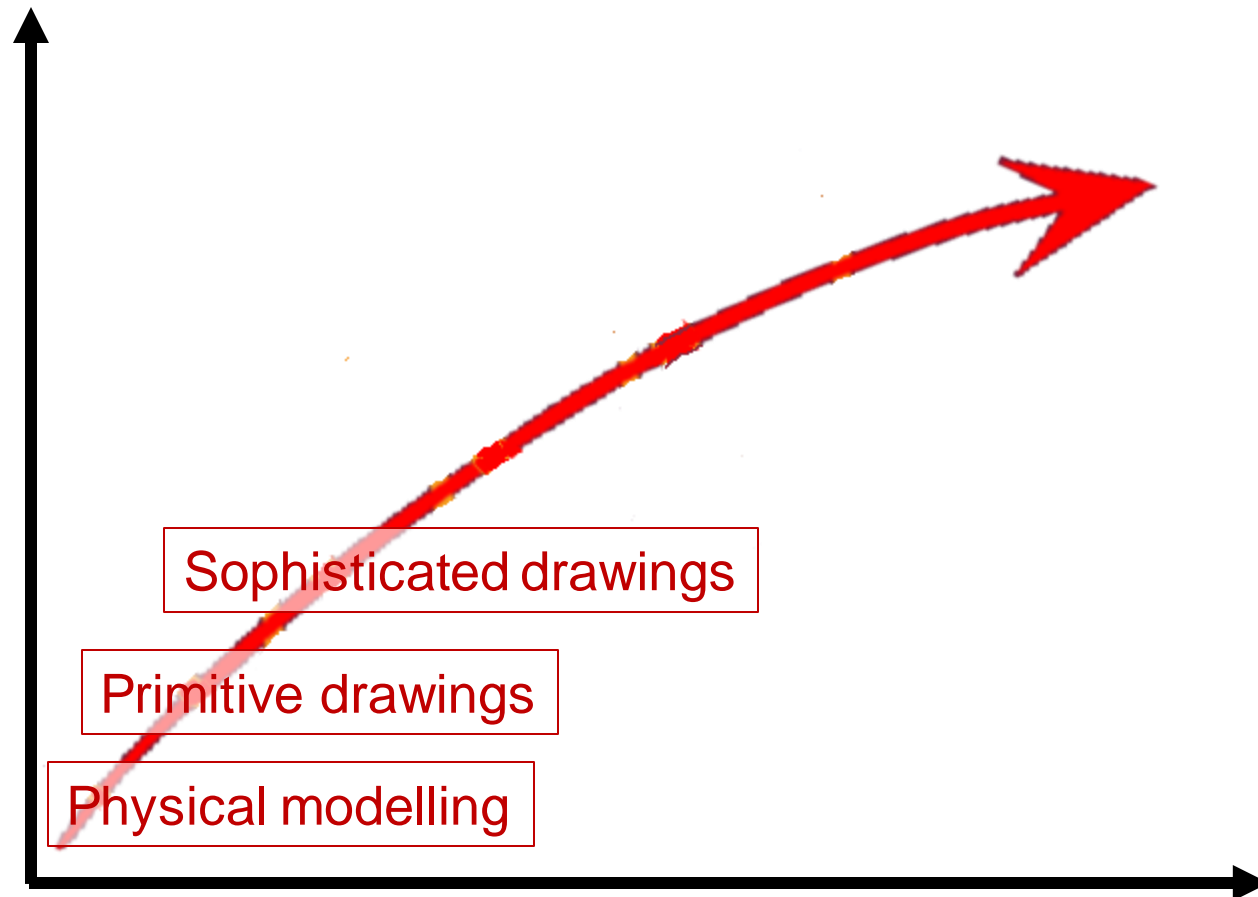
# The role of mathematical problem solving

Problems used to introduce the fraction concept:



# The role of mathematical problem solving

*2. Problems contribute to the development of age, grade and number range appropriate computational methods*





