SCIENCE OF TEACHING

MATH COMMUNITY OF PRACTICE WEBINAR

#4:

EXAMINING ALIGNMENT BETWEEN MATHEMATICS CURRICULUM, INSTRUCTIONAL MATERIALS, AND ASSESSMENT

June 26, 2025

WELCOME!

AGENDA

- INTRO TO SoT Math CoP
- MEET THE PRESENTERS
- PRESENTATIONS
- Q&A
- BREAKOUT GROUPS
- REGROUP & GALLERY WALK
- CLOSING REMARKS

INTRO: SCIENCE OF TEACHING & THE MATH COP

- Science of Teaching focuses on compiling, generating, and sharing evidence for FLN instruction
- The math COP was formed to promote:
  - resource sharing, networkingm and discussion
  - Foster opportunities for collaboration
  - Garner sustainability and growth of the community beyond the end of SoT

MEET THE PRESENTERS

Researcher, Chair of History of Education and Education Policy Analysis at the University of Zurich

Technical Director Education and Associates Educational Consulting Ltd

Teaching and Learning Advisor at University of the Witwatersrand's Faculty of Humanities

PRESENTATIONS

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Assessing Education Systems Alignment

Primary Education - Mathematics

Patrick Montjouridès

Universität Zürich[UZH]

Policy questions – system alignment

Overarching questions

What is the degree of alignment between the four main pedagogical inputs of an education system (intended curriculum, textbooks, teacher guides and learning assessment)?

To which extent do national education systems embed competencies needed to meet minimum global proficiency standards in foundational numeracy?

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Background - Mapping policy alignment

- **Qualitative** analysis (interview-based) of curriculum in Sudan (WB, 2021)
- RISE **Quantitative** measurement of alignment Uganda and Tanzania (Atuhurra and Kaffenberger, 2020)
- **Mixed** methods approaches: alignment of teaching and learning materials (G1) in South Africa (Evans and Sorto, 2022), India's early years mathematics curriculum (University of Leeds et al., 2022)

- Issue of cross-national comparability
- Reference set of skills needs to be constructed
- Time consuming

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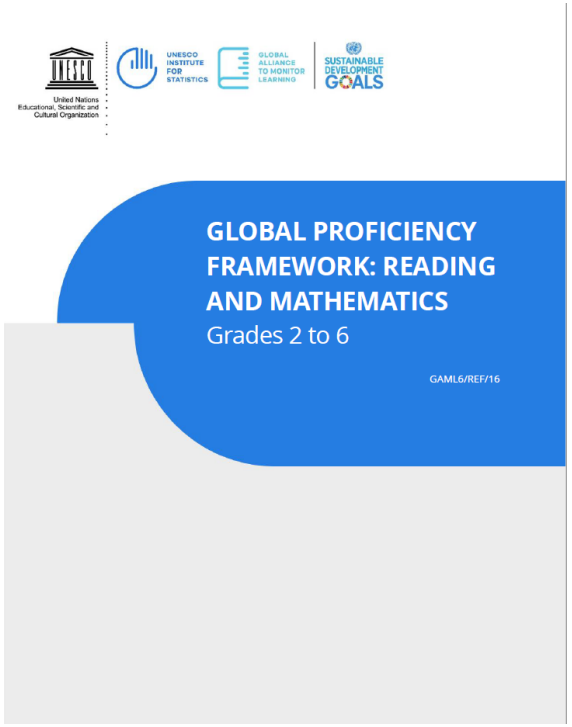
Policy alignment

Policy alignment's three components:

- ***Content alignment*** between all the pedagogical resources that determine pupils' learning experience
- ***Pedagogical and cognitive alignment*** between the curriculum and its application in the classroom, throughout pupils' learning experience
- ***Political alignment*** between a country's regional and international commitment, such as improving the proportion of pupils who meet minimum proficiency levels, and its national policy

