

A NEW DATA SET!

Can curriculum analytics improve
learning opportunities for children in
East Africa?

Describing Uganda's primary mathematics curriculum.

RISE conference – June 2018

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Twaweza – Kenya, Tanzania, Uganda

- **Uwezo**: Citizen-led household-based assessments of basic literacy and numeracy skills.
- Generate evidence of “**what works**” to improve learning.
- **Standards-based** model, regional approach to curriculum studies – primary level.

A standards-based model

What data is available?

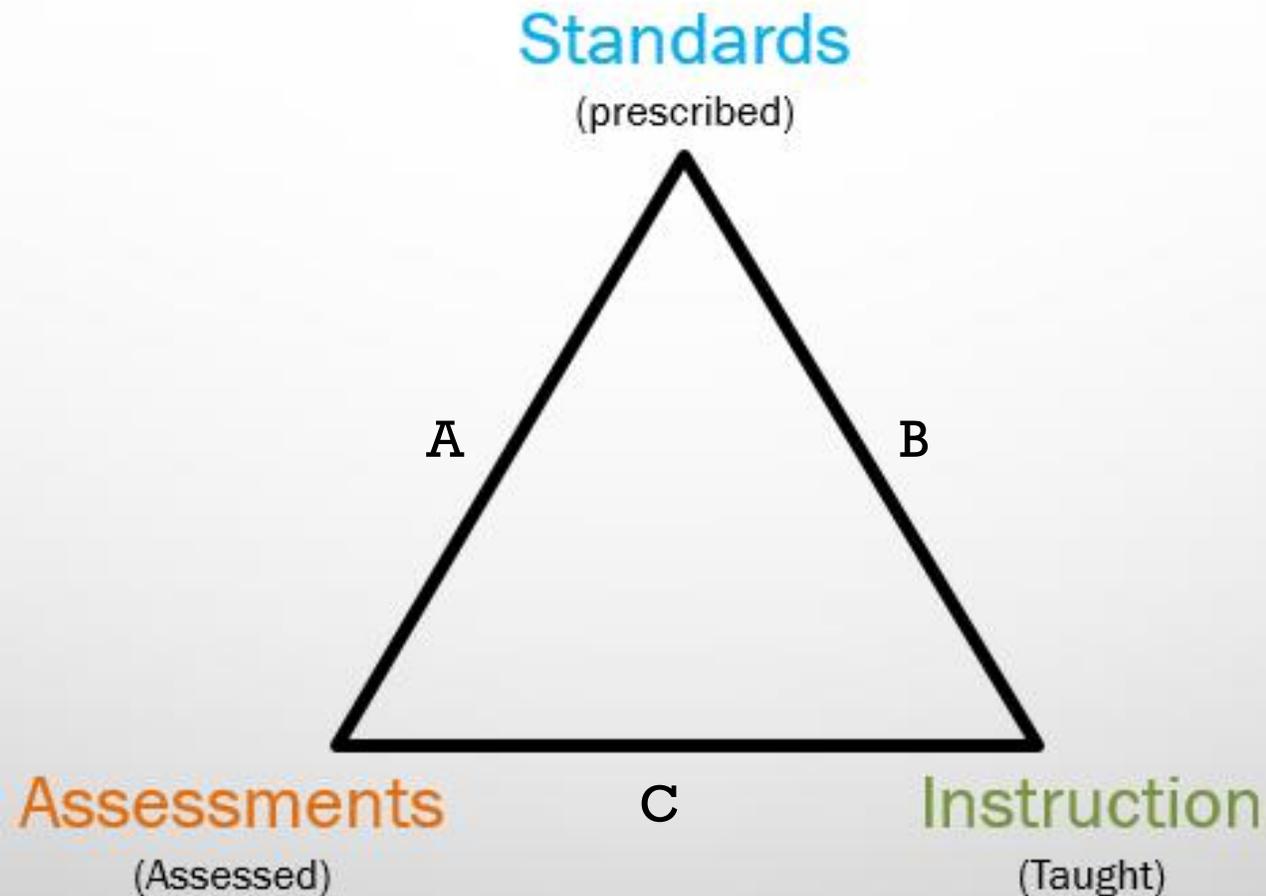
- **Test scores**
- **Demographics**
- **School climate**
- **‘Formative assessment data’**

Why more data?

- “students will perform better on assessments of content for which they have received instruction..”
i.e. both instruction and assessments must be aligned to a specific set of standards.

Of an effective Curriculum..

A Triangle of r-ships achieving coherence



One that achieves the set competences or intentions for children's learning – **what they should know and be able to do** – as a result of instruction.

The Surveys of Enacted Curriculum

A set of practical, reliable, research-based data collection tools used with teachers and other educators & specialists.

An easy but powerful and objective method to analyze the curriculum.

Collects and reports data on standards, assessments and instruction.

The Surveys of Enacted Curriculum

Facilitates reflection & discussions on improving classroom instructional practices and content at all levels.

Concise articulation of content progression across grades, cycles & levels.

A set of indicators to facilitate curriculum policy dev't, teacher reflection & professional dev't.

26a	Using a ruler, a pencil and a pair of compasses only: Construct a parallelogram ABCD such that line AB = 7 cm, BC = 5 cm and angle ABC = 120°	P47.31	707	C		
	ii) Drop a perpendicular from D to meet AB at M.	P47.32	709	C		
26b	Measure the line DM	P47.33	316	C		
27a	The time table shows how a pupil spent his time one Saturday. How long did he take playing?	P47.34	312	D	204	C
27b	If he dug maize garden at a rate of 2 rows in every 30 minutes, find the number of rows he dug that day.	P47.35	314	D		
28	The exchange rate for Kenya Shillings (K sh.) to Uganda (Ug Sh. and the United states dollars (Us\$) to Uganda shillings are shown below. Ksh 1 = Ug sh. 30. Us\$ = Ug. sh. 2580. How many United states dollars will one get from 21,500 Kenya shillings?	P47.36	303	C	313	F
28b	If the cost of a new bicycle is 90 United States dollars, how much would this be in Uganda shillings	P47.37	303	C		
29	At Kampala Bus Park, buses travelling to Arua and Mbarara leave after every 40 minutes and 50 minutes respectively. The first buses to the two towns leave together at 6:00am. At what time will buses to the two towns leave Kampala together again?	P47.38	312	F	312	E
30a	The mean of numbers 7,9,5,x+2 and 6 is 8. Find the value of x	P47.39	1001	D	503	D
30b	In a bag there are 15 pens. Out of these 4 are red and the rest blue. What is the probability that a pen picked at random from the bag is blue?	P47.40	1101	C		
31a	Nanziri has two children a son and a daughter. If the son is half her age, the daughter is a third of her age and the total age of the two children is 30 years. Find Nanziri's age	P47.41	507	F	503	F
31b	How old is the daughter	P47.42	507	D	503	D
32 a	A school wants to fence a circular flower garden of diameter 14 m using poles placed at intervals of 80 cm. How many poles are needed to fence the flower garden? (Take $\pi = \frac{22}{7}$).	P47.43	310	D	503	F
32b	If each pole costs sh. 3000, how much money will the school spend on the poles?	P47.44	202	D		

TeacherStart	CLASS	DISTRICT	kxp212d	kxp213d	kxp214d	kxp215d	kxp216d	kxp217d	kxp290d	kxp300d	kxp301d	kxp302d	kxp303d	kxp304d	kxp305d	kxp306d
50145	P5	IGANGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
50147	P5	IGANGA	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.02	0.01
50149	P5	IGANGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
50150	P5	IGANGA	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50151	P5	IGANGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50152	P5	IGANGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
50153	P5	IGANGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50156	P5	IGANGA	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01
50157	P5	IGANGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00
50158	P5	IGANGA	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50161	P5	IGANGA	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50169	P5	IGANGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
50171	P5	IGANGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50006	P5	WAKISO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
50007	P5	WAKISO	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
50008	P5	WAKISO	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50010	P5	WAKISO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.00
50013	P5	WAKISO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50014	P5	WAKISO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50017	P5	WAKISO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50018	P5	WAKISO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.02	0.02
50020	P5	WAKISO	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
50022	P5	WAKISO	0.02	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02
50023	P5	WAKISO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00

SEC data analysis & processing

Indiv. ratings
are discussed
in the
subject-team.

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graph LR; A[Indiv. ratings are discussed in the subject-team.] --> B[Indiv. data processed.]; B --> C[Avg. across all tchrs, analysts.]; C --> D[Measures of rel. emphasis produced.]
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Indiv. data
processed.

Avg. across
all tchrs,
analysts.

Measures of
rel.
emphasis
produced.

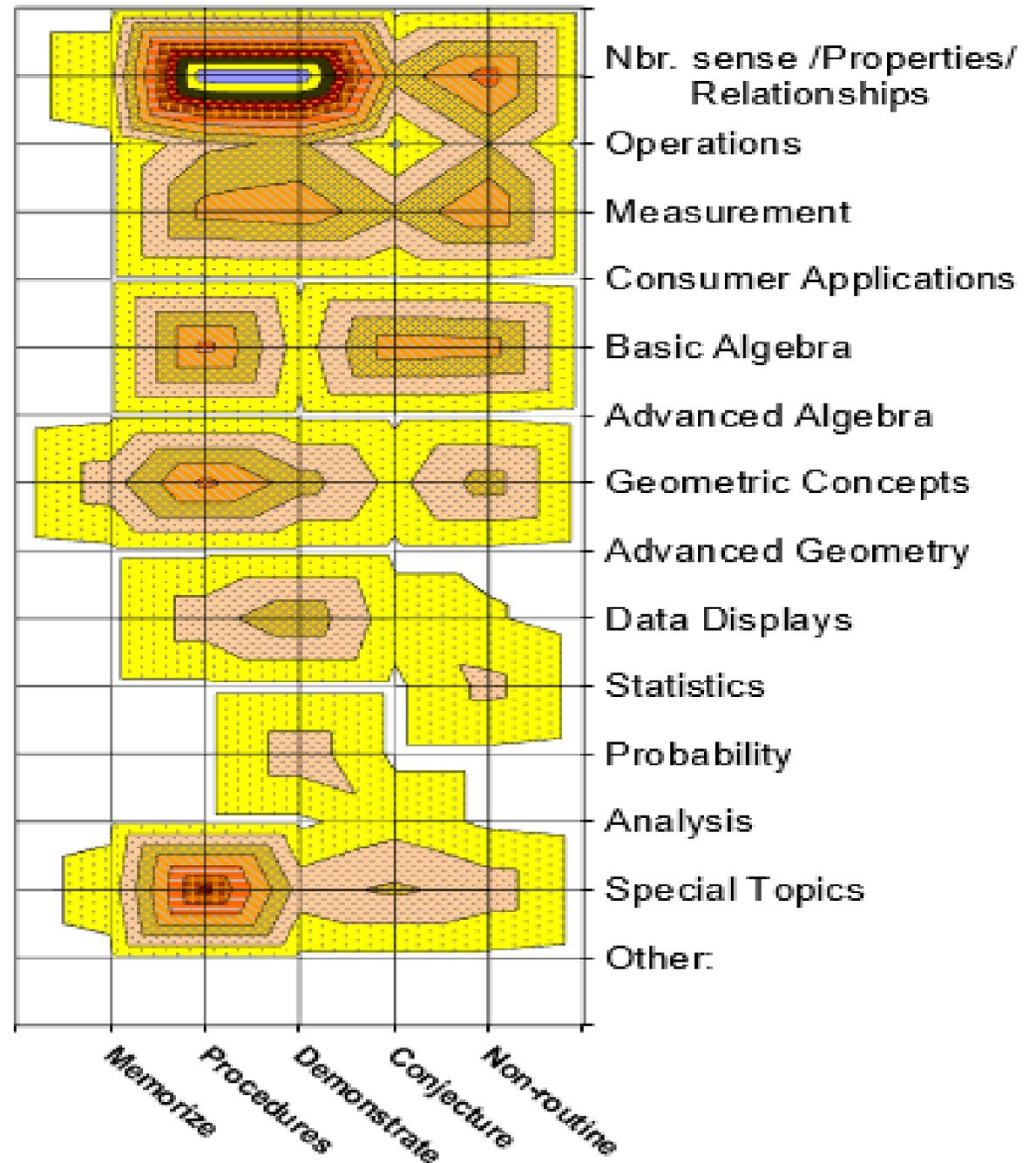


THE REPUBLIC OF UGANDA
Ministry of Education and Sports

Primary Seven Curriculum

Set One: English, Integrated Science, Local Language, Mathematics, Religious Education (Christian Religious Education & Islamic Religious Education) and Social Studies.