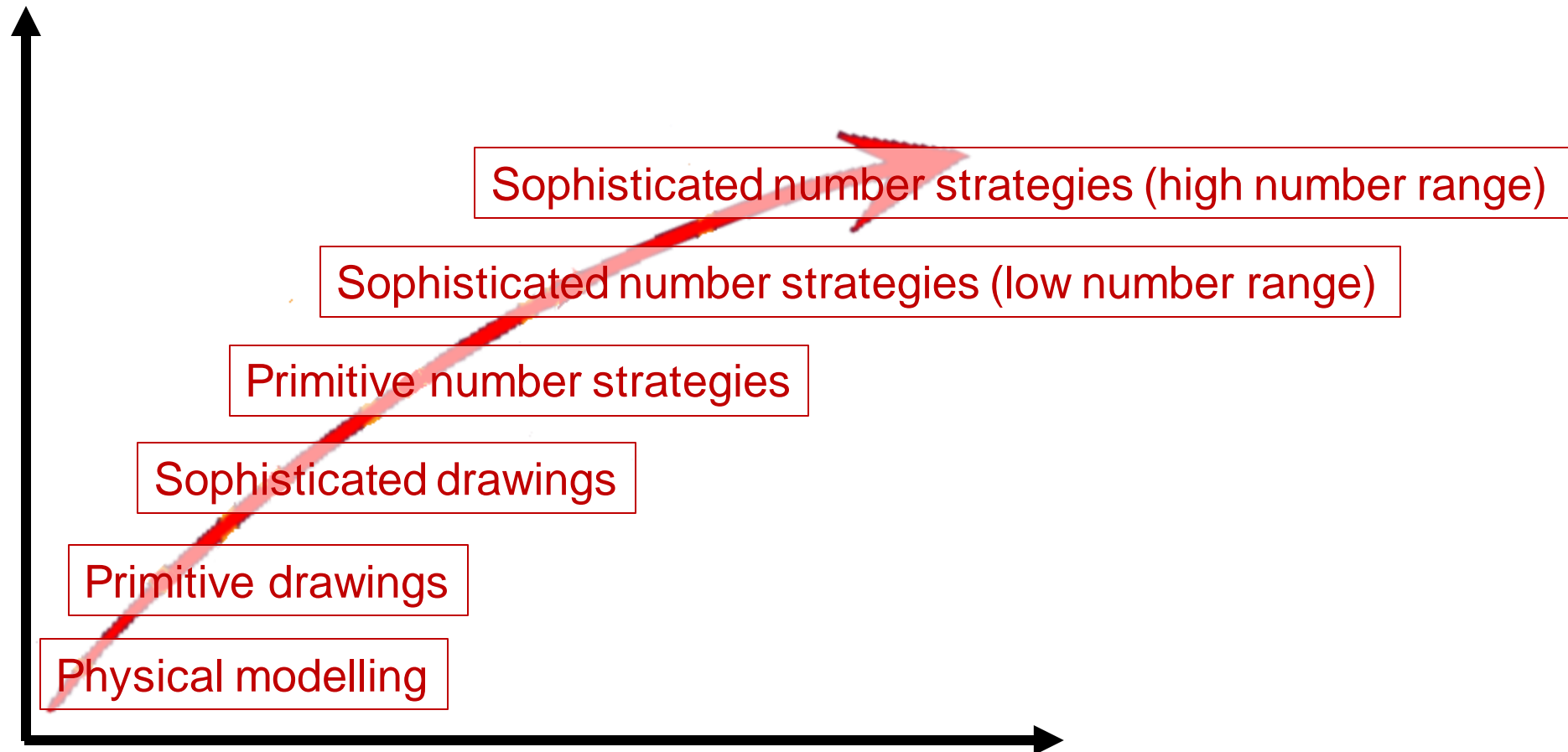






# The role of mathematical problem solving

*2. Problems contribute to the development of age, grade and number range appropriate computational methods*



# The role of mathematical problem solving

- 3. Problems make the mathematical experiences of the child meaningful and relevant.*

# The role of mathematical problem solving

## The role of the teacher in managing problem solving in class:

- Pose the problem
- Children make a plan and solve the problem
  - Teacher monitors the children and identifies:
    - Primitive solution that will help those who cannot get started
    - Sophisticated solution that reflects understanding and “where we want to be”
    - Solutions that represent misunderstanding and/or mistakes
- Teacher manages discussion and reflection
- Pose a related problem



## How problem solving is being implemented by RAMP trained teachers.

Aarnout Brombacher

Senior Education Program Specialist, RTI International



## How is problem solving being implemented

- Participants were six teachers and their classrooms in three schools (two in Zarqa and one in Jerash). In each school, one grade 2 and one grade 3 class was observed.
- The research team consisted of:
  - The Reading and Mathematics Specialist from the RAMP initiative supported by the RAMP interpreter (who translated from the Arabic used in the lesson to English) and accompanied by a colleague on the technical team of RAMP, and
  - The lead mathematics materials developer for the RAMP initiative from the Queen Rania Teacher Academy
- The research team visited all six classrooms and conducted a classroom observation, teacher interview, and four to six student interviews per school.



# How is problem solving being implemented

- The classroom observation focused on the implementation of the problem-solving routine.
- Observed teachers were informed that the research team was visiting their classes with a view to observing them implement the problem-solving routine.
- Problem solving was chosen because:
  - It is the most unfamiliar of the RAMP routines that teachers have been asked to introduce; and
  - Coaching reports from the MoE Supervisors and RAMP coaches responsible for conducting the classroom-based support component of the in-service training have indicated that the problem-solving routine is, in general, not being well implemented.

## How is problem solving being implemented

- Although all six teachers implemented a problem-solving lesson, not one of them implemented the lesson in the way that the RAMP mathematics teacher guide anticipates that the lesson will be implemented.
- Not one of the teachers:
  - Set a problem that forced the students to have to “make a plan,”
  - Observed the students making different plans, and/or
  - Facilitated a meaningful discussion of the strategies that the students had used to make sense of and solve the problem.

## How is problem solving being implemented

- All six teachers used the problem-solving lesson to “teach” the key stages of solving a problem.

Problem solving was a topic not a way of teaching mathematics.

- Although incidents during each lesson demonstrated that the teachers had been exposed to the RAMP training on the use of problem solving , the overriding impression was that the teachers had assimilated the RAMP problem-solving routines into their existing mental model of what it means to teach problem solving in a mathematics classroom.

# How is problem solving being implemented

- Each of the six lessons followed a similar script.
  - First, the teacher told the students that they would be solving problems.
  - Next, the teacher reminded the students of the four (or five) steps that are used to solve a problem.
  - Then, the teacher presented a problem and modeled applying the four steps to solve the problem (with or without the involvement of the class).
  - Finally, the teacher reviewed the steps just done.

## How is problem solving being implemented

- In four of the six lessons observed the teacher also used the gradual release of responsibility model (“I do, We do, You do”) to structure the lesson.
  - Although this model is not mentioned in the RAMP mathematics materials, it does form an integral part of the RAMP approach to developing foundational skills for reading

# How is problem solving being implemented

## Problem solving:

1. Understand the problem;
2. Make a plan;
3. Execute the plan; and
4. Verify the answer

## Classroom management:

- “I do”
- “You do”
- “We do”

## How is problem solving being implemented

- In observing the lessons, it became clear that “making a plan” constituted translating the problem into a mathematical expression and doing the associated arithmetic to solve the mathematical expression.
- In almost all of the classes, the teacher wrote the problem on the board (or provided it in a worksheet) and either used a different color to highlight the numbers in the problem or circled the numbers in the problem.