Global Proficiency Framework

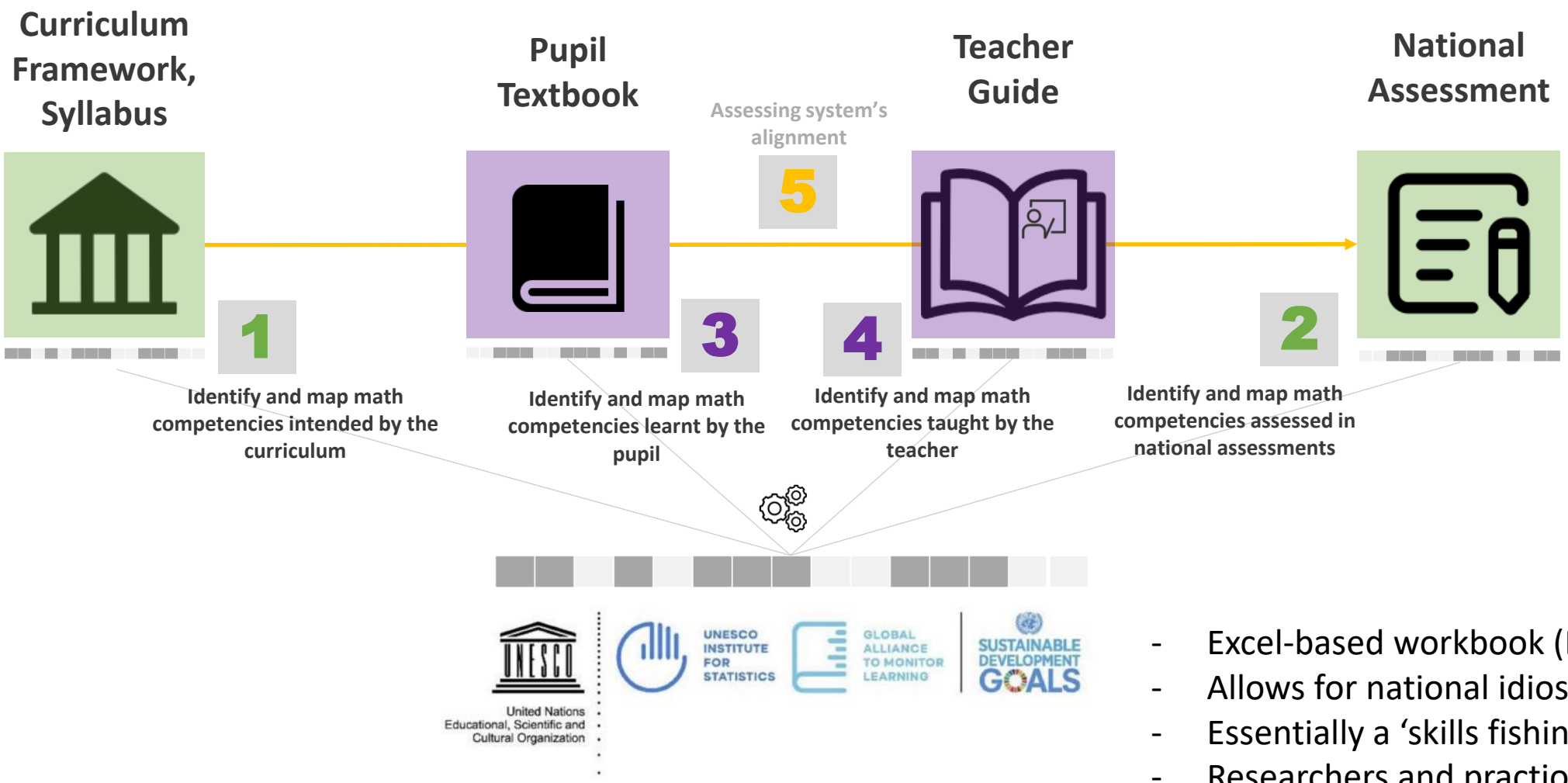


GPF: Global public good designed by mathematics educators, curriculum specialists, and psychometricians to outline a research-based progression of the minimum knowledge and skills learners should be able to demonstrate, through the basic education cycle, with respect to the key domains of mathematics.

Global Content Framework of Reference for Mathematics used as the common competencies reference list:

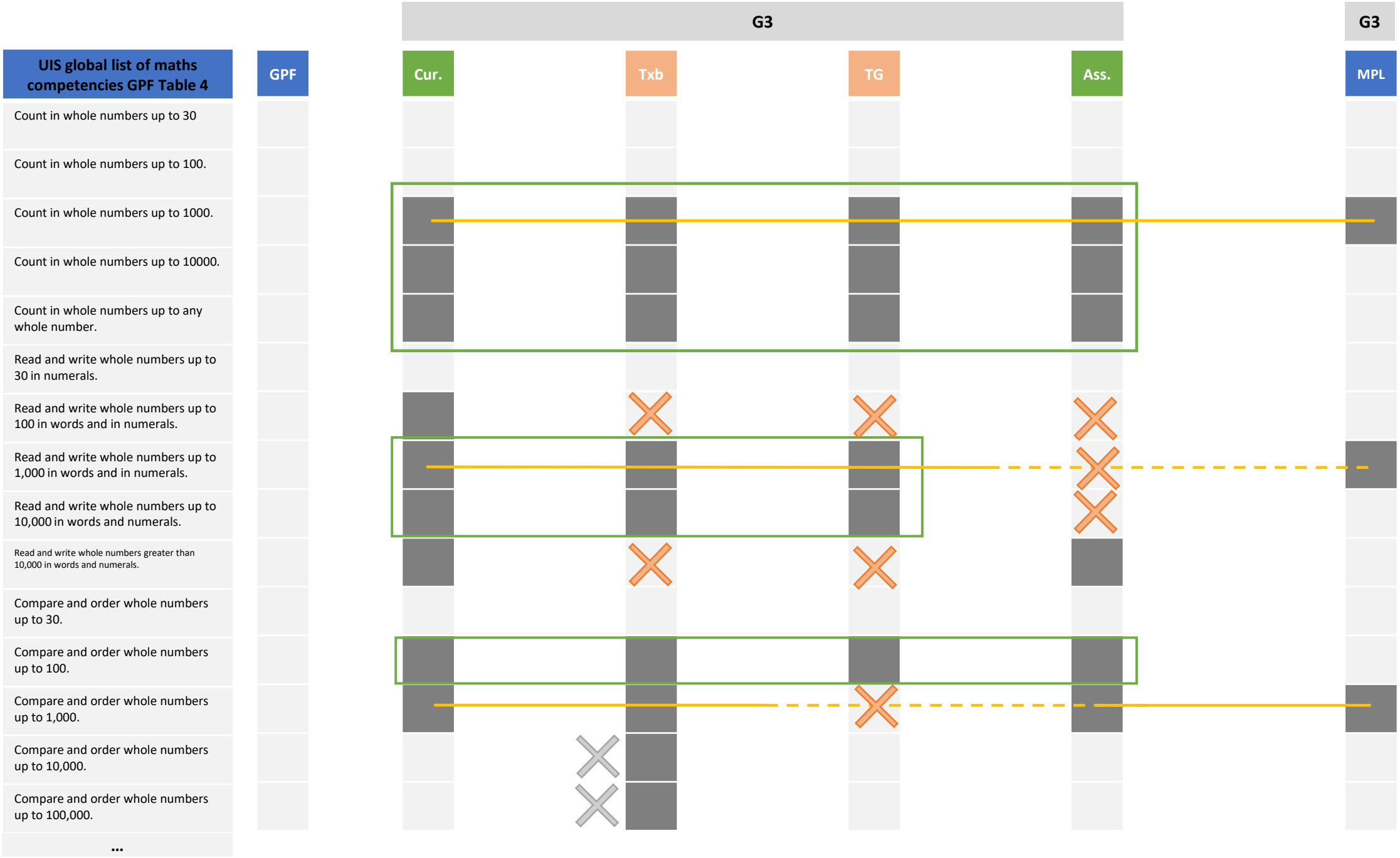
- Removes the need for initial (often long) meetings to agree upon a list of learning domains and competencies
- Fosters peer-learning and policy dialogue by proposing an agreed upon list of learning domains and competencies for foundational learning.