National Curriculum Development Centre



SEC Inputs – Outputs

Mathematics Taxonomy - Uganda

100	Nbr. sense /Properties/ Relationships	300	Measurement
101	Place value	301	Use of measuring instruments
102	Whole numbers and Integers	302	Theory (arbitrary, standard units and
103	Operations	303	Conversions
104	Fractions	304	Metric (SI) system
105	Decimals	305	Length and perimeter
106	Percents	306	Area and volume
107	Ratio and proportion	307	Surface Area
108	Patterns	308	Direction, Location
109	Real and/or Rational numbers	309	Angles

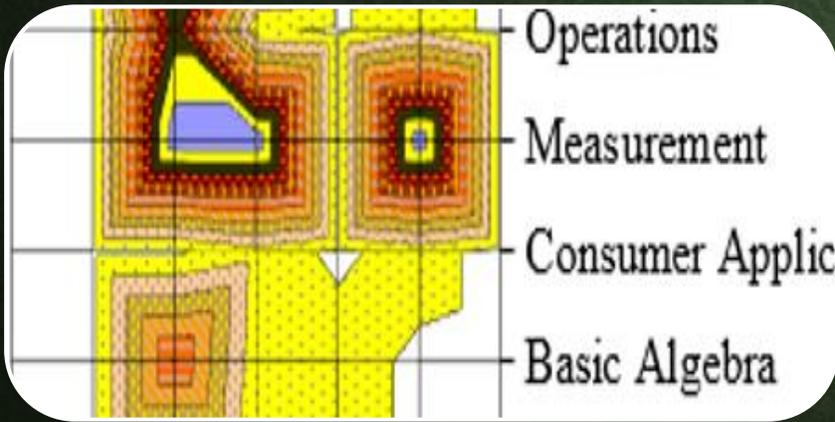
Taxonomy of topics/subtopics

B	C	D	E
Memorize Facts, Definitions, Formulas	Perform Procedures	Demonstrate Understanding of Mathematical Ideas	Conjecture, Analyze, Generalize, Prove
Recite basic mathematical facts	Use numbers to count, order, denote	Communicate mathematical ideas	Determine the truth of a mathematical pattern or proposition
Recall mathematics terms and definitions	Do computational procedures or algorithms	Use representations to model mathematical ideas	Write formal or informal proofs
Recall formulas and computational procedures	Follow procedures / instructions	Explain findings and results from data analysis strategies	Recognize, generate or create patterns

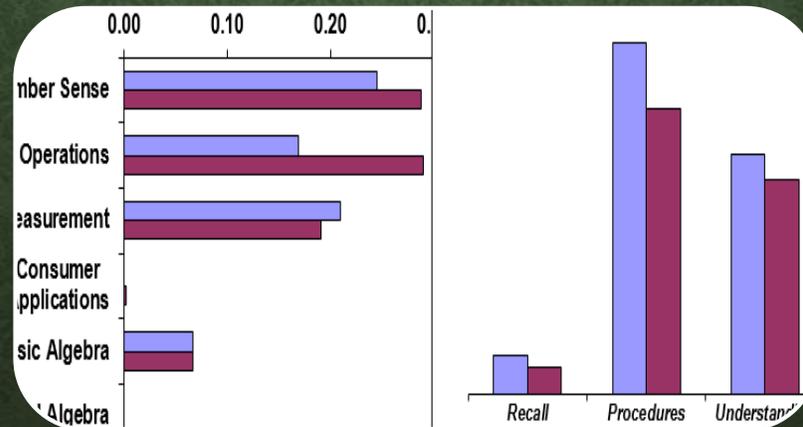
Performance expectations for students learning

Converts numbers from other bases to base ten and vice versa.	P7.13	117	C	116	D
Adds, subtracts and multiplies in binary system up to 5 digits.	P7.14	117	C		
Applies the basic operations integrated with commutative, associative and distributive properties.	P7.15	204	C	204	F
Writes numbers in expanded form and vice versa.	P7.16	103	D	114	D
Writes numbers in standard form.	P7.17	110	C	110	D
Prime factorizes whole numbers.	P7.18	111	C	512	E
Writes prime factors of whole numbers	P7.19	111	C	111	D
Finds the square roots of square numbers	P7.20	513	C	513	E
Solves problems involving application of square roots.	P7.21	513	D	513	F
Finds out whether a number is divisible by another using divisibility	P7.22	111	E	111	D

Expert/teacher judgement of content & practices – “data set”



Descriptive contour maps



User-friendly marginal charts

Primary 5 teachers all	Alignment	(Topics)		(Cog. Dmnc)
		Balance of Representation	Categorical Concurrence	Cognitive Complexity
Number Sense	0.37	0.06	0.58	0.73
Operations	0.35	0.07	0.60	0.27
Measurement	0.24	-0.01	0.42	0.67
Consumer Applications	0.00	0.00	0.00	0.15
Basic Algebra	0.22	0.01	0.41	0.71

Alignment tables & indices

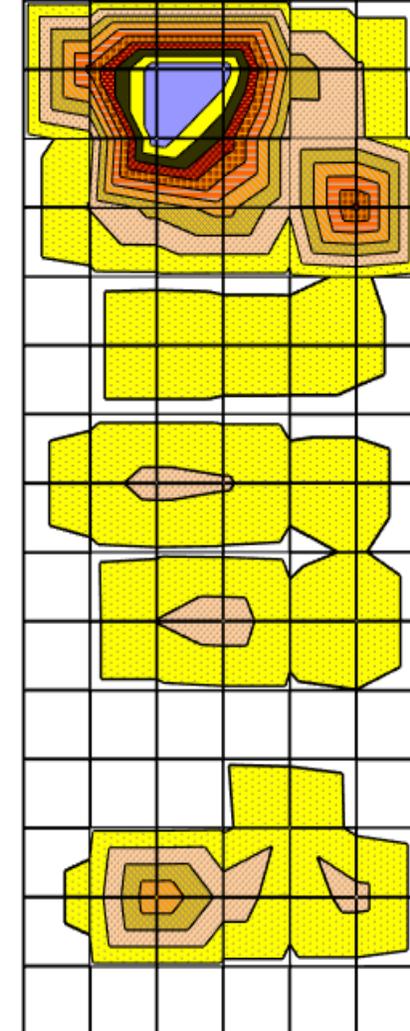
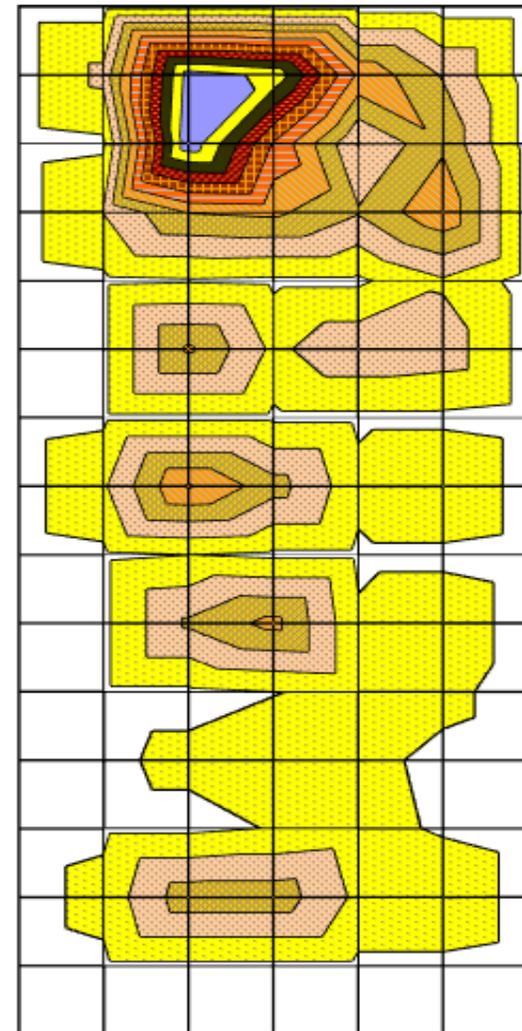
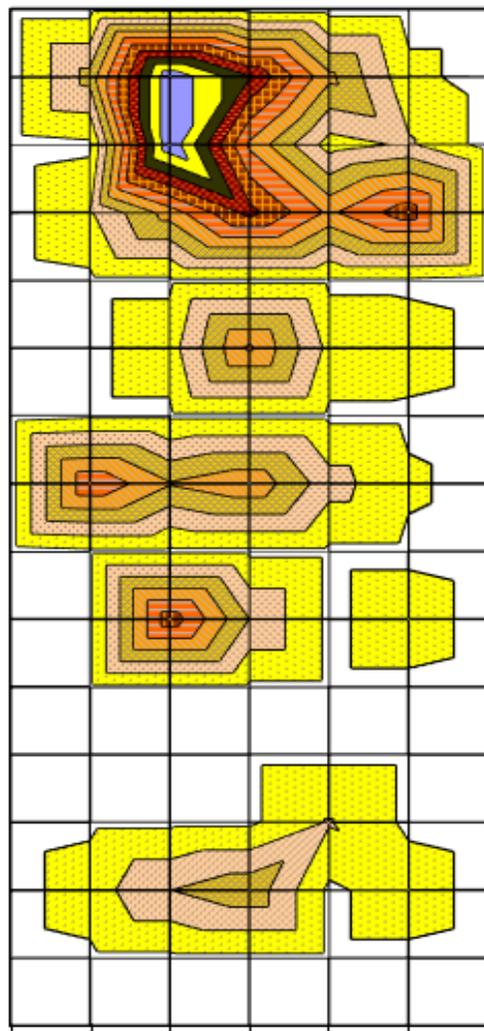
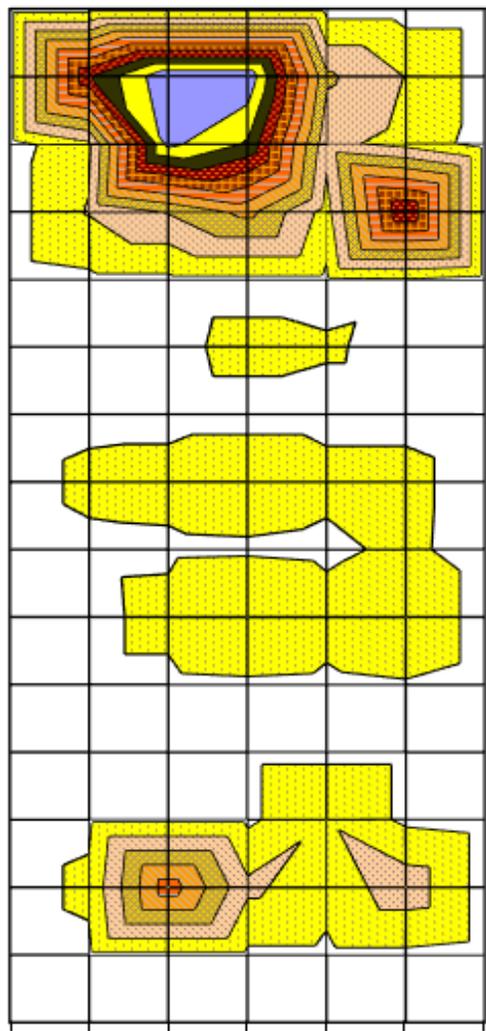
Primary Mathematics standards

P1- P3

P4 - transition

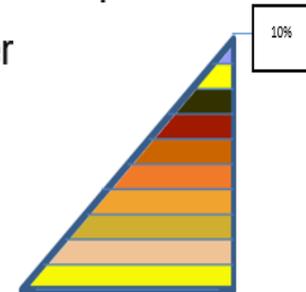
P5 - P7

P1-P7

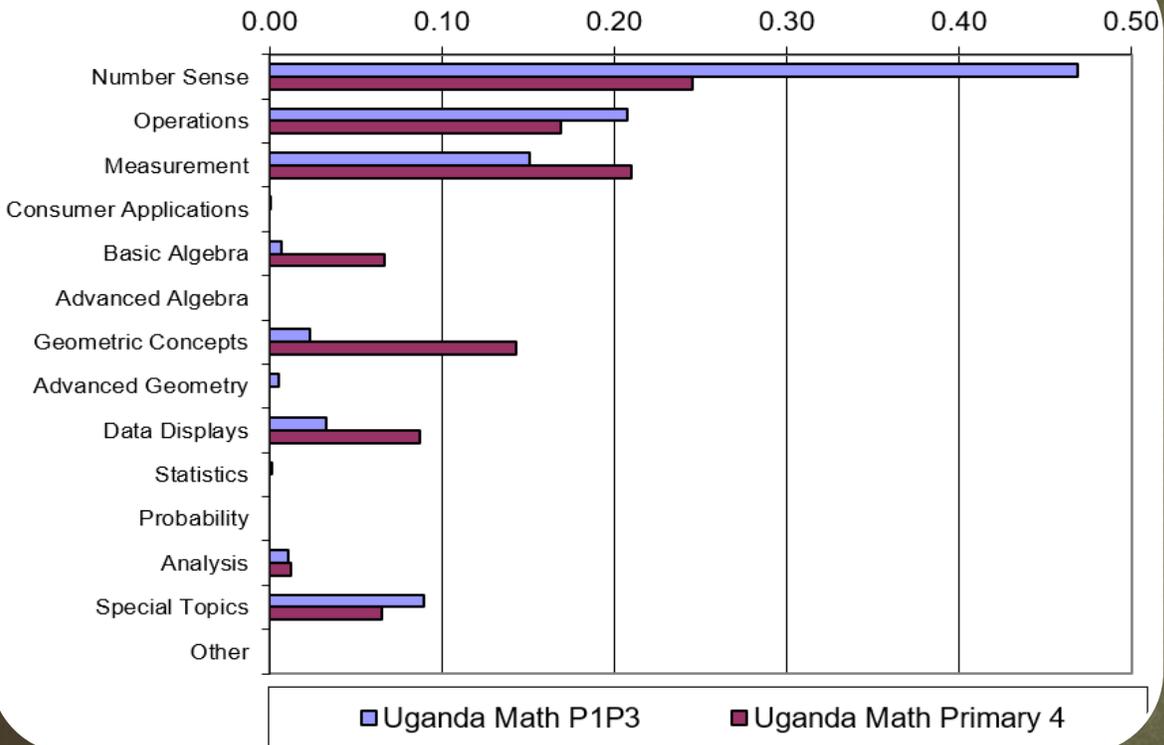


- Nbr. sense / Properties / Relationships
- Operations
- Measurement
- Consumer Applications
- Basic Algebra
- Advanced Algebra
- Geometric Concepts
- Advanced Geometry
- Data Displays
- Statistics
- Probability
- Analysis
- Special Topics
- Other