## How is problem solving being implemented

A grade 3 teacher wrote a problem on the board (with the two numbers circled in red) and said:

*“Let us see who the smartest child in this class is. In this problem, item one costs JOD60 and item two costs JOD35. How many more JOD does item one cost?”*

After discussing the problem briefly she went on:

*“Now we need to make a plan. What operation should we use: plus, minus, divide, or multiply? In this case we will use minus. How do we know that should use minus? We know this because of the words ‘How many more.’”*

# How is problem solving being implemented

A grade 2 teacher started her lesson by saying:

*“Today we will be doing subtraction problems. Rula has 24 sweets, She give her friend 13 of the sweets. How many sweets does she have left over?”*

- The focus of the teacher lesson was on translating the “problem” into the equation:  $24 - 13 = \underline{\quad}$ .
- **The lesson was not about sense making**—the teacher told the class that the problems were subtraction problems.
- **The lesson was also not about making a plan and developing computational strategies**
  - The number range of the problem was such that grade 2 students would simply know that  $24 - 13 = 11$ .

## How is problem solving being implemented

- After the grade 2 teacher modeled the implementation of the problem-solving steps to solve the Rula problem, she handed out three different worksheets, each with a similar problem on it.
- The teacher differentiated the problems according to the strengths of the students
  - Group one was given a problem with the structure:  $45 - 20 = \underline{\quad}$ ;
  - Group two was given a problem with the structure:  $89 - 56 = \underline{\quad}$ ; &
  - Group three was given a problem with the structure:  $135 - 70 = \underline{\quad}$
  - While providing different students with problems according to their developmental needs is an encouraging manifestation of the RAMP approach, it is striking that none of the problems involved bridging, suggesting again that the focus was not on the arithmetic as such, but rather on the implementation of the problem-solving steps.

## How is problem solving being implemented

An incident in another grade two lesson highlights the focus on translating each problem into a mathematical expression and solving it, as opposed to applying a sense-making approach.

The teacher posed a problem from the RAMP teacher guide:

“How many 5kg bags can be filled from a 45kg bag of sand?”

This is a grouping problem. The purpose of grouping problems is support students' awareness of division as repeated addition or repeated subtraction.

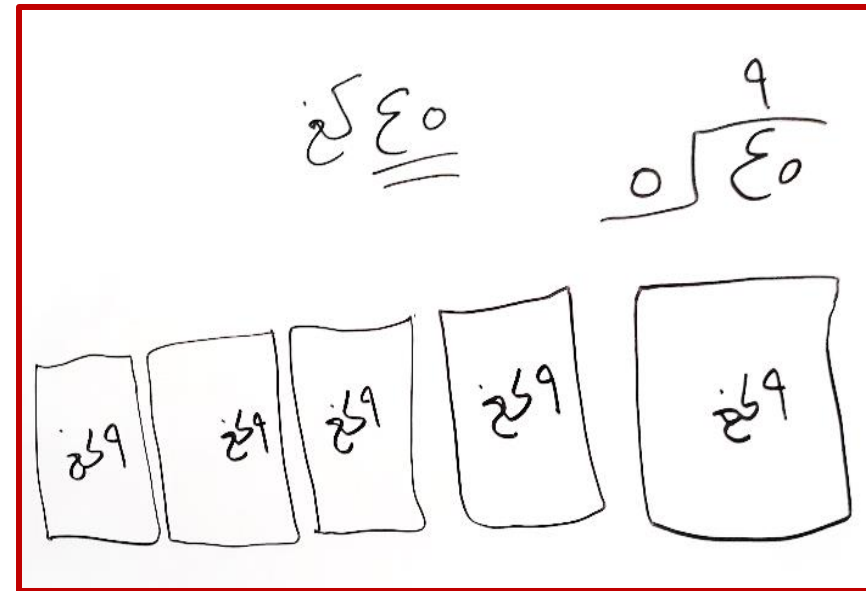
## How is problem solving being implemented

The teacher's solution demonstrates that she did not take the context seriously.

She wrote the expression

$$45 \div 5 = [\underline{\quad}]$$

on the board, did the calculation, and illustrated the answer by drawing five bags and writing "9kg" on each bag.



The drawing does not represent the situation, even if  $45 \div 5 = [\underline{\quad}]$  is an appropriate number sentence.

# How is problem solving being implemented

- The observed lessons suggest that most of the teachers had:
  - Assimilated some of the RAMP methodology into their existing practices—e.g., using problems even if the focus was on the use of the four problem-solving steps in the problem-solving routine;
  - Recognized the value of the RAMP philosophy, even if the implementation fell short of the vision—e.g., they had recognized the possibility of a range of problem-solving approaches, even if they taught these rather than looking out for them in the work of the children;
  - Provided differentiated support to the children in their class; and
  - Tried to give students greater responsibility for their learning, even if it was through the misplaced implementation of the gradual release of responsibility model (the “I do, We do, You do” model).

# How is problem solving being implemented

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How is problem solving being implemented

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What about the students?

## How is problem solving being implemented

In Zarqa the researcher was interviewing a grade 1 student. The interviewer gave the child a bunch of counters and told the child that he could use these to help him solve the problem if he wanted to, but that he did not have to. The researcher asked the child:

*“If 3 friends share 18 candies equally, can you work out for me how many candies each of the friends will get?”*

The child did not touch the counters, nor did the child write anything on the paper provided. Instead, the child sat still for a very long time.