GPF-referenced mapping tool



Global Proficiency Framework for Mathematics

- Excel-based workbook (EN/FR)
- Allows for national idiosyncrasies
- Essentially a 'skills fishing' exercise
- Researchers and practioners can be trained easily and rapidly
- Automated data visualizations


G3
G3
UIS global list of maths competencies GPF Table 4
GPF
Cur.
Txb
TG
Ass.
MPL
Count in whole numbers up to 30
Count in whole numbers up to 100.
Count in whole numbers up to 1000.
Count in whole numbers up to 10000.
Count in whole numbers up to any whole number.
Read and write whole numbers up to 30 in numerals.
Read and write whole numbers up to 100 in words and in numerals.
Read and write whole numbers up to 1,000 in words and in numerals.
Read and write whole numbers up to 10,000 in words and numerals.
Read and write whole numbers greater than 10,000 in words and numerals.
Compare and order whole numbers up to 30.
Compare and order whole numbers up to 100.
Compare and order whole numbers up to 1,000.
Compare and order whole numbers up to 10,000.
Compare and order whole numbers up to 100,000.
...

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Outputs examples

- *Which domains, constructs, subconstructs, and competencies are included in the country's curriculum/textbooks/teacher guides/national assessment for a given grade?*

- *To which extent do teaching and learning materials and learning assessments align with the intended curriculum?*

- *How do teaching and learning materials reflect pedagogical guidance expressed in curriculum document?*

- *How does the national curriculum compare with the GPF's minimum proficiency requirements at a given grade?*

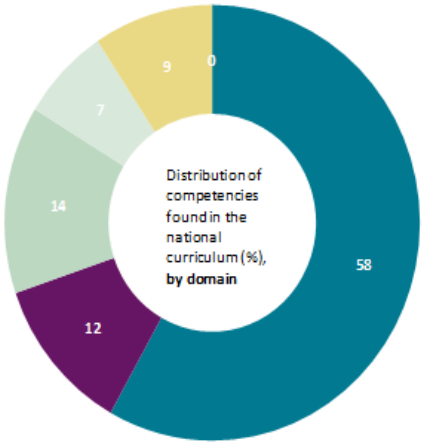
- *Do pupils in the country learn foundational skills earlier or latter in comparison to the global sequence depicted in the GPF?*

Outputs examples

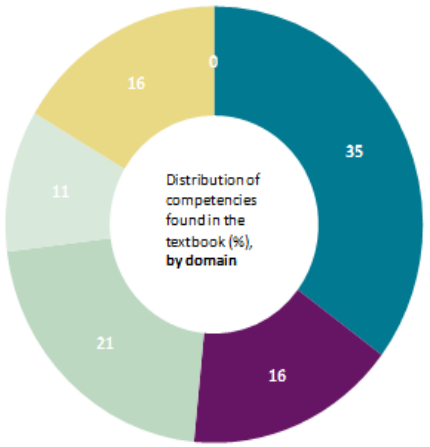
Distribution of curriculum, textbooks and national assessments competencies, by domain

Uganda
Grade 7

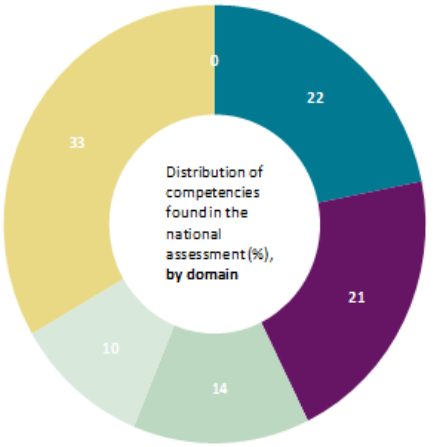
Which mathematics competencies are intended



Which mathematics competencies are enacted



Which mathematics competencies are assessed



- N. Numbers and Number Operations
- M. Measurement
- G. Geometry
- S. Statistics and probability
- A. Algebra
- O. Other

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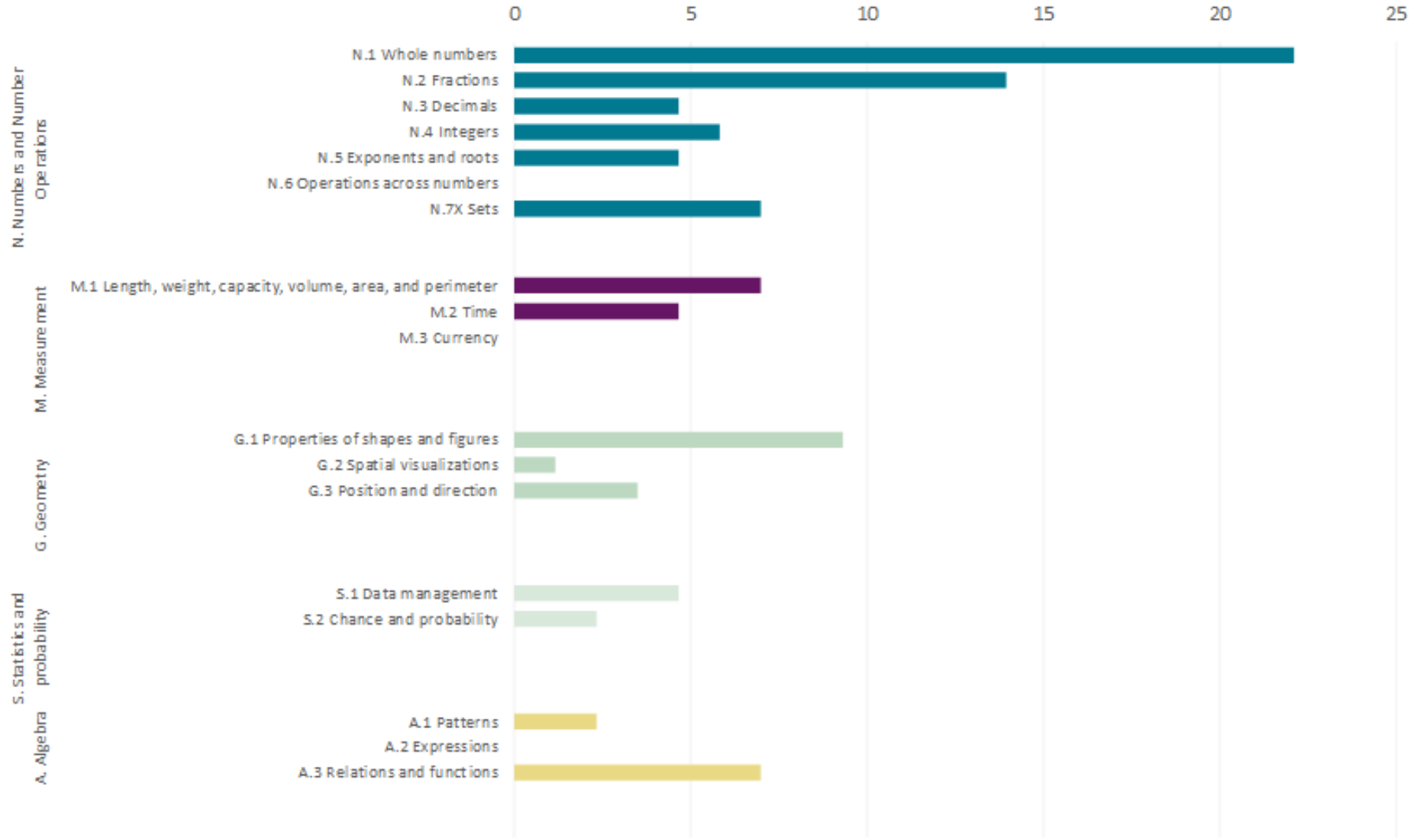
Outputs examples