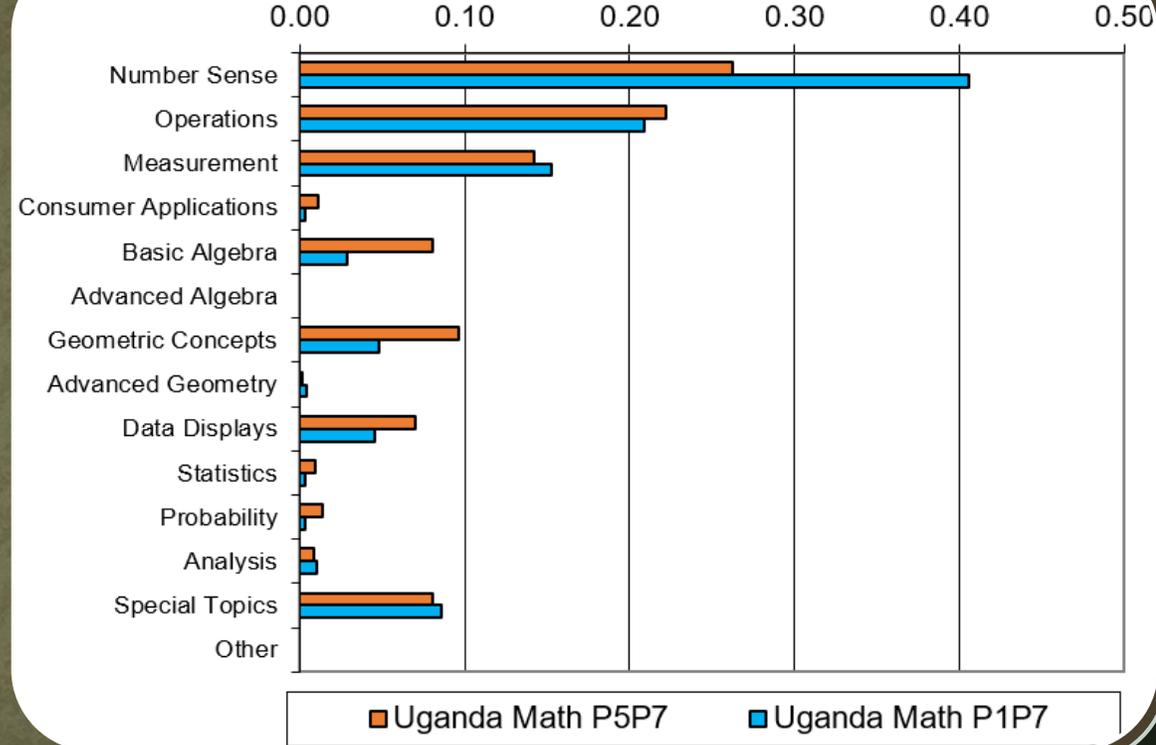
Memorize
Procedures
Demonstrate
Conjecture
Non-routine