How is problem solving being implemented

After a while the researcher asked the child:

*“What are you thinking?”*

and the child responded:

*“I don’t know how to work out the answer using mathematics!”*

## How is problem solving being implemented

It is interesting that at no point in the interaction between the researcher and the child did the researcher suggest that this was a mathematical task or say that the interview was about mathematics. The researcher had only asked the child to help him solve a few problems. That said, it is probably fair to assume that the child's teacher may have told him that the researcher was interested in mathematics.

## How is problem solving being implemented

The researcher went on to encourage the child not to think about the problem as a mathematics problem but rather as a normal day-to-day problem that needed to be solved. The researcher counted out 6 counters and said to the child:

*“If you and I shared these counters, can you show me how many each of us would get?”*

The child reached for the counters, gave two to the researcher and took two for himself. He then gave the researcher another counter, took one more for himself, and said:

*“We will each get three.”*

## How is problem solving being implemented

The researcher then asked:

*“Could you use the same approach to determine how many candies each of the 3 friends will get when they share 18 candies equally among them?”*

This time the child counted out 18 counters and he put 4 counters in each of three piles and then looked at the counters remaining and put another 2 counters on each pile. He said:

*“Each friend will get 6 candies.”*

# How is problem solving being implemented

So what did the boy mean when he said:

*“I don’t know how to work out the answer using mathematics!”*

## How is problem solving being implemented

Based on the classroom observations, our conjecture is that the child was at first trying to follow the “problem-solving stages” in his head and, in particular, when “making a plan” the child was trying to choose a mathematical operation that would give him the answer (which he probably has some sense of).

Being in grade 1, the only mathematical operations available to the child were addition and subtraction. Neither  $18 - 3 = 15$  nor  $18 + 3 = 21$  seemed reasonable solutions to the child, so, at a loss of what mathematical operation to choose he said:

*“I don’t know how to work out the answer using mathematics!”*



How is problem solving being implemented

*“I don’t know how to work out the answer using mathematics!”*

*“do(ing) this using mathematics”*

meant choosing a mathematical operation as opposed to making sense of the situation which we know that he can do.

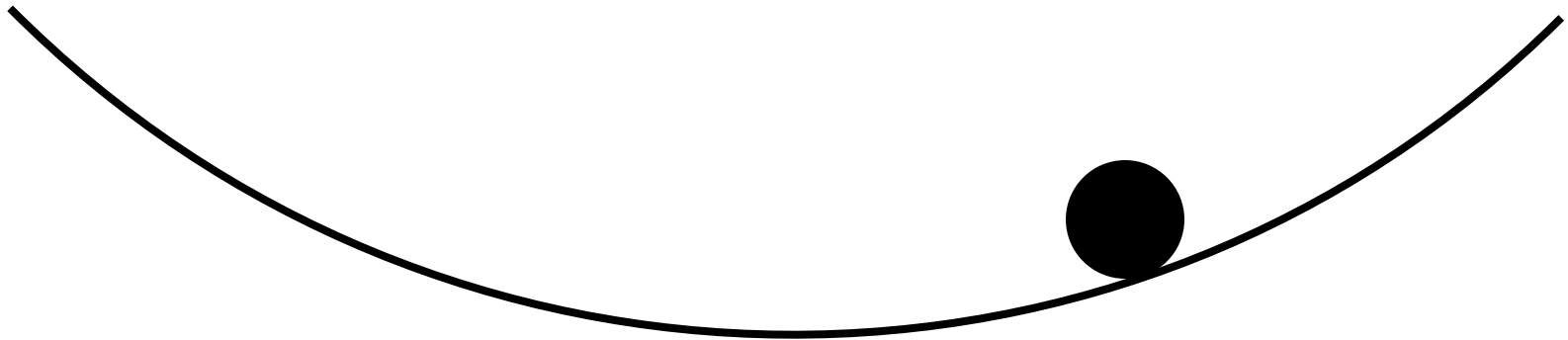
# The role of mathematical problem solving

## From mathematics as:

The memorisation of facts, rules, formulas and procedures needed to determine the answers to questions.

## To mathematics as:

A meaningful, sense-making, problem solving activity.



## Assessment task: problem solving

The focus of the word problems subtask is on assessing the students' abilities to make a plan and solve a problem, the numerical values involved in the problem are deliberately small (single-digit arithmetic).

The reason the numerical values are small is to allow for the targeted skills to be assessed without confounding problems with calculation skills that might otherwise impede performance.

There are two (2) children in a vehicle.  
Three (3) more children get into the vehicle.  
How many children are there in the vehicle?

**Change  
result unknown**

A mother has eight (8) children, and she has three (3) oranges. How many more oranges does mother need so that each child gets one (1) orange?

**Compare  
part unknown**

There are six (6) children in the classroom.  
Two (2) of the children are boys. The rest are girls. How many girls are there?

**Combine  
part unknown**

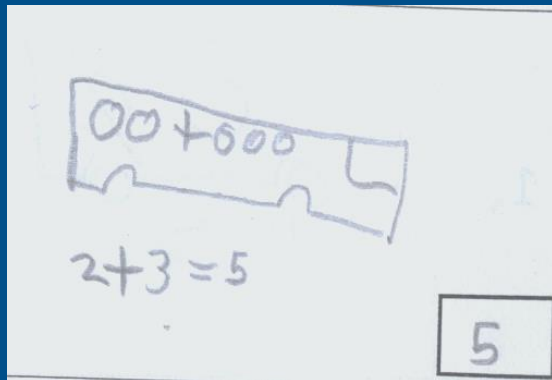
There are some mangoes in the basket.  
Five (5) mangoes are added to the basket.  
Now there are nine (9) mangoes in the basket. How many mangoes were there in the basket to begin with?