Distribution of curriculum competencies, by domain and construct

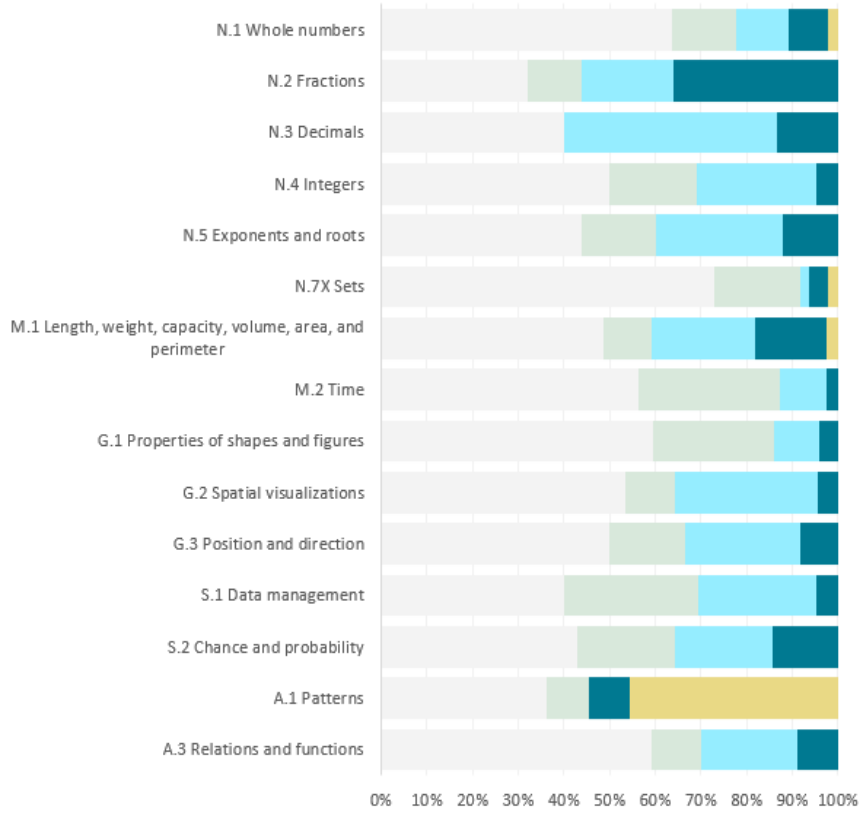


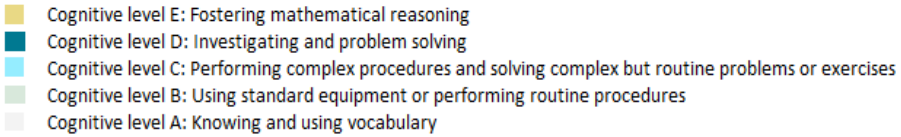
Outputs examples

Distribution of textbook blocks by type and cognitive demand, by construct

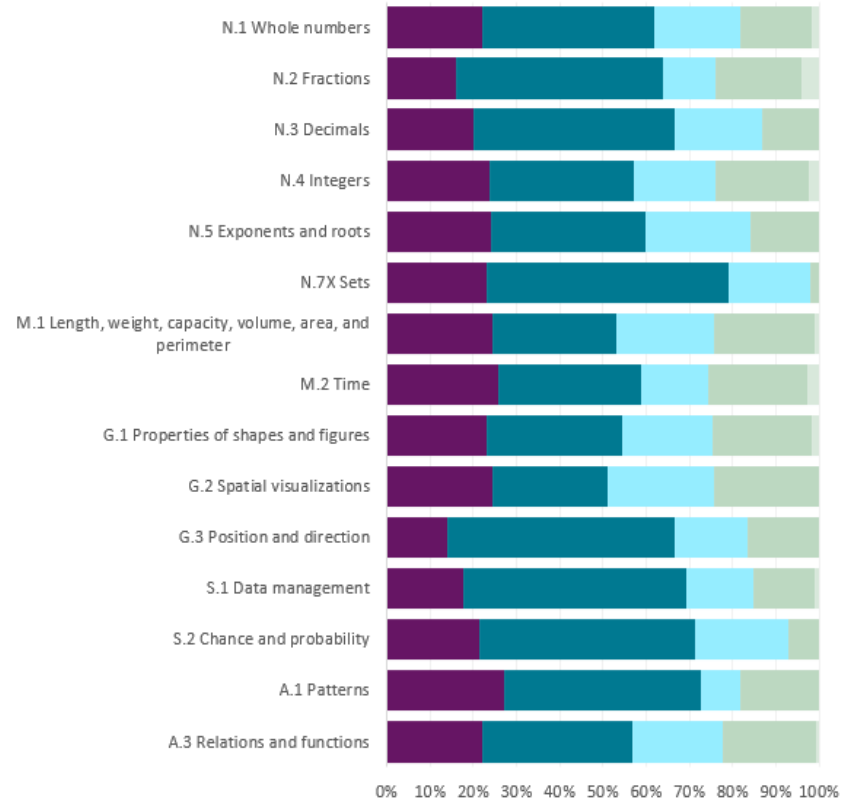
Grade 7 Textbook

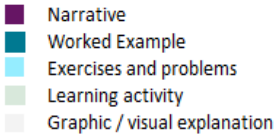
Distribution of textbook blocks according to cognitive demand, by construct