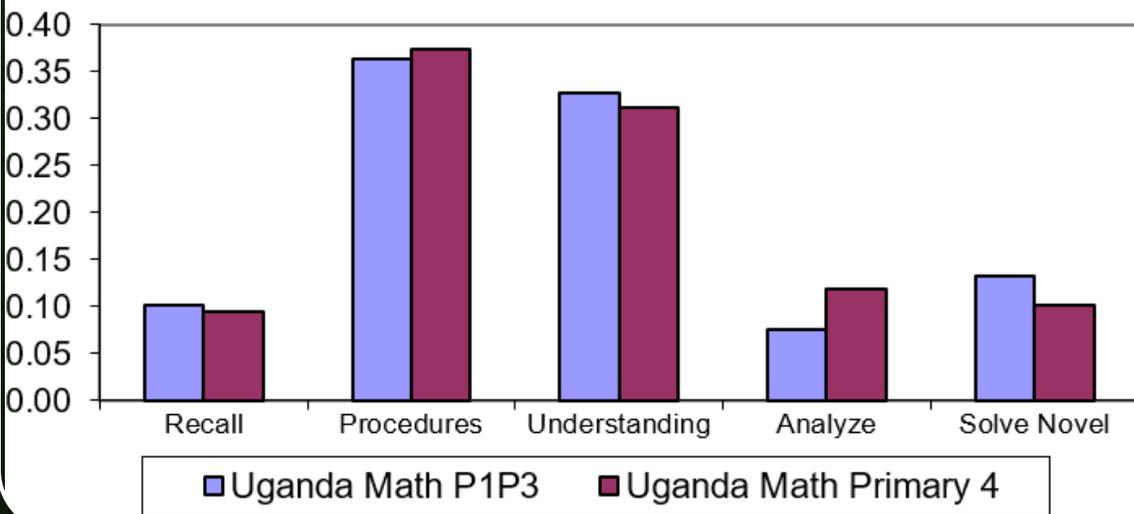
All Content Areas Topic Coverage



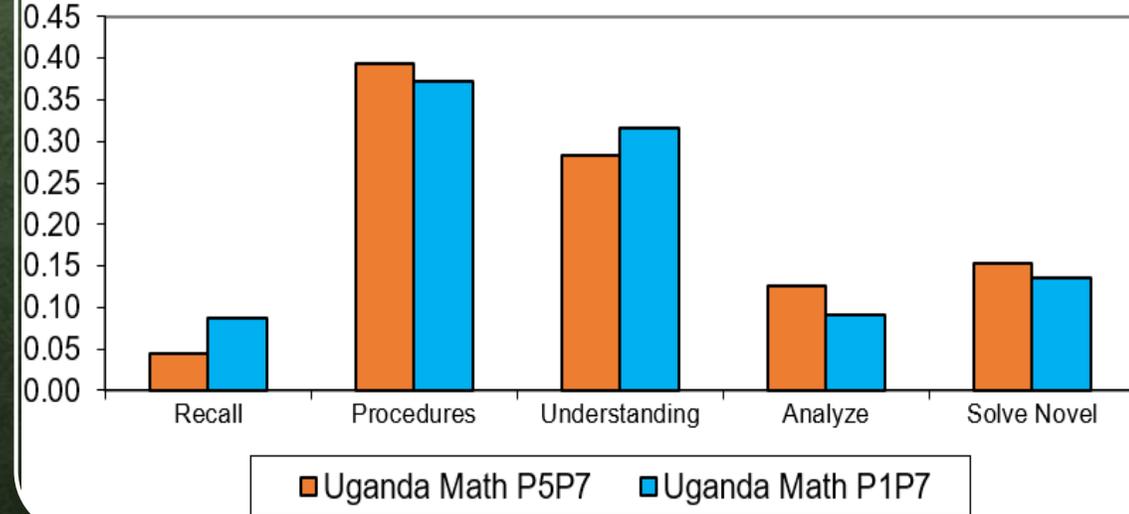
All Content Areas Topic Coverage



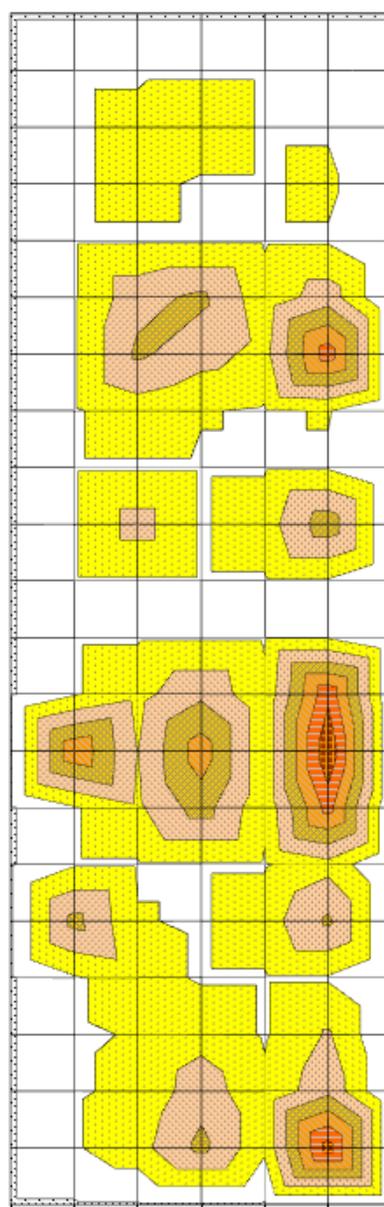
All Content Areas Cognitive Demand



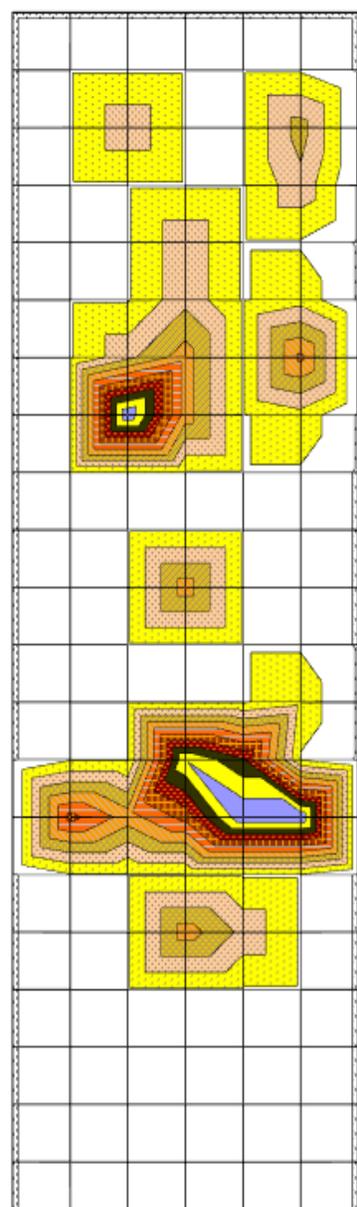
All Content Areas Cognitive Demand



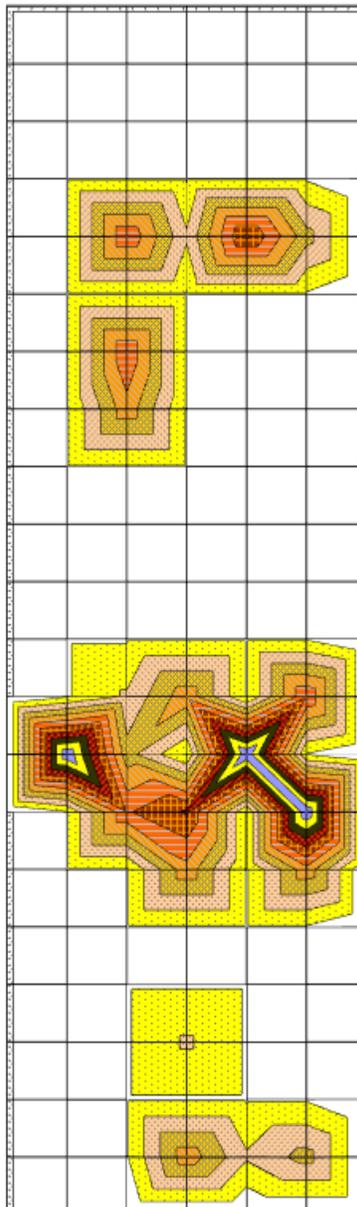
P1- P3 - Measurement



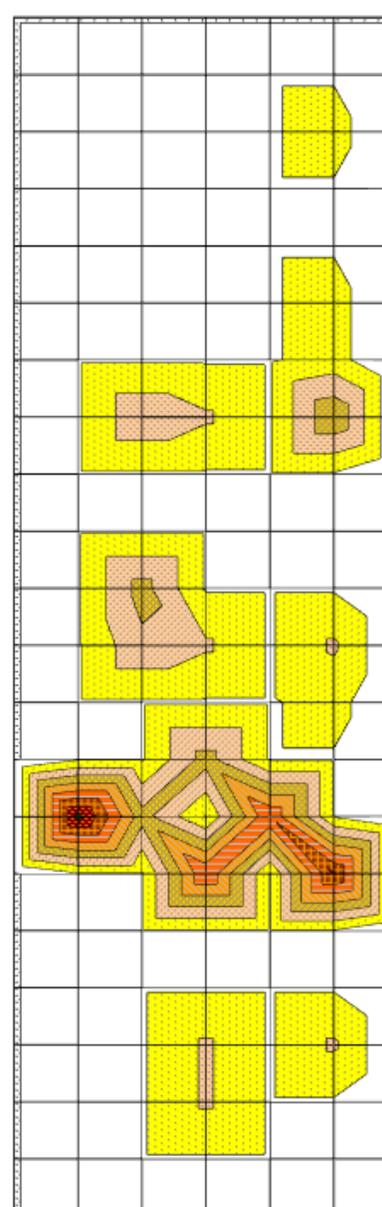
P4 - Measurement



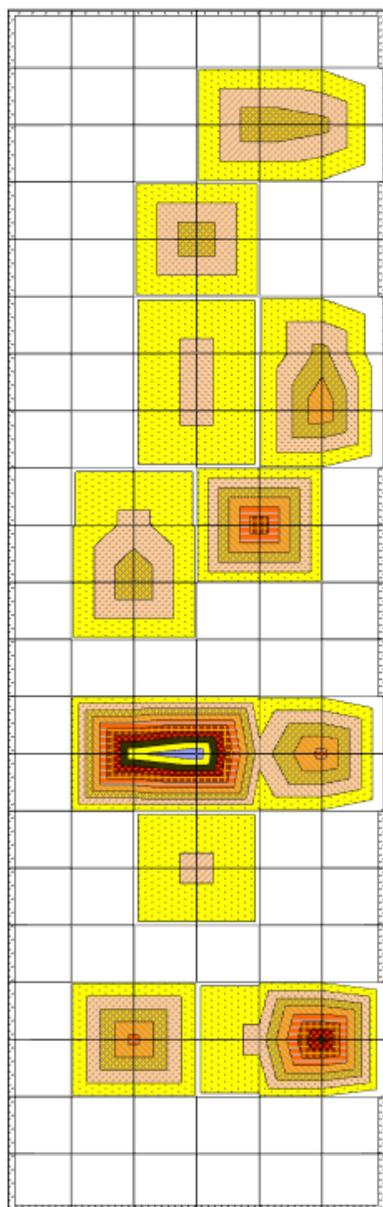
P5 - Measurement



P6 - Measurement

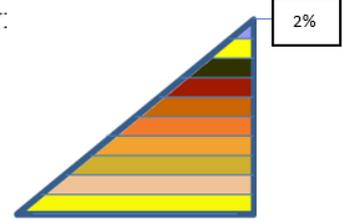


P7 - Measurement



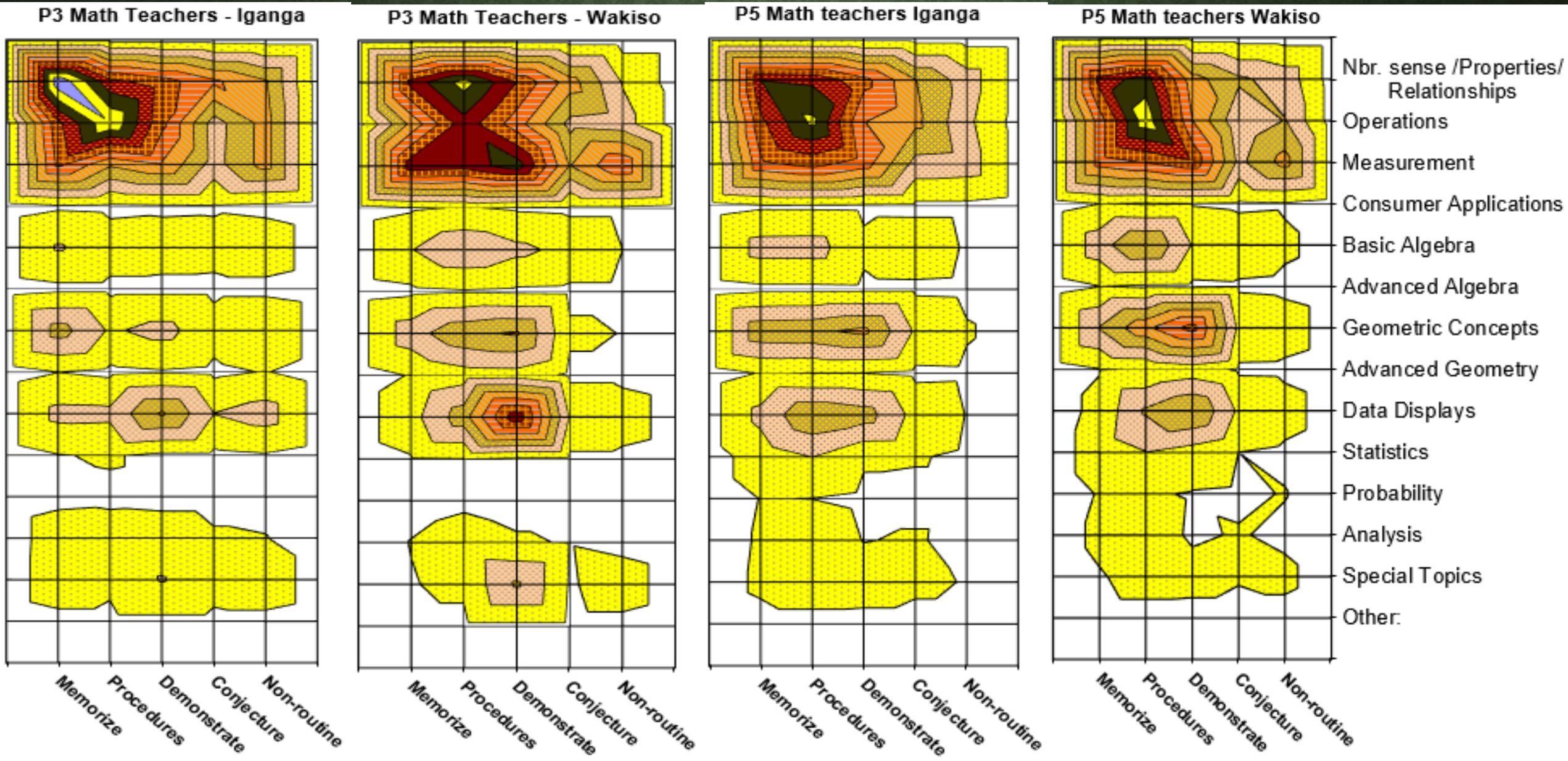
- (non-specific)
- Use of measuring instruments
- Theory (arbitrary, standard units, unit size)
- Conversions
- Metric (SI) system
- Length, perimeter
- Area, volume
- Surface Area
- Direction, Location, Navigation
- Angles
- Circles (e.g., pi, radius, area)
- Mass (weight)
- Time, temperature
- Money
- Derived measures (e.g. rate/speed)
- Calendar
- Accuracy, Precision
- Capacity
- Distance
- Other:

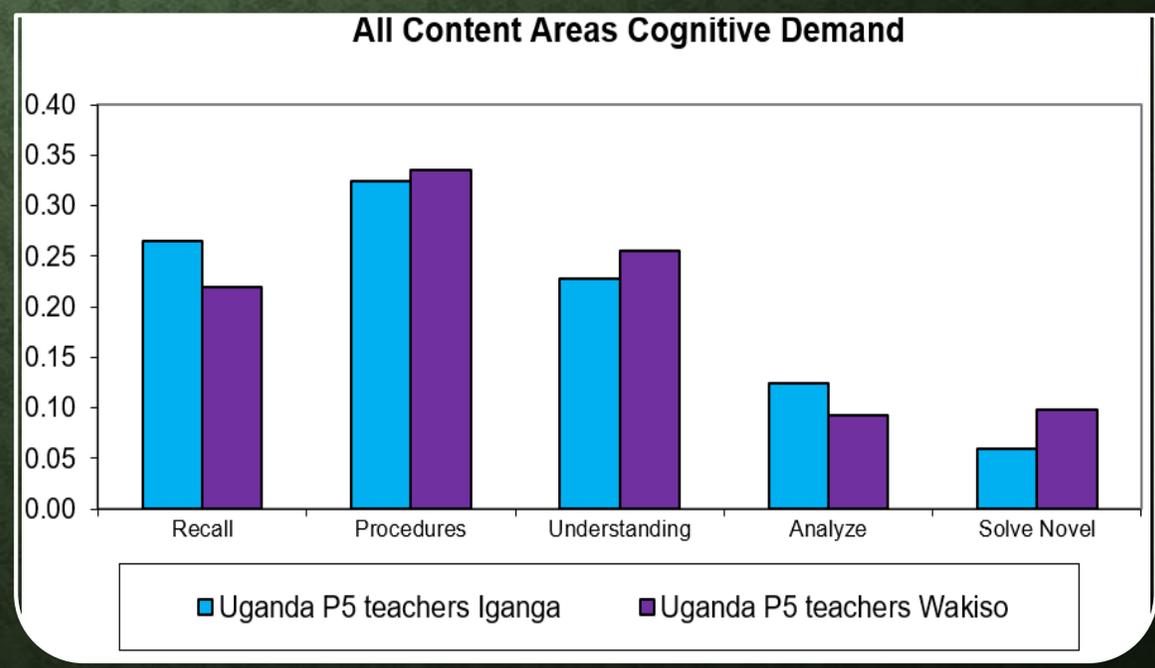
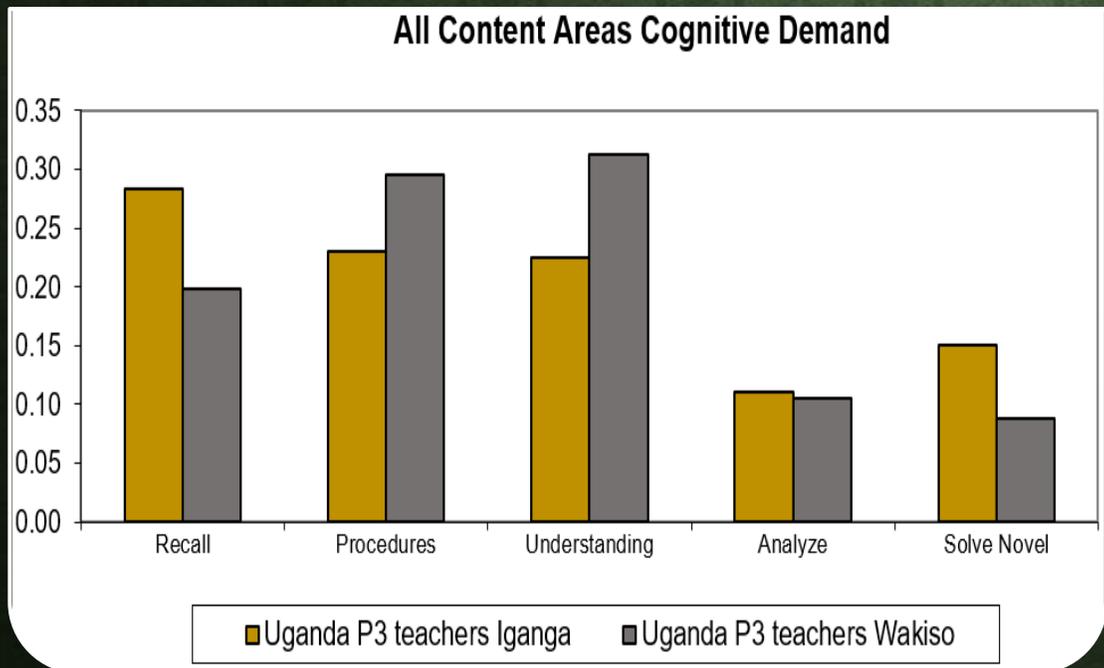
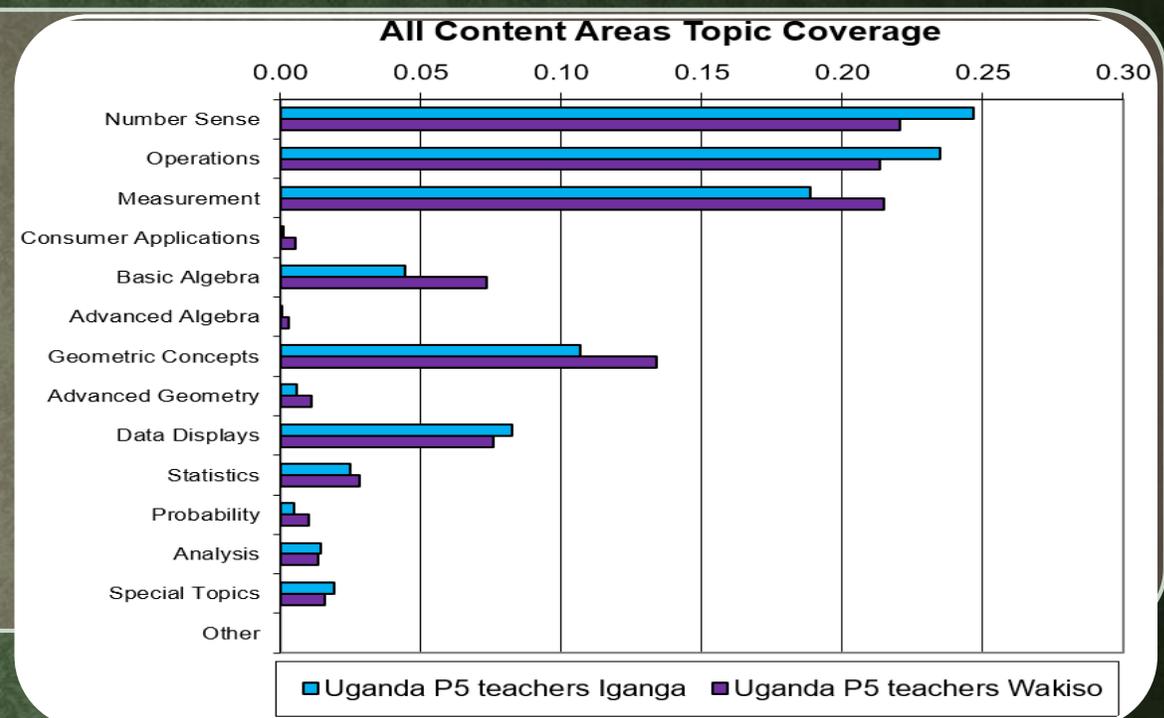
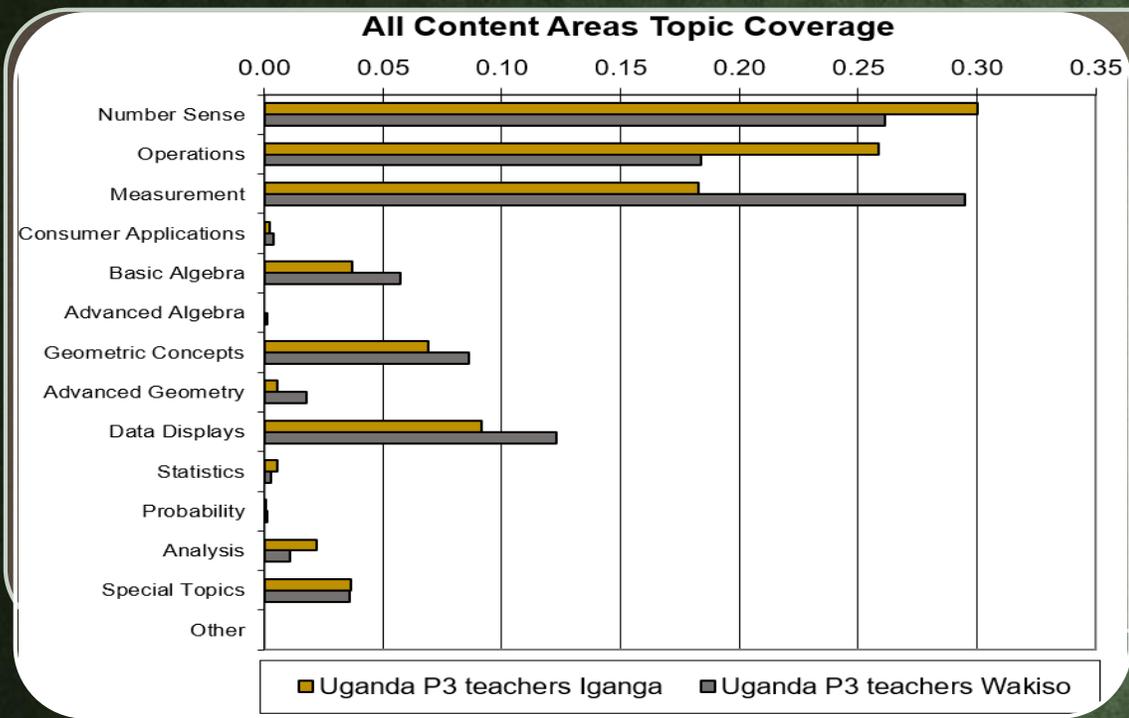
Memorize
Procedures
Demonstrate
Conjecture
Non-routine