**Change  
start unknown**

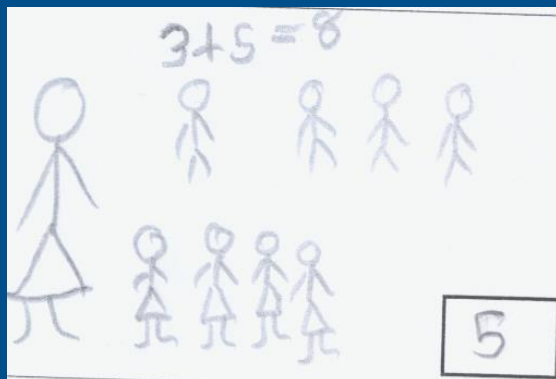
## Assessment task: problem solving

- For each child's responses:
  - Try to understand and explain what the child is doing, and
  - Discuss, what the child's response tells us about how they experience mathematics

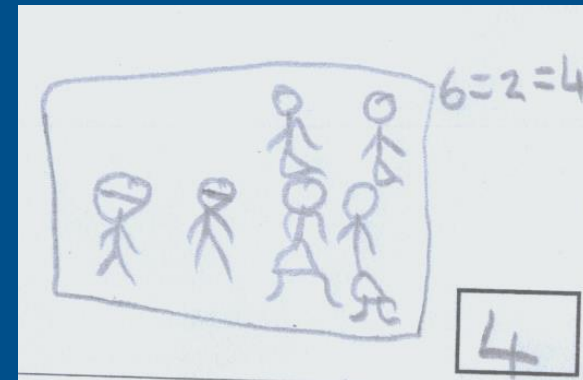
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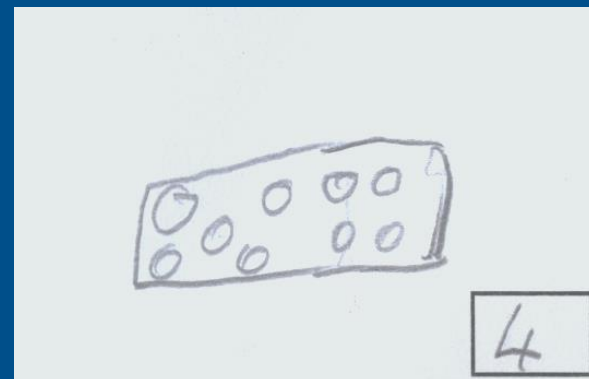
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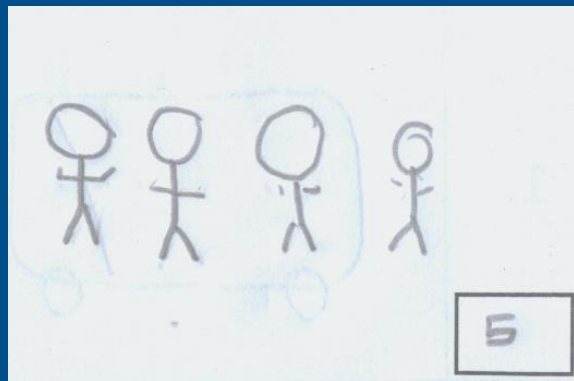


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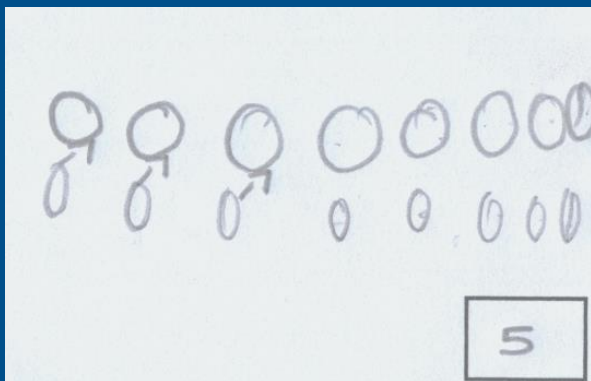


Alutha (Grade 1)

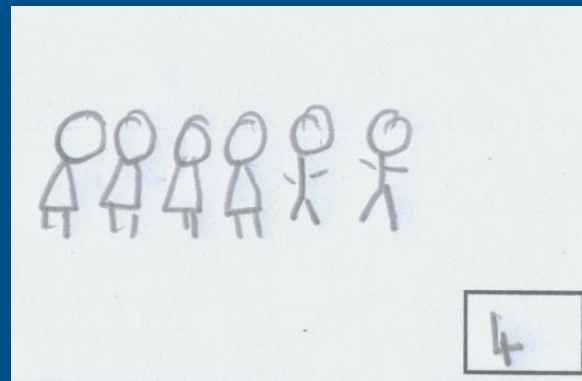
There are two (2) children in a vehicle.  
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How many children are there in the vehicle?



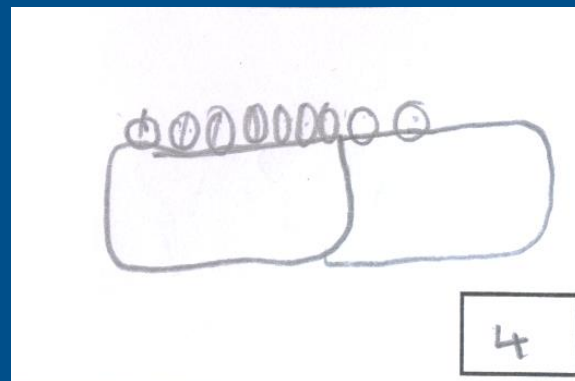
A mother has eight (8) children, and she has three (3) oranges. How many more oranges does mother need so that each child gets one (1) orange?