Distribution of blocks by type, by construct





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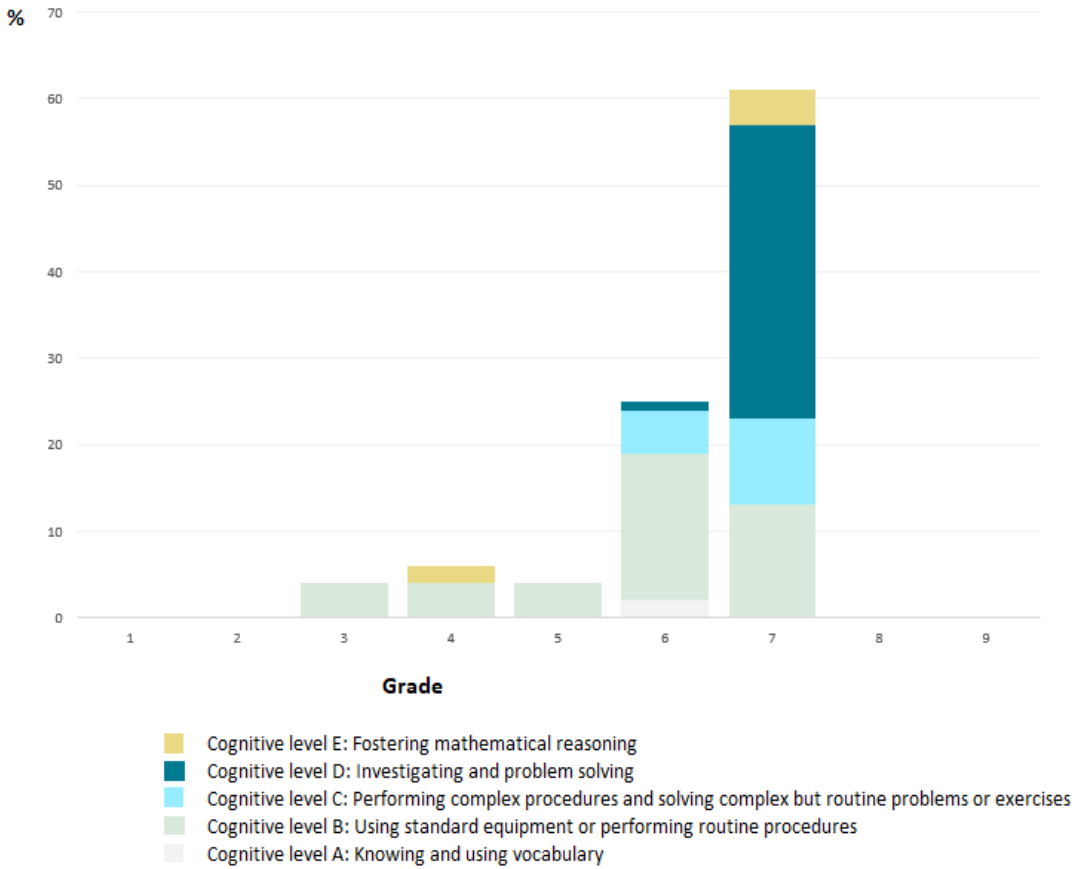
Outputs examples

Assessment items by cognitive demand, by grade

Grade 7 National learning assessment

Distribution of assessment items according to cognitive demand and theoretical grade in the national curriculum



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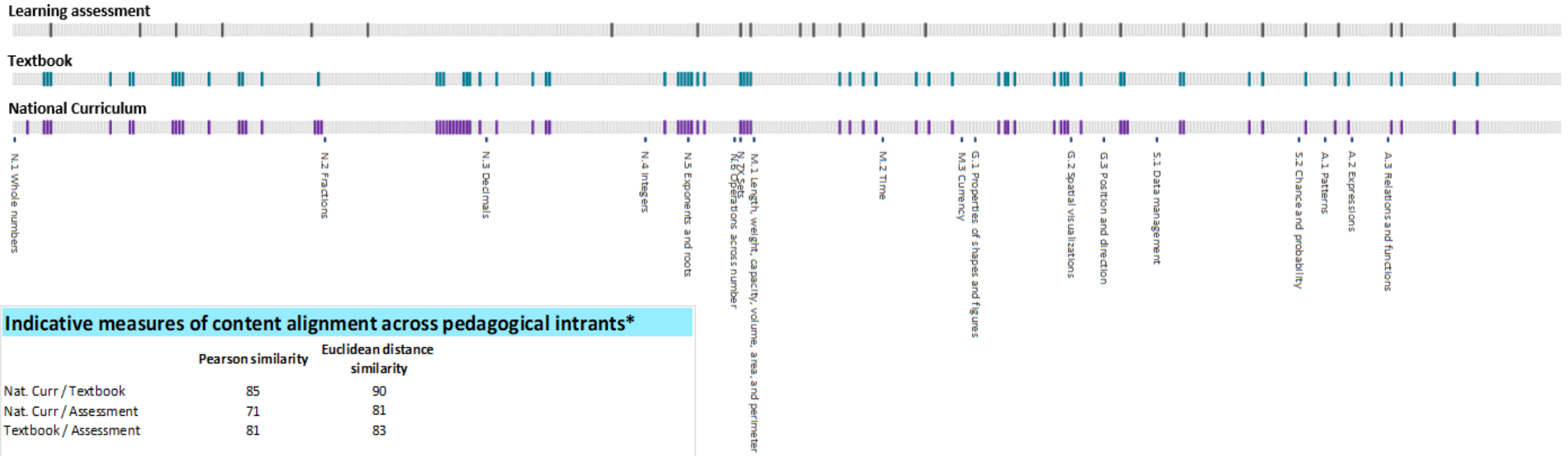
Outputs examples