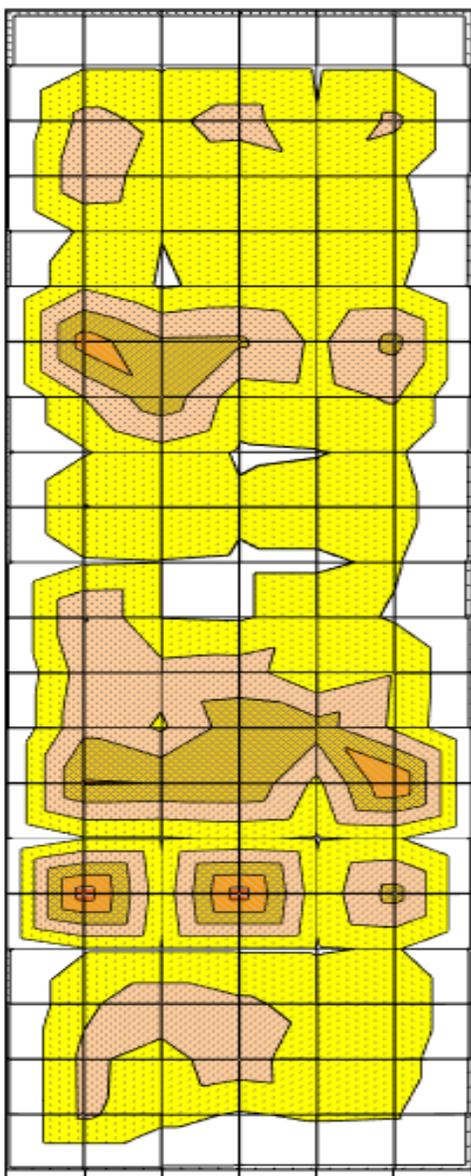
- Three topics dominate overall emphasis – over 60% of the emphasis on topic coverage.
- Lower primary – almost entirely focuses on the three dominant topics. **A broader coverage from P4 – upwards.**
- Sub-topic level analyses: Certain subtopics dominate emphasis: **“Measurement” – money, time & temperature.**
- Emphasis on learner perf. expectations is placed on “perform procedures” and “demonstrate understanding”
 - **“Measurement” emphasizes “making connections & applying to real world situations”**

Survey of instructional content

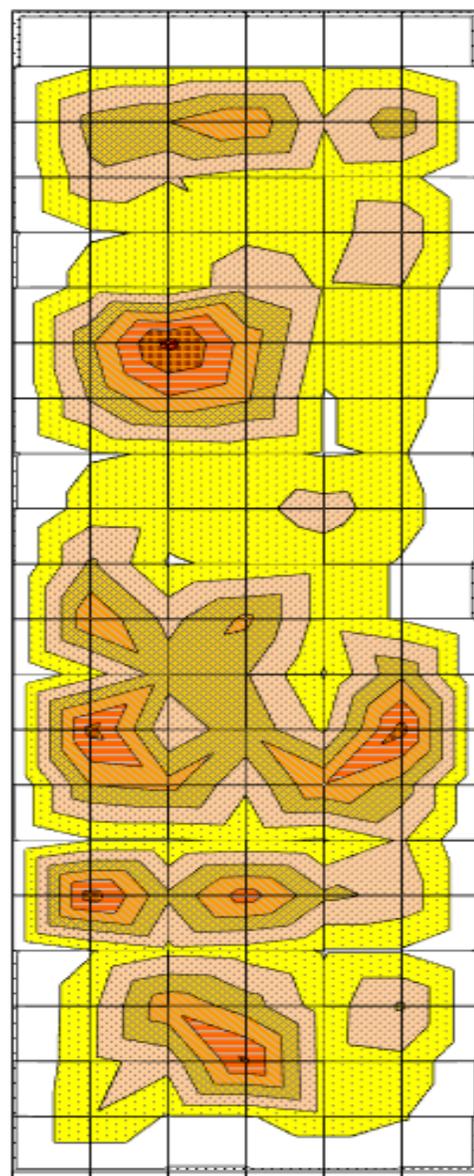




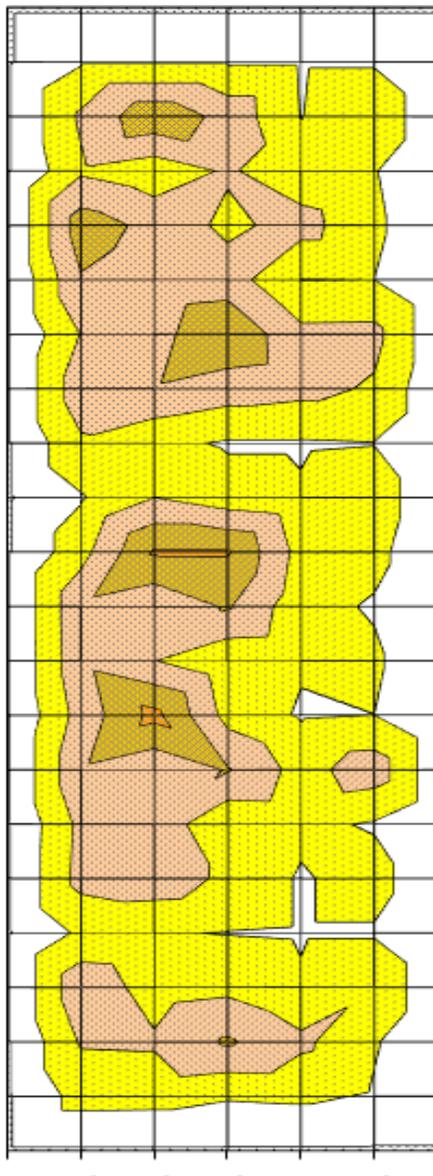
Iganga P3 teachers Measurement



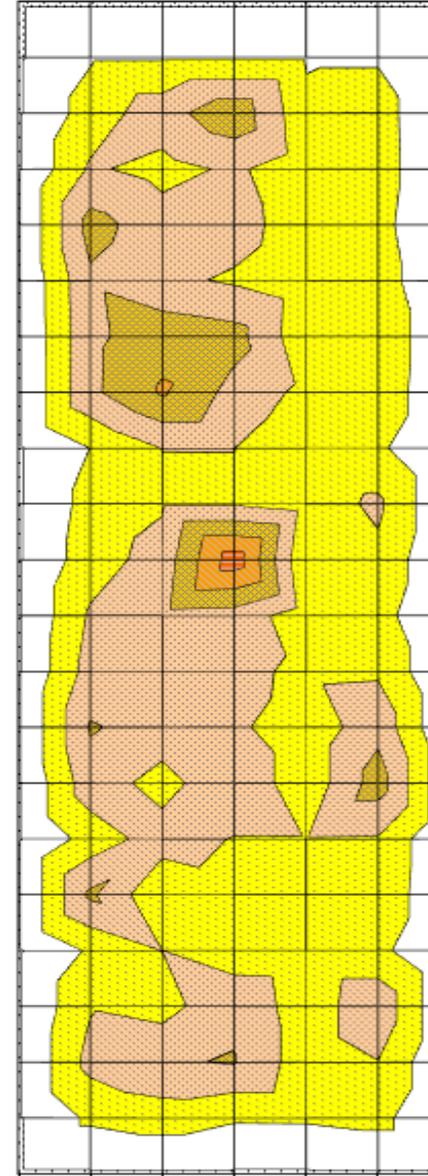
Wakiso P3 teachers Measurement



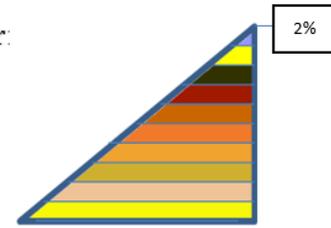
Iganga P5 teachers Measurement



Wakiso P5 teachers Measurement



- (non-specific)
- Use of measuring instruments
- Theory (arbitrary, standard units, unit size)
- Conversions
- Metric (SI) system
- Length, perimeter
- Area, volume
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- Time, temperature
- Money
- Derived measures (e.g. rate/speed)
- Calendar
- Accuracy, Precision
- Capacity
- Distance
- Other:

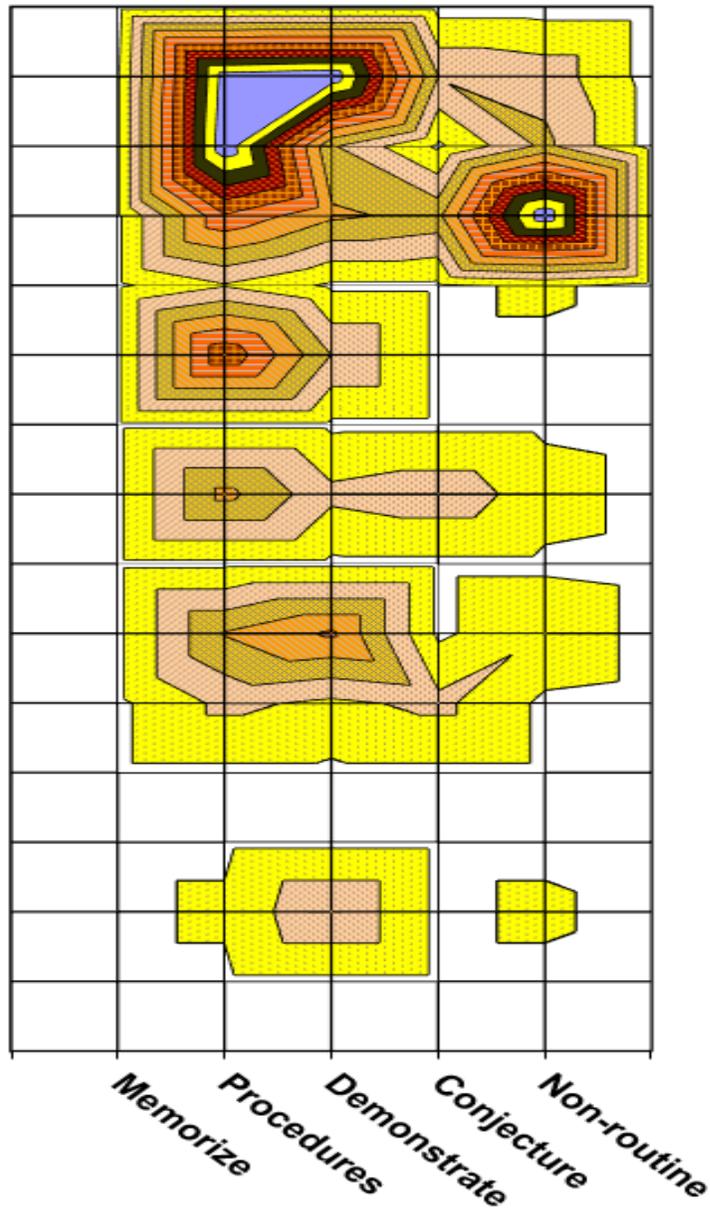


Memorize
Procedures
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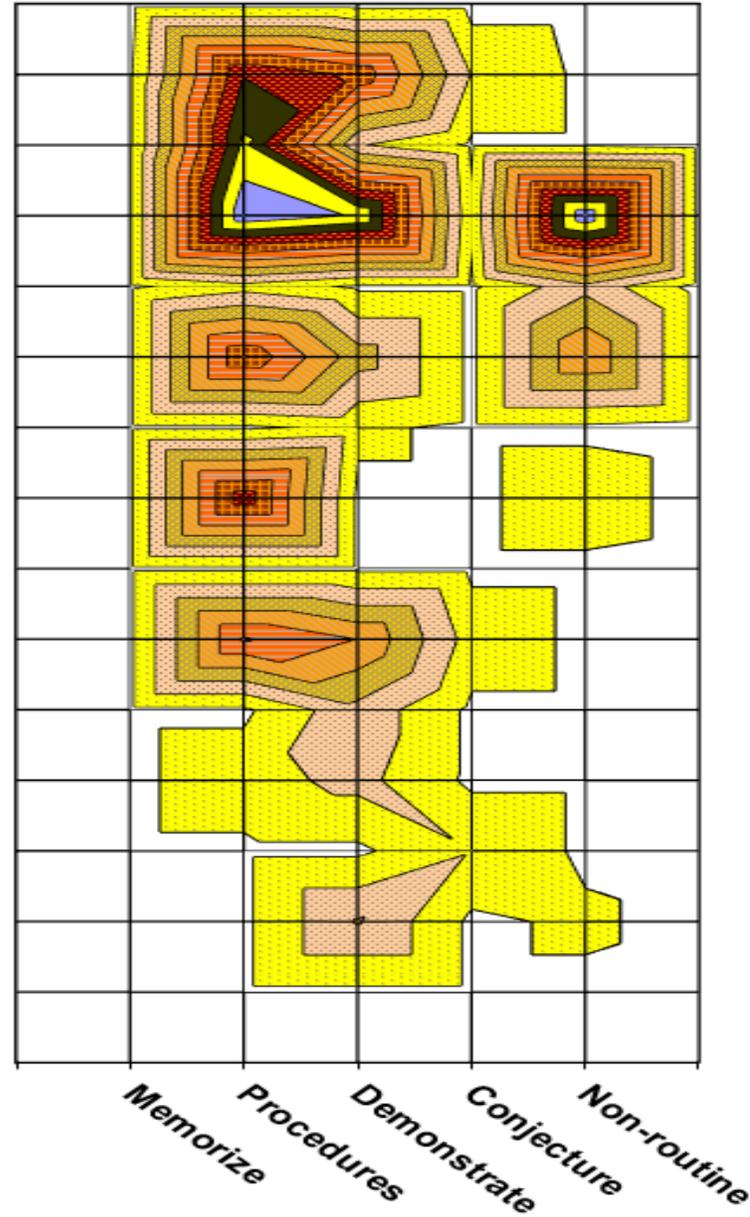
- Emphasis structure on topics and learner performance expectations are more similar in P5 than in P3.
 - P3 teachers: Iganga – ‘Number sense’ & ‘Recall’
Wakiso – ‘Measurement’ & ‘Demonstrate’
 - Sub-topic level analyses: Some practical application competences are less emphasized in Iganga, e.g. “Measurement” – use of measuring instruments.

Assessments: PLEs 2013 – 2015

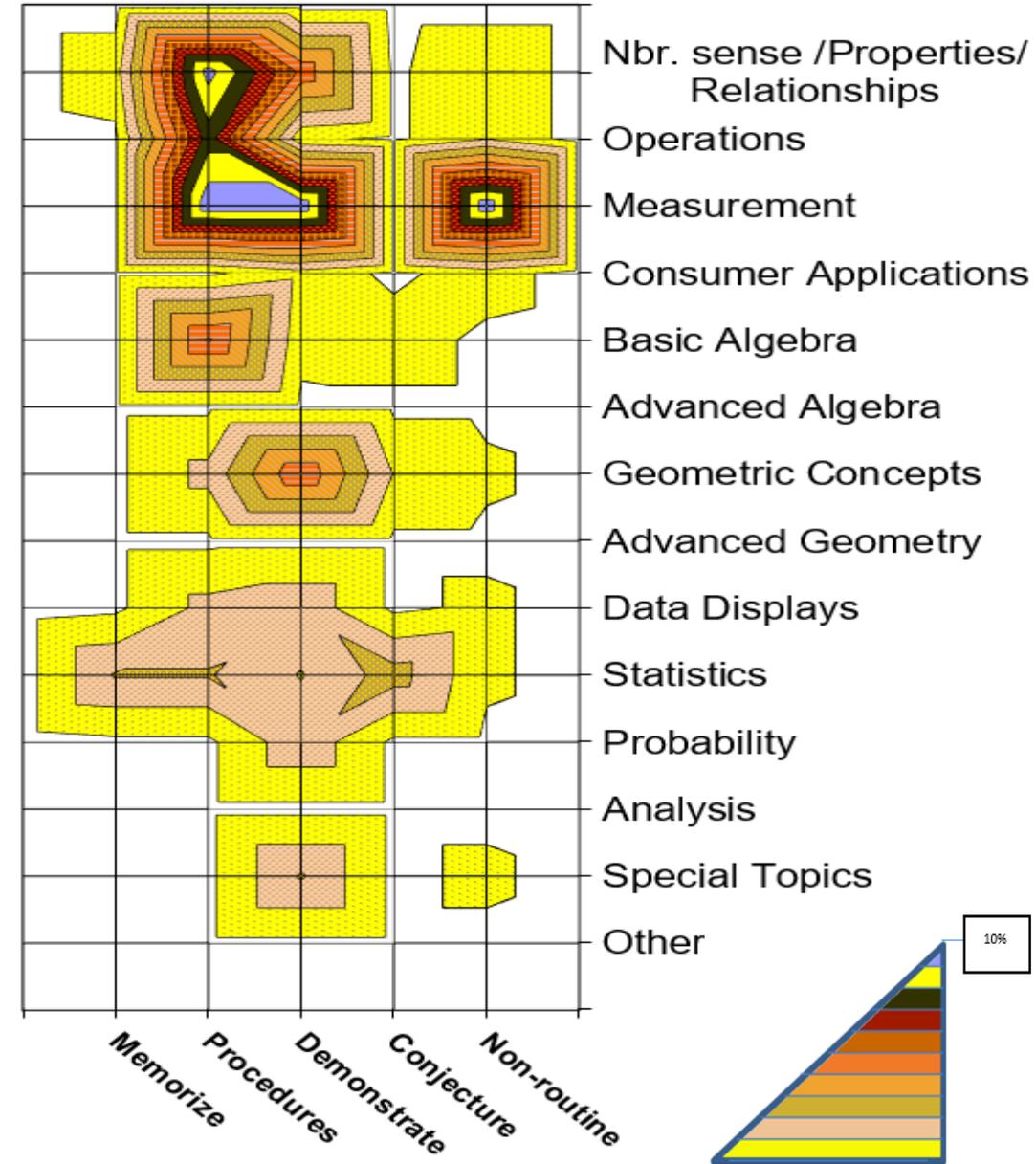
UNEB: PLE 2013



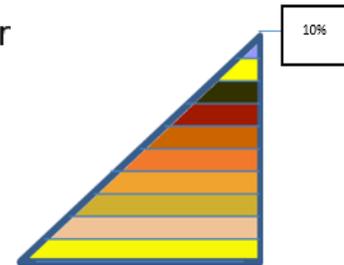
UNEB: PLE 2014



UNEB: PLE 2015



- Nbr. sense / Properties / Relationships
- Operations
- Measurement
- Consumer Applications
- Basic Algebra
- Advanced Algebra
- Geometric Concepts
- Advanced Geometry
- Data Displays
- Statistics
- Probability
- Analysis
- Special Topics
- Other