There are six (6) children in the classroom.  
Two (2) of the children are boys. The rest are girls.  
How many girls are there?




There are some mangoes in the basket.  
Five (5) mangoes are added to the basket.  
Now there are nine (9) mangoes in the basket.  
How many mangoes were there in the basket to begin with?




Tyrone (Grade 1)

There are two (2) children in a vehicle.  
Three (3) more children get into the vehicle.  
How many children are there in the vehicle?

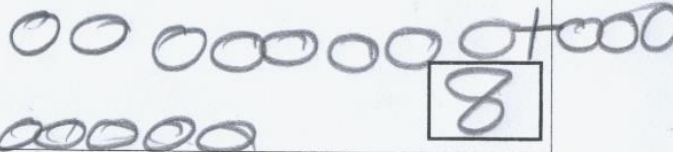
$$2 + 3 = 5$$


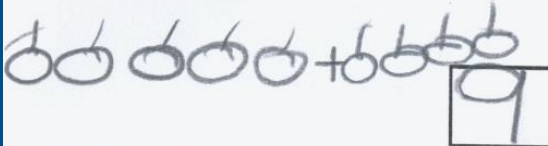
There are six (6) children in the classroom.  
Two (2) of the children are boys. The rest are girls. How many girls are there?

$$6 + 2 = 8$$


A mother has eight (8) children, and she has three (3) oranges. How many more oranges does mother need so that each child gets one (1) orange?

There are some mangoes in the basket.  
Five (5) mangoes are added to the basket.  
Now there are nine (9) mangoes in the basket. How many mangoes were there in the basket to begin with?

$$3 + 5 = 8$$


$$5 + 4 = 9$$


Mitchell (Grade 3)



There are two (2) children in a vehicle.  
Three (3) more children get into the vehicle.  
How many children are there in the vehicle?

$$\begin{array}{l} 2+3=5 \\ 3+2=5 \end{array}$$

5

There are six (6) children in the classroom.  
Two (2) of the children are boys. The rest  
are girls. How many girls are there?

$$\begin{array}{l} 6+2=8 \\ 2+6=8 \\ 6+2=8 \end{array}$$

8

A mother has eight (8) children, and she has  
three (3) oranges. How many more oranges  
does mother need so that each child gets  
one (1) orange?

$$\begin{array}{l} 8+2=10 \\ 2+8=10 \end{array}$$

10

There are some mangoes in the basket.  
Five (5) mangoes are added to the basket.  
Now there are nine (9) mangoes in the  
basket. How many mangoes were there in  
the basket to begin with?

$$\begin{array}{l} 5+9=14 \\ 9+5=14 \end{array}$$

14

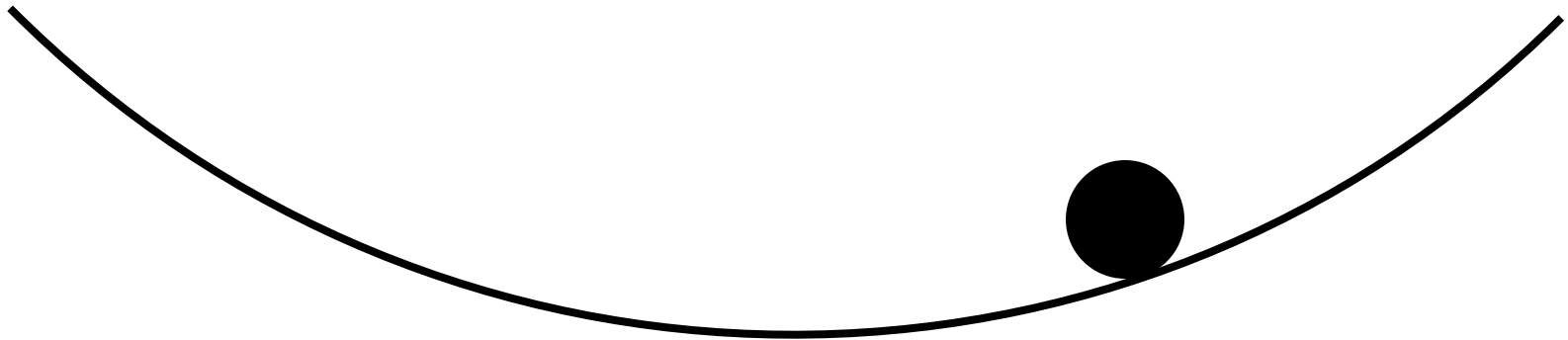
# The role of mathematical problem solving

## From mathematics as:

The memorisation of facts, rules, formulas and procedures needed to determine the answers to questions.

## To mathematics as:

A meaningful, sense-making, problem solving activity.





How can the ministry support teachers to implement the RAMP problem solving methodologies more successfully?