Content alignment at the competency level (National): Curriculum vs Textbook vs Learning Assessment

Overview of content alignement at Grade 7: *Which competencies are accounted for in the curriculum, textbook and national assessment?*



Indicative measures of content alignment across pedagogical intrants*

	Pearson similarity	Euclidean distance similarity
Nat. Curr / Textbook	85	90
Nat. Curr / Assessment	71	81
Textbook / Assessment	81	83

*Note: The Pearson-based similarity score and Euclidean distance similarity score are two common approaches to assess similarity between two vectors. The closer to 0 the lower the similarity in terms of content and the closer to 1 the higher content similarity. In the case of assessment, competencies are weighted by their scores and in the case of textbooks, competencies are weighted by the number of blocks that target the competency

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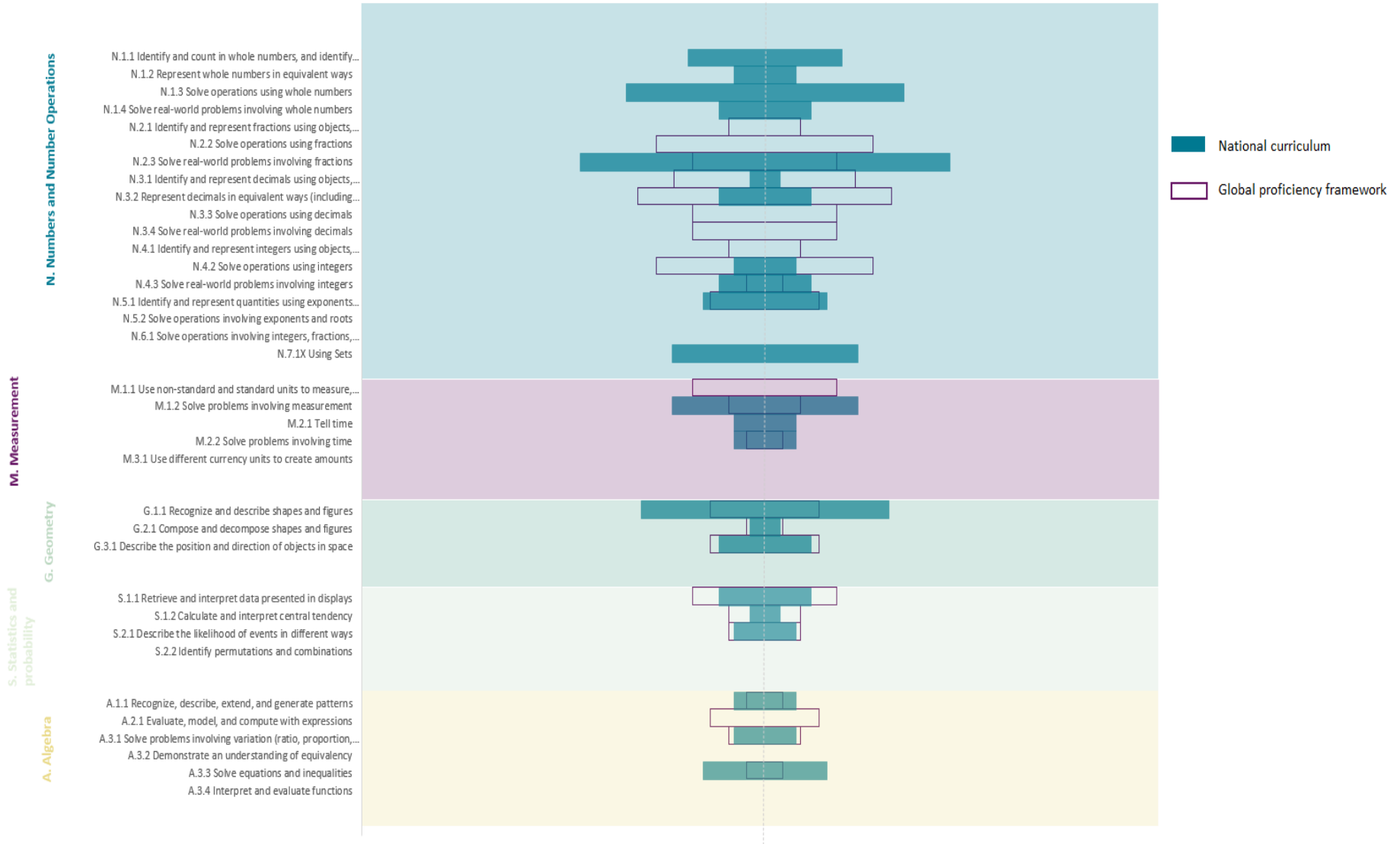
Outputs examples

How does the Uganda Grade 7 curriculum compares to the global proficiency framework?

Distribution of competencies found in the national curriculum and the GPF, **by domain, construct and sub-construct**



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What's next?

- Instruments exist but not used – potential for application is large:
  - Programmatic
  - Curriculum, textbooks and assessment design
  - Targeted teacher training

  …
- Excel workbook still has some glitches and requires optimization
- How to make it a global public good (EGMAT)?
- Move to better technology (e.g., R notebooks embedding AI or ML)?
- Any suggested use case?