Assessment alignment analysis

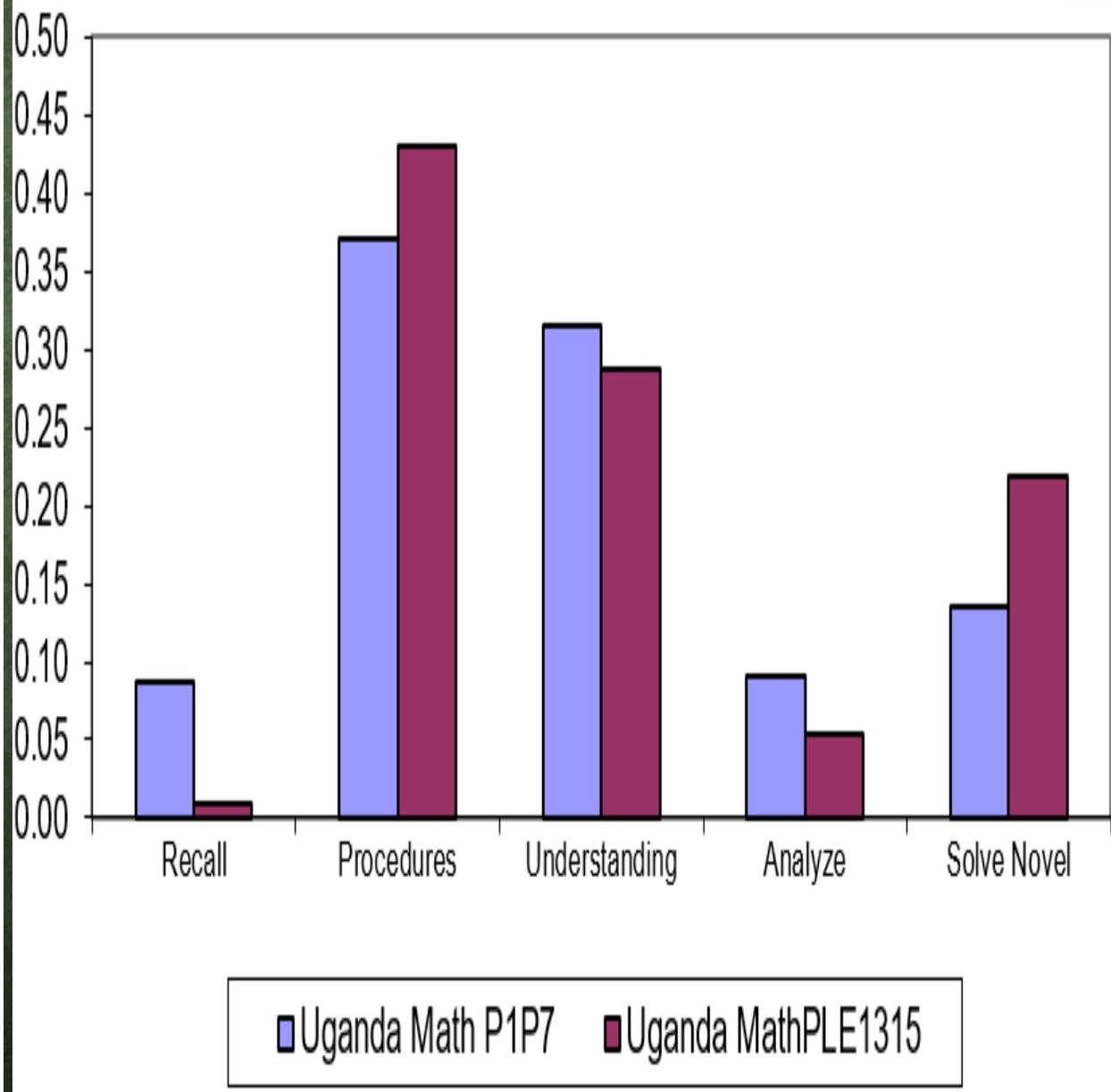
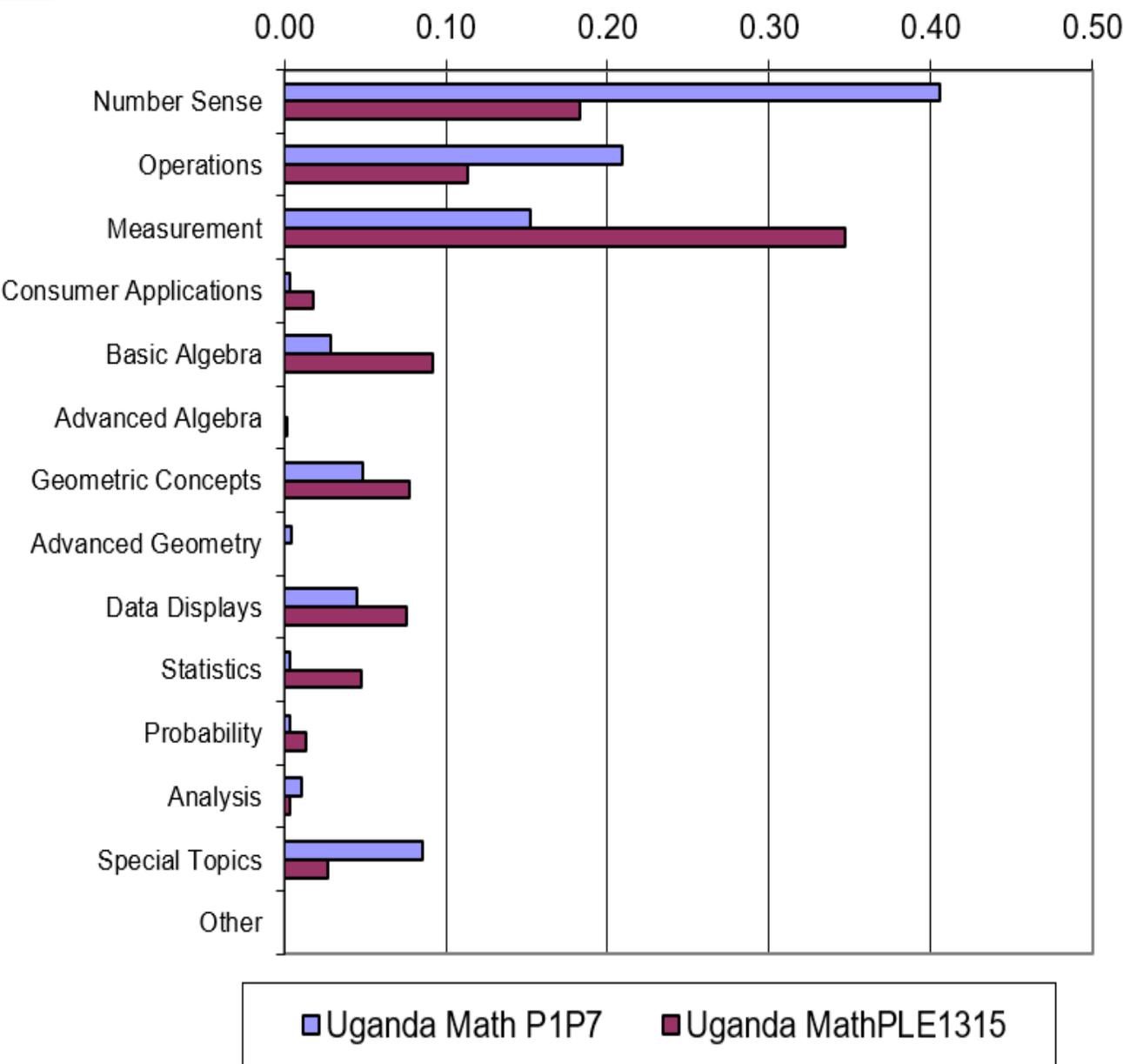
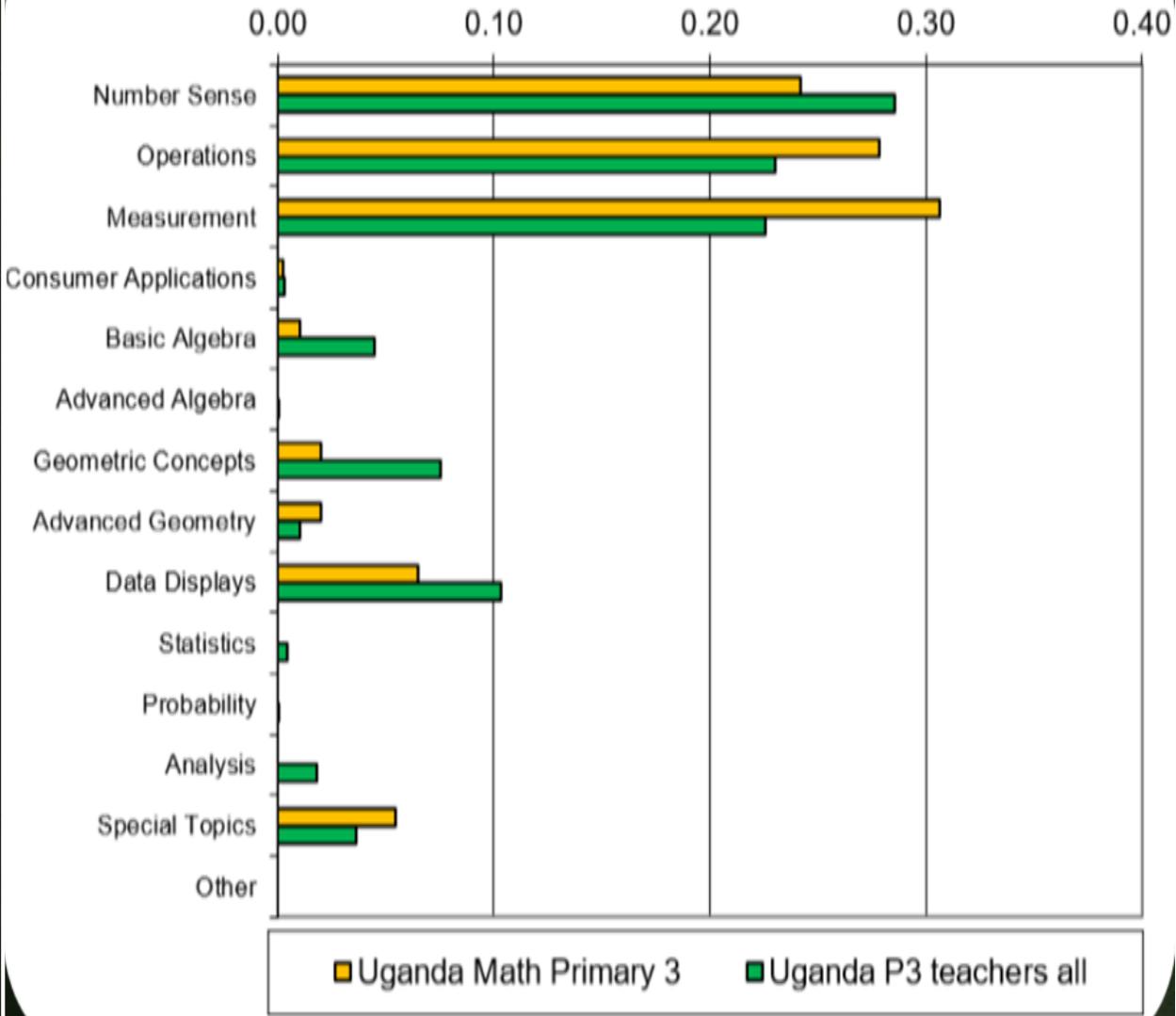


Table 1. Alignment Analysis Summary Table

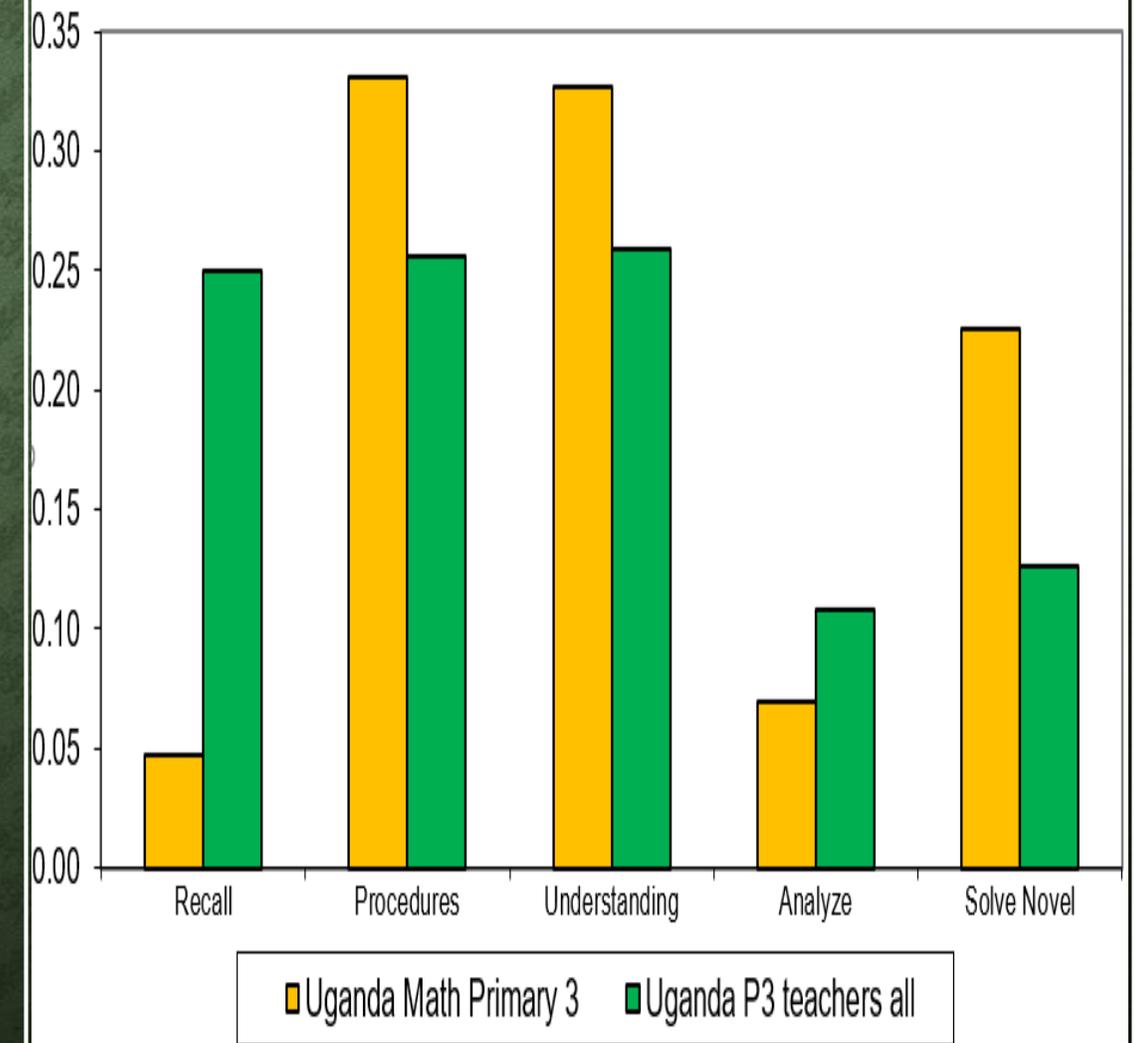
			(Topics)	(Cog. <u>Dmnd.</u>)
Uganda Math P1-P7		Balance of Representation	Categorical Concurrence	Cognitive Complexity
TO: Uganda MathPLE13-15	Alignment			
Number Sense	0.29	0.22	0.37	0.87
Operations	0.47	0.10	0.55	0.18
Measurement	0.57	-0.19	0.75	0.62
Consumer Applications	0.51	-0.01	0.56	0.59
Basic Algebra	0.33	-0.06	0.16	0.68
Advanced Algebra	#DIV/0!	0.00	#DIV/0!	#DIV/0!
Geometric Concepts	0.26	-0.03	0.44	0.79
Advanced Geometry	#DIV/0!	0.00	#DIV/0!	#DIV/0!
Data Displays	0.40	-0.03	0.46	0.77
Statistics	0.38	-0.04	0.65	0.50
Probability	0.56	-0.01	1.00	0.56
Analysis	0.93	0.01	1.00	0.93
Special Topics	0.40	0.06	0.99	0.40
Other	#REF!	0.00	#REF!	#REF!
Overall	0.33	0.61	0.44	0.57