Zainab Al-Shawabkeh

Director: Education Management, Ministry of Education,  
Jordan

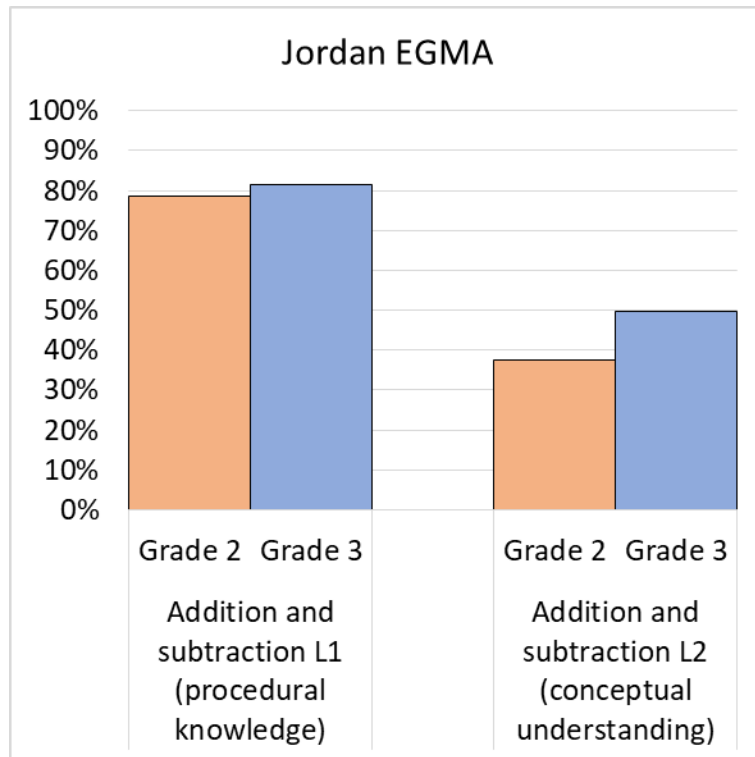


## The role of the ministry in supporting teachers

- In both 2012 and 2014 the Ministry of Education conducted a national Early Grade Mathematics Assessment (EGMA)
- The EGMA, which was administered orally, consisted of six subtasks:
  - Number identification,
  - Quantity discrimination,
  - Missing number (number patterns),
  - Addition and subtraction (L1),
  - Addition and subtraction (L2), and
  - Word problems.

# The role of the ministry in supporting teachers

Although students answered the more procedural addition and subtraction L1 items with confidence, performance dropped significantly on the more conceptual addition and subtraction L2 items.



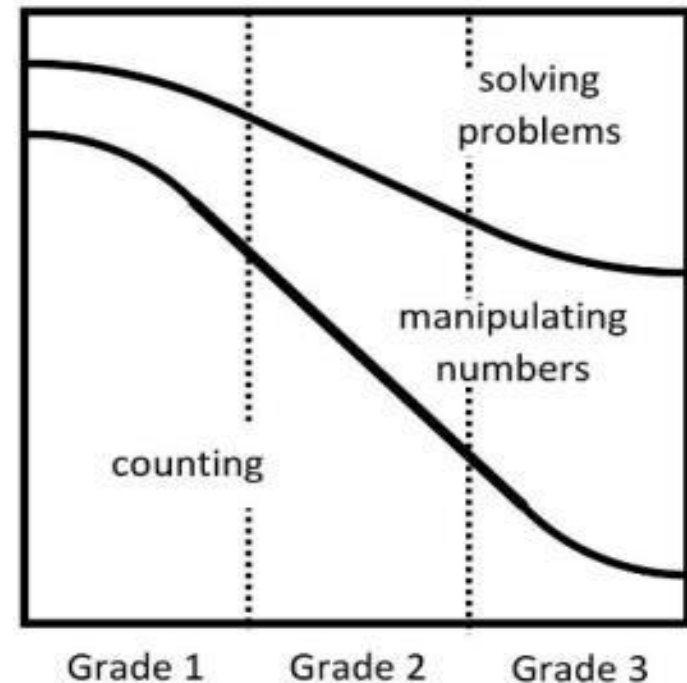
$\square = 3 - 19$	$\square = 3 + 16$
$\square = 7 - 20$	$\square = 7 + 18$
$\square = 12 - 36$	$\square = 12 + 24$
$\square = 37 - 09$	$\square = 37 + 22$
$\square = 26 - 64$	$\square = 26 + 38$