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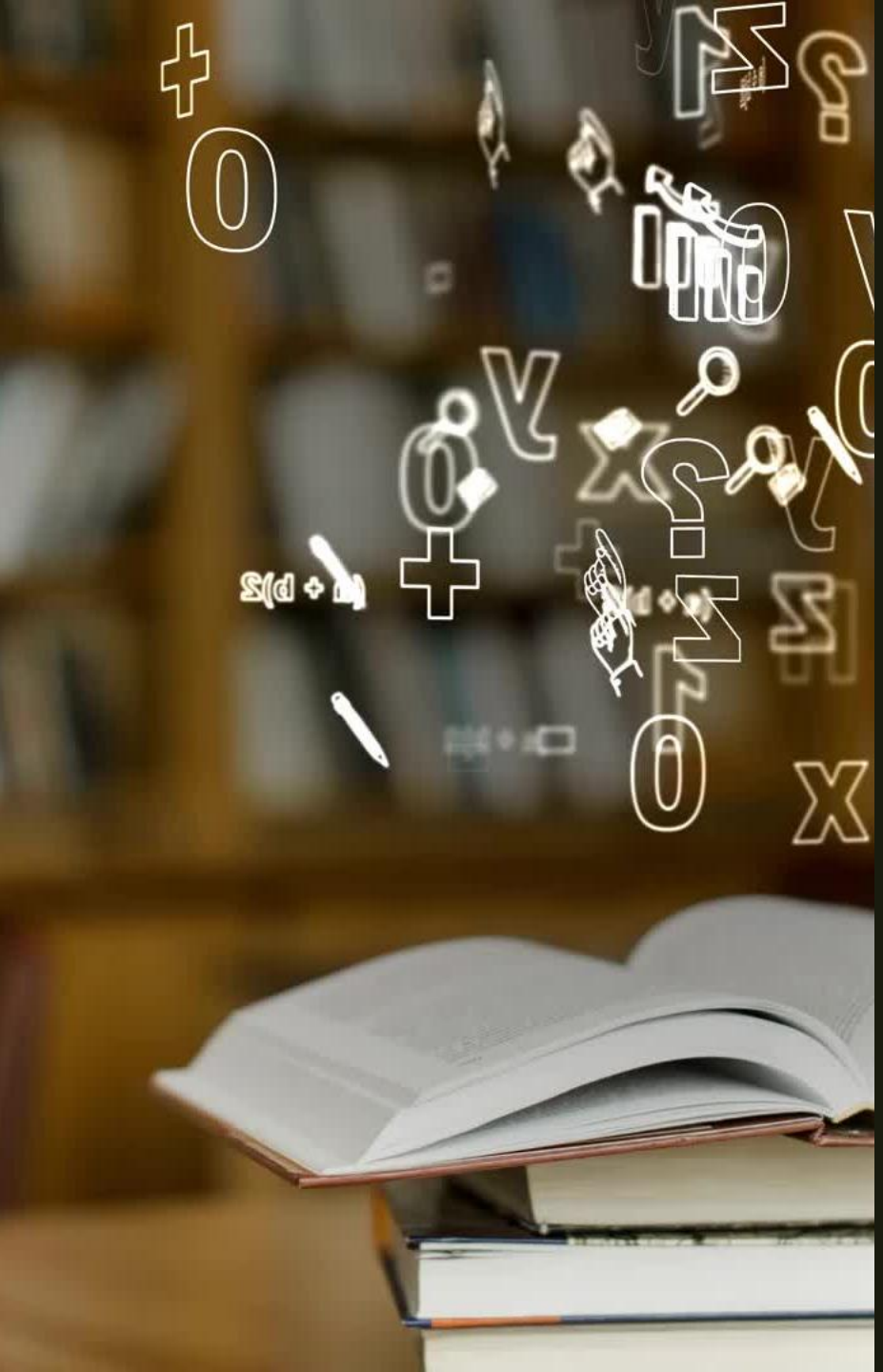
FINDINGS

Cross country study



Elements examined

- Alignment with GPF
- Alignment across pedagogical inputs (curriculum, TG, textbooks, assessments)
- Quality of TGs and textbooks
  - *Nature of TGs*
  - *Nature of learning activities*
  - *Cognitive demand of learning activities*

Alignment with GPF – What is taught

HOW WE MEASURED - Coded curriculum learning outcomes by GPF domain (construct, subconstruct and knowledge/skills)

WHAT WE FOUND

Domains addressed, End of early primary

Domain	Zambia	Uganda	S. Africa	Mauritania	Niger
Number and number operations	yes	yes	yes	yes	yes
Geometry	yes	yes	yes	yes	yes
Measurement	yes	yes	yes	yes	yes
Statistics and probability	yes	yes	yes	no	no
Algebra	yes	yes	yes	no	yes

Countries include constructs and subconstructs not included in GPF (e.g., set theory, logic)

Alignment with GPF – Time allocation

HOW WE MEASURED – Calculated the relative weight of learning outcomes for each domain

Calculation: (Number of learning outcomes for a domain ➗ total number of curriculum learning outcomes for that grade level) x 100

WHAT WE FOUND - Considerable variation between amount of instructional time devoted to some domains.

Weighting by domain, End of early primary

Domain	Zambia	Uganda	S. Africa	Mauritania	Niger
Number and number operations	69%	66%	46%	62%	43%
Measurement	19%	16%	28%	24%	41%
Geometry	4%	5%	13%	14%	14%
Statistics and probability	4%	5%	6%	0%	0%
Algebra	4%	7%	6%	0%	20%

- Niger: 1 out of 5 competencies in early primary (20%) and 1 out of 4 in late primary (25%) focus on algebra, compared with an average of 4% for the other four countries in early primary and 8% in late primary.

Alignment with GPF – Pace of learning

HOW WE MEASURED – Compared grade level when country expects students to demonstrate mastery of knowledge, skill to grade level specified in GPF

Over ambitious: Country expects students to demonstrate given knowledge of skill 2 or more grade levels before that specified in GPF (e.g., grade 3 versus grade 5 in GPF)

Under ambitious: Country expects students to demonstrate knowledge of skill 2 or more grade levels after that specified in GPF (e.g., grade 3 versus grade 5 in GPF)

WHAT WE FOUND

- Generally pace of learning aligned the GPF
- Some competencies where certain countries were overly (or under) ambitious with respect to the GPF
  - *Only a concern if national assessments reveal students are not meeting grade level expectations*

Alignment between curriculum, assessment and instructional materials (Teacher's Guide (TG), textbooks (TB))

HOW WE MEASURED – Coded learning activities in TG and Textbook, and items in assessment, by domain addressed (and construct, subconstruct, knowledge and skill). Then calculated % of all learning activities, assessment items, by domain

WHAT WE FOUND – With exception of SA, high degree of alignment between curriculum, TG and TB. Assessments less well aligned