Instructional alignment analysis – P3

All Content Areas Topic Coverage

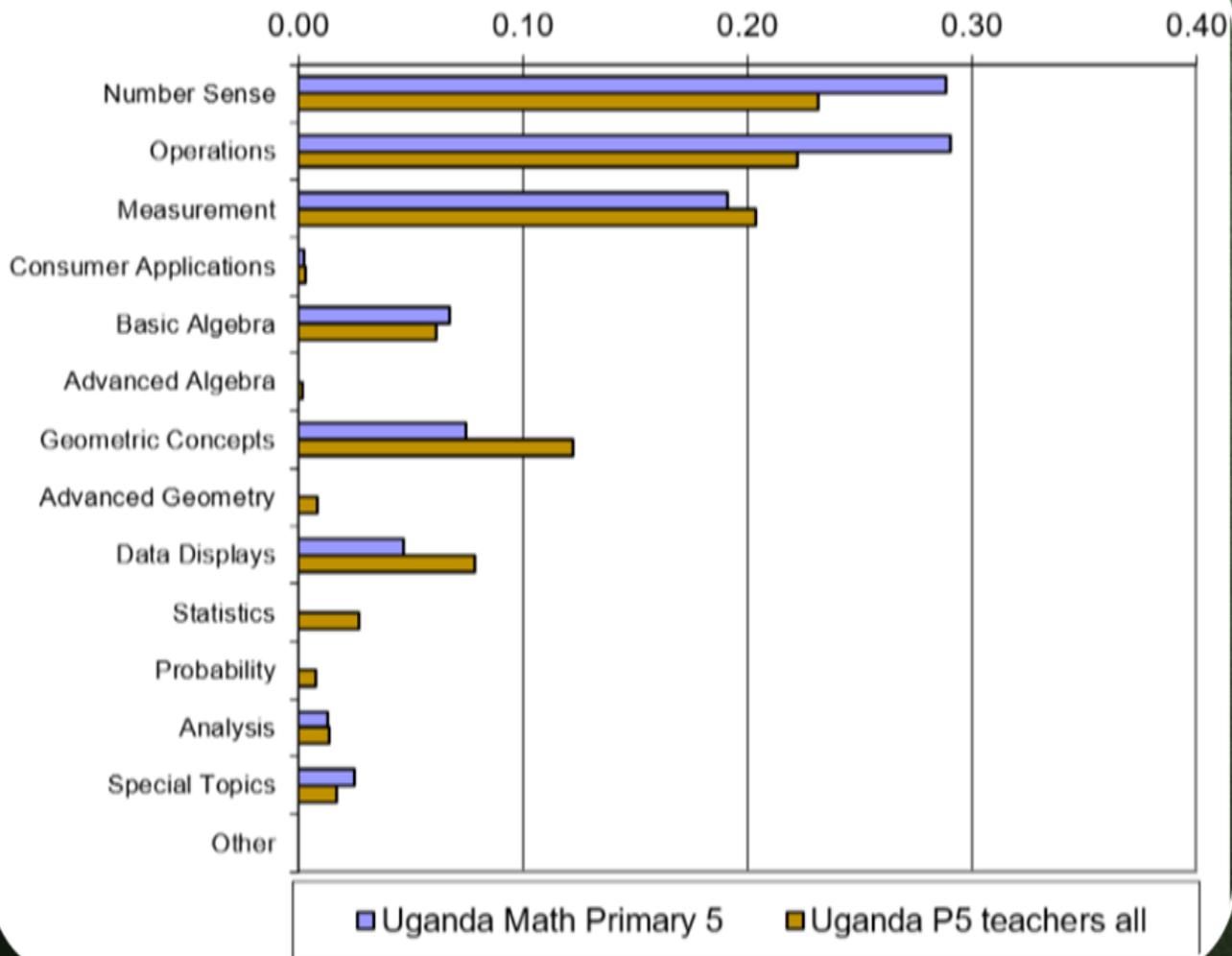


All Content Areas Cognitive Demand

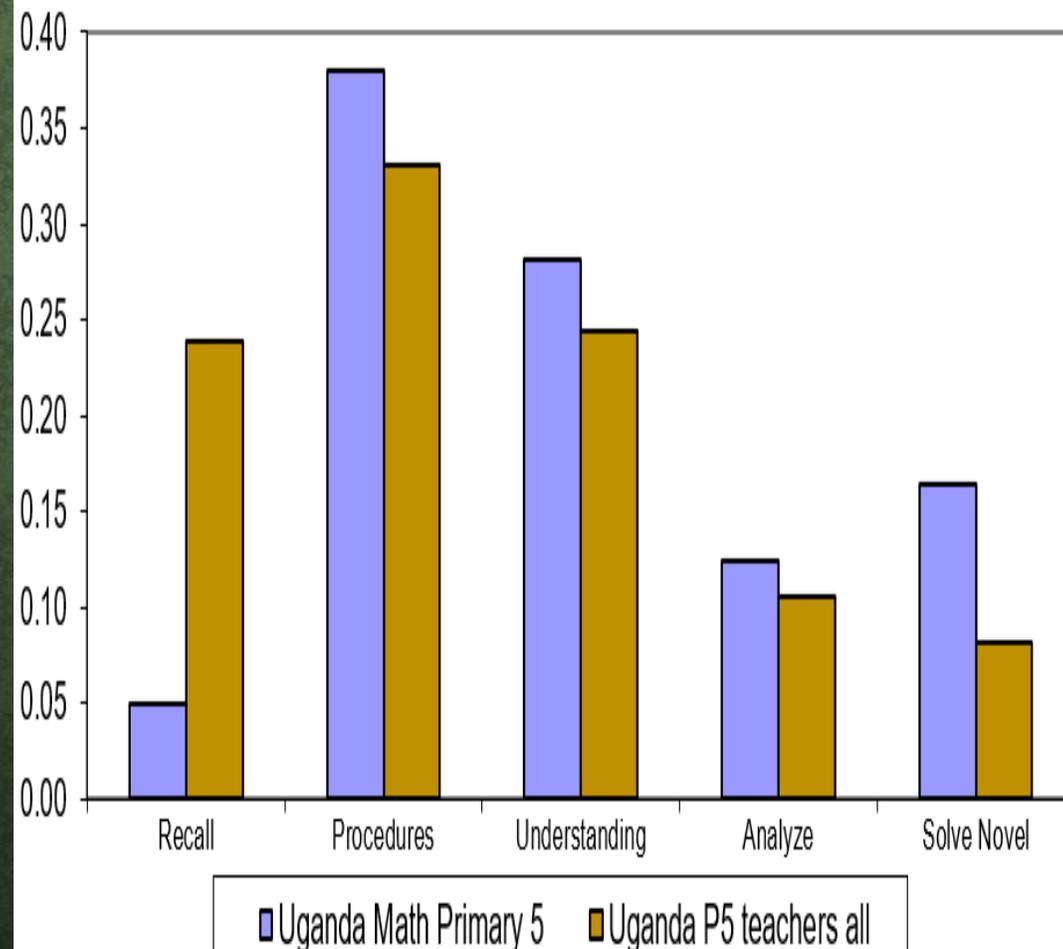


Instructional alignment analysis – P5

All Content Areas Topic Coverage



All Content Areas Cognitive Demand



- PLEs cover the whole breadth of the prescribed content in the standards. **The three topics also dominate the PLEs.**
- **'Measurement'** is disproportionately over emphasized in the PLEs.
- Similar emphasis structure on learner performance expectations – **first 'perform', then 'demonstrate', then 'apply to real-world'.**
- Very low assessment and instructional alignment indices (**OAI: PLEs - 0.33; P3 - 0.38; P5 - 0.30**).

Summary - Discussion

- Need for comprehensive subject taxonomies – multi-dimensional specifications of topics, sub-topics, and learner performance expectations.
 - Planned sequential progress on content
 - Fit across grades and cycles
 - Eliminate gaps and duplications
- Need to address alignment issues existing between standards, instruction and the PLEs at both topic/subtopic and cognitive demand levels – eliminate rote learning techniques that teachers employ targeting PLE performances.
- Instructional disparities between rural and urban classrooms need to be addressed – implications on teacher-related policy issues:
 - Teacher recruitment, education, deployment, development and support.

Thank You

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100	Nbr. sense /Properties/ Relationships
101	Place value
102	Whole numbers and Integers
103	Operations
104	Fractions
105	Decimals
106	Percents
107	Ratio and proportion
108	Patterns
109	Real and/or Rational numbers
110	Exponents and scientific notation
111	Factors, multiples, and divisibility
112	Odd/even/prime/composite/square numbers
113	Estimation
114	Number Comparisons (order, magnitude, relative size, inverse, opposites, equivalent forms, scale or number line)
115	Order of operations
116	Relationships between operations
117	Number Theory (e.g. base-ten and non-base-ten systems)
118	Mathematical properties (e.g., distributive property)
190	Other
200	Operations
201	Add/subtract whole numbers and integers
202	Multiply whole numbers and integers
203	Divide whole numbers and integers
204	Combinations of operations on whole numbers or integers
205	Equivalent and non-equivalent fractions
206	Add/subtract fractions
207	Multiply fractions
208	Divide fractions
209	Combinations of operations on fractions
210	Ratio and proportion
211	Representations of fractions
212	Equivalence of decimals, fractions, and percents
213	Add/ subtract decimals
214	Multiply decimals
215	Divide decimals
216	Combinations of operations on decimals
217	Computing with percents
290	Other

300	Measurement
301	Use of measuring instruments
302	Theory (arbitrary, standard units and unit size)
303	Conversions
304	Metric (SI) system
305	Length and perimeter
306	Area and volume
307	Surface Area
308	Direction, Location
309	Angles
310	Circles (e.g., pi, radius, area)
311	Mass (weight)
312	Time and temperature
313	Money
314	Derived measures (e.g., rate and speed)
315	Calendar
316	Accuracy and precision
317	Capacity
318	Distance
390	Other
400	Consumer Applications
401	Simple interest
402	Rates (e.g., discount and commission)
490	Other
500	Basic Algebra
501	Absolute value
502	Use of variables
503	Evaluation of formulas, expressions, and equations
504	One-step equations
505	Coordinate Planes
506	Patterns
507	Multi-step equations
508	Inequalities
509	Linear and non-linear relations
510	Rate of change/slope/line
511	Operations on polynomials
512	Factoring
513	Square roots
590	Other

600	Advanced Algebra
601	Rules for exponents
690	Other
700	Geometric Concepts
701	Basic terminology
702	Points, lines, rays, segments, and vectors
703	Patterns
704	Similarity
705	Parallels
706	Triangles
707	Quadrilaterals
708	Circles
709	Angles
710	Polygons
711	3-D relationships
712	Symmetry
713	Transformations (e.g., flips or turns)
714	Pythagorean Theorem
790	Other
800	Advanced Geometry
801	Spheres, cones, and cylinders
802	Coordinate Geometry
890	Other

900	Data Displays
901	Summarize data in a table or graph
902	Bar graph and histograms
903	Pie charts and circle graphs
904	Pictographs
905	Line graphs
906	Venn diagrams
990	Other
1000	Statistics
1001	Mean, median, and mode
1002	range
1090	Other
1100	Probability
1101	Simple probability
1190	Other
1200	Analysis
1201	Sequences and series
1290	Other
1300	Special Topics
1301	Sets
1390	Other

Cognitive Demand Categories for Mathematics

B	C	D	E	F
Memorize Facts, Definitions, Formulas	Perform Procedures	Demonstrate Understanding of Mathematical Ideas	Conjecture, Analyze, Generalize, Prove	Solve Non-Routine Problems / Make Connections
<u>Recite basic mathematical facts</u>	<u>Use numbers to count, order, denote</u>	<u>Communicate mathematical ideas</u>	<u>Determine the truth of a mathematical pattern or proposition</u>	<u>Apply and adapt a variety of appropriate strategies to solve non-routine problems</u>
<u>Recall mathematics terms and definitions</u>	<u>Do computational procedures or algorithms</u>	<u>Use representations to model mathematical ideas</u>	<u>Write formal or informal proofs</u>	<u>Apply mathematics in contexts outside of mathematics</u>
<u>Recall formulas and computational procedures</u>	<u>Follow procedures / instructions</u>	<u>Explain findings and results from data analysis strategies</u>	<u>Recognize, generate or create patterns</u>	<u>Apply to real world situations</u>
	<u>Solve equations/formulas/ routine word problems</u>	<u>Develop/explain relationships between concepts</u>	<u>Find a mathematical rule to generate a pattern or number sequence</u>	<u>Synthesize content and ideas from several sources</u>
	<u>Organize or display data</u>	<u>Show or explain relationships between models, diagrams, and/or other representations</u>	<u>Make and investigate mathematical conjectures</u>	
	<u>Read or produce graphs and tables</u>		<u>Identify faulty arguments or misrepresentations of data</u>	
	<u>Execute geometric constructions</u>		<u>Reason inductively or deductively</u>	

Bloom's Taxonomy (2001)	Remember	Understand	Apply	Analyze	Evaluate	Create	
SEC (Porter & Smithson, 2002)	Memorize	Perform procedures	Demonstrate understanding		Analyze	Integrate	
Webb's DoK (1997, 2002)	Recall		Concept		Strategic thinking		Extended thinking