## The role of the ministry in supporting teachers

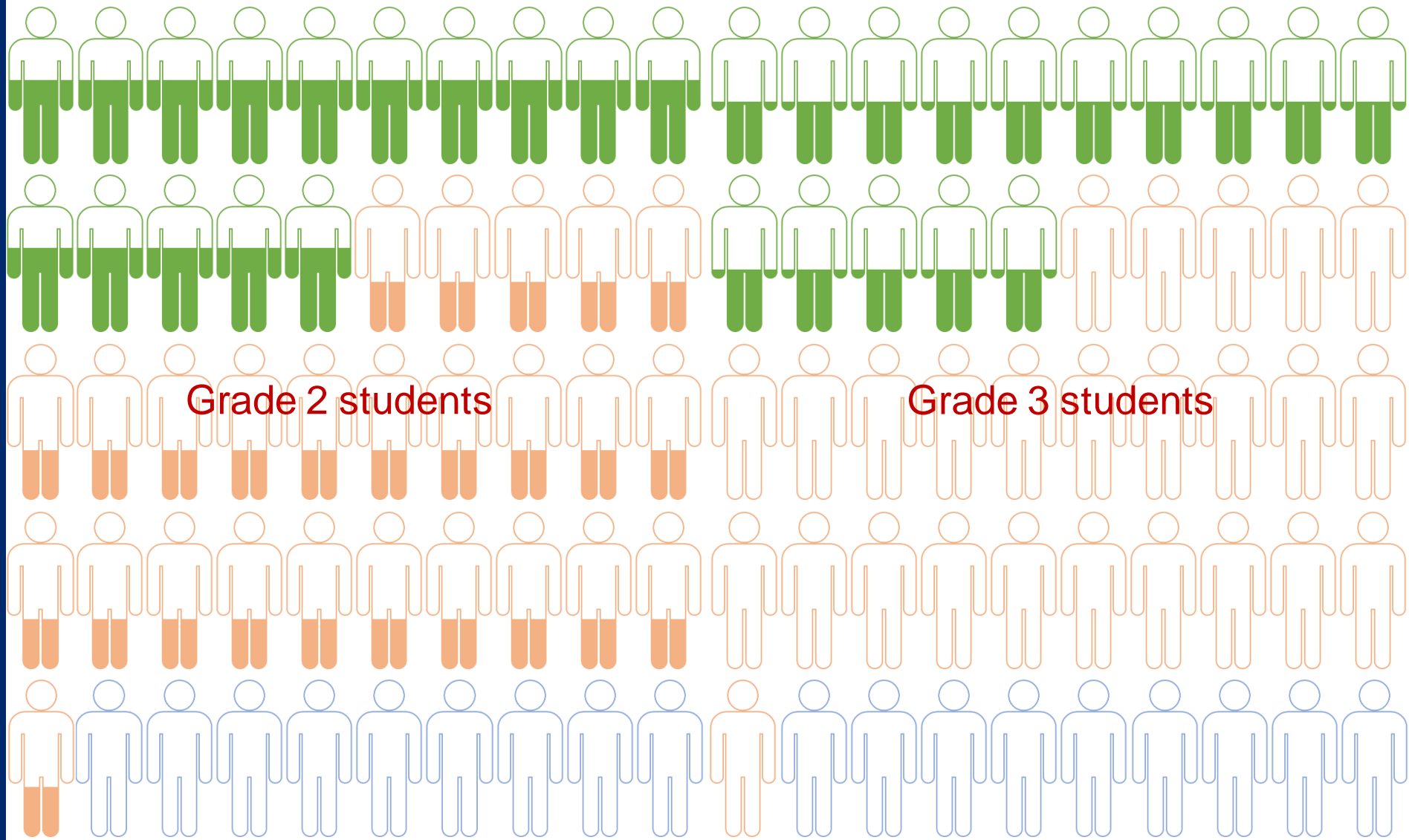
- These results suggested that memorization plays a large role in the way that children know and learn mathematics.
- This suggestion was supported by the clear trend in the results showing that students were doing well on the items that rely on procedural knowledge—knowledge that can also be memorized—and doing markedly less well on the tasks and items that require both the understanding and the application of what should be procedural (rather than memorized) knowledge

# The role of the ministry in supporting teachers

- The mathematics component of the RAMP initiative, which is a response to the findings of the 2012 and 2014 studies, aims to support students to develop a deeper conceptual understanding of mathematics and to experience mathematics as a meaningful, sense-making, problem solving activity.
- The RAMP mathematics activities focus on:
  - Counting,
  - Manipulating numbers, and
  - Solving problems



# The role of the ministry in supporting teachers





# The role of the ministry in supporting teachers



At the time of the 2017 midline survey:

- 79% of the Grade 2 students in the midline survey have been exposed to RAMP methodologies for between 2 and 3 semesters
- 27% of the Grade 3 students in the midline survey have been exposed to RAMP methodologies for at most 3 semesters

# The role of the ministry in supporting teachers

- The results of the RAMP midline survey conducted in May 2017 show that there is a statistically significant improvement on both the procedural skills and on the more conceptual skills.
- On the more conceptual mathematics tasks the 2017 Grade 2 students are approaching the performance levels of the 2014 Grade 3 students.

Subtask	Measure	Grade 2		Grade 3	
		2014	2017	2014	2017
Addition and Subtraction L1	% correct	82.6%	85.0%	85.5%	87.0%
Addition and Subtraction L2	% correct	36.8%	42.5%	47.5%	51.2%
Missing Number	% correct	54.3%	60.2%	66.9%	68.9%

## The role of the ministry in supporting teachers

- The improvement in the performance on the mathematics tasks is not as striking as it is for the reading skills component of RAMP measured using the Early Grade Mathematics Assessment (EGRA).
- The classroom observation research activity already reported on in this panel has also shown that the problem solving component of the mathematics program is not being implemented as envisioned and is instead being assimilated into teachers' existing mental models of what it means to do mathematics, a model that is focused on memorization and performing procedures without understanding.

## The role of the ministry in supporting teachers

These research results raise important questions for the MoE:

Why have teachers adopted and implemented the reading component of the RAMP initiative more successfully than the mathematics component?

And, more significantly:

How can the MoE support teachers to implement the RAMP approach to mathematics with greater fidelity?

# The role of the ministry in supporting teachers

- An initial response of the MoE has been to:
  - Develop a number of videos that demonstrate teachers implementing the problem solving routines as envisioned. These videos are being used in both initial and refresher in-service teacher training.
  - Provide additional training for MoE Supervisors on the philosophy of the RAMP mathematics approach and on supporting teachers to implement this effectively.

# The role of the ministry in supporting teachers



أقرأ الكتاب وأفهم الحساب

مبادرة القراءة والحساب للصفوف المبكرة  
Early Grade Reading and Mathematics Initiative



USAID  
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INTERNATIONAL



# The role of the ministry in supporting teachers

The deep challenge, for the MoE, remains:

How to support teachers (and supervisors) to modify their understanding of what it means to do mathematics.

The solution may lie in supporting teachers to research the efficacy of different proposed solutions as opposed to being implementers of a ready-made solution.

That is, re-mapping the role of the teacher in education.



I don't know how to do that using mathematics.

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