End of early primary results

Domain	Zambia				Uganda				S. Africa				Mauritania				Niger			
	Cur	Ass	TG	TB	Cur	Ass	TG	TB	Cur	Ass	TG	TB	Cur	Ass	TG	TB	Cur	Ass	TG	TB
Number and number operations	69%	NA	74%	71%	66%	NA	66%	65%	46%	73 %	68%	62 %	62%	81%	57%	61%	43%	98%	37%	38%
Measurement	19%	NA	12%	12%	16%	NA	19%	20%	28%	27 %	13%	17 %	24%	0%	26%	24%	41%	0%	26%	20%
Geometry	4%	NA	4%	6%	5%	NA	5%	6%	13%	0	9%	12 %	14%	0%	14%	13%	14%	2%	27%	22%
Statistics and probability	4%	NA	4%	5%	5%	NA	6%	6%	6%	0	5%	5%	0%	19%	0%	0%	0%	0%	5%	8%
Algebra	4%	NA	6%	7%	7%	NA	4%	4%	6%	0	5%	4%	0%	0%	3%	2%	20%	0%	5%	10%

Quality - Nature of TG

HOW WE MEASURED – Coded activities in TG as to whether or not they correspond to an activity in student TB

WHAT WE FOUND

- With exception of Niger, all TGs:
  - *are closely aligned with student textbook*
  - *Provide structured (not scripted) lesson plans for entire school year, i.e., lesson plans outline activities teachers were to conduct and the order in which they were to teach them.*

- Opportunities to learn
  - *All activities in student textbook* vs *Some in student textbook, others in TG*

Mauritania, Niger, Zambia early primary

Nature of learning activities in textbook, TG

HOW WE MEASURED – Coded each "block" of activity in TB lessons and additional blocks in TG lessons, using TIMSS activity coding

WHAT WE FOUND - Opportunities to engage in authentic learning experiences varies by country; language load of textbook explanations varies by country

Result, End of early primary

Nature of activity		Zambia		Uganda		South Africa		Mauritania		Niger	
		TB	TG	TB	TG	TB	TG	TB	TG	TB	TG
Explanations	Narrative explanations	10%	0%	4%	2%	0%	--	4%	10%	24%	12%
	Graphic explanations	8%	0%	6%	0%	0%	--	1%	0%	1%	1%
	Worked examples	9%	0%	26%	18%	0%	--	0%	3%	8%	20%
Exercices and problems		68%	2%	60%	30%	94%	--	93%	64%	50%	38%
Learning activities		4%	98%	5%	49%	6%	--	2%	22%	17%	30%

Nature of learning activities in textbook, TG

Results, End of primary

Nature of activity		Zambia		Uganda		South Africa		Mauritania		Niger	
		TB	TG	TB	TG	TB	TG	TB	TG	TB	TG
Explanations	Narrative explanations	35%	21%	22%	12%	5%	--	8%	5%	26%	25%
	Graphic explanations	2%	0%	1%	0%	2%	--	3%	0%	1%	3%
	Worked examples	17%	24%	20%	3%	7%	--	8%	0%	29%	16%
Exercices and problems		42%	6%	38%	17%	65%	--	73%	91%	44%	40%
Learning activities		3%	50%	19%	68%	22%	--	9%	4%	1%	18%

Cognitive demand of textbook, TG activities

HOW WE MEASURED – Coded each "block" of activities in textbook lessons, and additional blocks in TG lessons according to TIMSS cognitive demand level

WHAT WE FOUND - Opportunities to develop higher level thinking skills vary by country

Results, End of early primary

COGNITIVE LEVELS	Zambia		Uganda		South Africa		Mauritania		Niger	
	TB	TG	TB	TG	TB	TG	TB	TG	TB	TG
A: Knowing and using vocabulary	33%	1%	55%	49%	47%	90%	29%	50%	44%	44%
B: Using standard equipment or performing routine procedures	65%	67%	32%	41%	51%	10%	35%	40%	36%	38%
C: Performing complex procedures and solving complex but routine problems	2%	17%	7%	10%	1%	0%	17%	0%	1%	6%
D: Investigating and problem solving	0%	15%	2%	0%	1%	0%	16%	7%	4%	5%
E: Fostering mathematical reasoning	0%	0%	5%	0%	0%	0%	4%	2%	13%	6%
F: Fostering complex	0%	0%	0%	0%	0%	0%	0%	0%	2%	1%

Cognitive demand of textbook, TG activities

Results, End of primary

COGNITIVE LEVELS	Zambia		Uganda		South Africa		Mauritania		Niger	
	TB	TG	TB	TG	TB	TG	TB	TG	TB	TG
A: Knowing and using vocabulary	62%	55%	55%	36%	50%	--	20%	31%	60%	38%
B: Using standard equipment or performing routine procedures	34%	6%	17%	27%	33%	--	26%	58%	21%	50%
C: Performing complex procedures and solving complex but routine problems	1%	35%	18%	28%	12%	--	15%	6%	9%	3%
D: Investigating and problem solving	2%	3%	9%	9%	1%	--	10%	2%	3%	2%
E: Fostering mathematical reasoning	1%	0%	1%	0%	4%	--	26%	3%	6%	3%
F: Fostering complex communication	0%	0%	0%	0%	1%	--	3%	1%	0%	3%

BREAKOUT GROUPS

30 MINS

GROUPS WILL DISCUSS THE FOLLOWING QUESTIONS, AND SHARE THOUGHTS ON MURAL:

1. Tools/methodology:
   a. What aspects of the tools/methodology do you find most interesting/useful? Why?
   b. What remaining questions do you have about the tools/methodology?
2. Findings:
   a. What types of findings do you think would be most useful/important in your context? Why?
   b. What remaining questions do you have about the findings?
3. Country experience:
   a. Would this type of study/analysis be useful in your context? Why/why not?
   b. What remaining questions do you have about the findings?


WELCOME BACK

WHAT'S COMING?

JULY 1: JOIN THE SCIENCE OF TEACHING WEBINAR: STRENGTHENING EARLY MATHEMATICS INSTRUCTION WITH PROFESSIONAL DEVELOPMENT TOOLS

END OF JULY: JOIN THE COP WEBINAR #5: FINDINGS FROM SOT MATH RESEARCH STUDIES.

AUGUST: JOIN THE SCIENCE OF TEACHING FINAL WEBINAR

ANY TIME: EXPLORE ALL THE SCIENCE OF TEACHING MATH PRODUCTS AT:

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THANK YOU!