

# What is Algebra? Cross-Curricular Textbook Analyses

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## Research Question

What are the characteristics of different curricular approaches to high-school algebra?

- What is the content, including the breadth, sequence, and depth of topics covered?
- What sets of behaviors are expected of students as they engage with the content?

## Rationale

There is large variation in the content of courses called "algebra" in the US and abroad (Kendal & Stacey, 2004). Characterizing textbooks as either "traditional" or "reform" masks important distinctions between programs that really are quite different (Huntley, 2008). Describing these differences in coherent, comprehensive, and commensurable ways will allow curriculum decision makers and other stakeholders to compare curricula and make informed decisions.

## Textbooks Analyzed

Integrated*	Subject Specific	
	Commercially Generated	Extensive Field Testing during Development
Core-Plus Mathematics Program (CPMP), Glencoe/McGraw-Hill (2008-2009)	Glencoe Algebra 1 & 2 (2008)	University of Chicago School Mathematics Project (UCSMP), Wright Group (2008/2009)
Interactive Mathematics Program (IMP), Key Curriculum Press (2008-2009)		

\*Only units in Years 1-3 with major focus on algebra (as identified by the textbook authors).

## Analytical Frameworks

### Content

Survey of Enacted Curriculum (SEC) K-12 Mathematics Taxonomy (Wisconsin Center for Education Research, 2007)

### Cognitive Behavior

TIMSS Advanced 2008 Assessment Framework (Garden et al., 2006)

## Coding Procedures

Every textbook item is coded by two people

- Narrative (excluding worked-out examples)
- Exercises (homework problems)

### Coders

- Mathematician (Terrell)
- Mathematics Educator (Huntley)
- 2 High-School Teachers (10+ years of experience, master's degree)

Periodic reliability checks

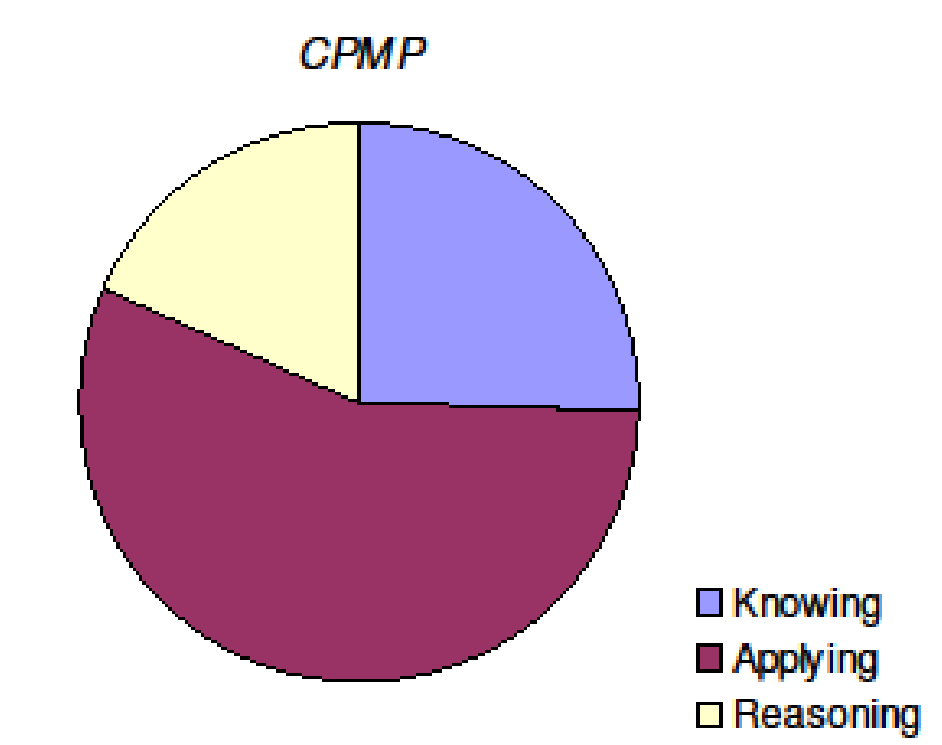
## Preliminary Findings – Frequency of Content

The table show the ten most frequently used content codes in each curricular program.

	CPMP	%		Glencoe	%		UCSMP	%
1	1503 – Linear Functions	13.0	1	510 – Rate of Change/Slope/Line	6.9	1	510 – Rate of Change/Slope/Line	10.8
2	1504 – Quadratic Functions	9.3	2	601 – Quadratic Equations	6.3	2	511 – Operations on Polynomials	8.1
3	1508 – Exponential Functions	7.6	3	507 – Multi-Step Equations	5.1	3	1504 – Quadratic Functions	8.0
4	605 – Matrices & Determinants	6.6	4	511 – Operations on Polynomials	4.7	4	507 – Multi-Step Equations	6.3
5	1406 – Iteration & Recursion	6.5	5	515 – Rational Expressions & Eqns	4.6	5	508 – Inequalities	5.3
6	511 – Operations on Polynomials	5.9	6	508 – Inequalities	4.5	6	512 – Factoring	4.8
7	601 – Quadratic Equations	5.5	7	602 – Systems of Linear Eqns	4.5	7	502 – Use of Variables	4.7
8	510 – Rate of Change/Slope/Line	4.3	8	512 – Factoring	4.5	8	602 – Systems of Linear Eqns	4.4
9	602 – Systems of Linear Eqns	3.8	9	1504 – Quadratic Functions	4.2	9	601 – Quadratic Equations	4.4
10	1515 – Power Functions	3.4	10	503 – Eval of Formulas/Exprs/Eqns	4.2	10	306 – Area & Volume	3.8

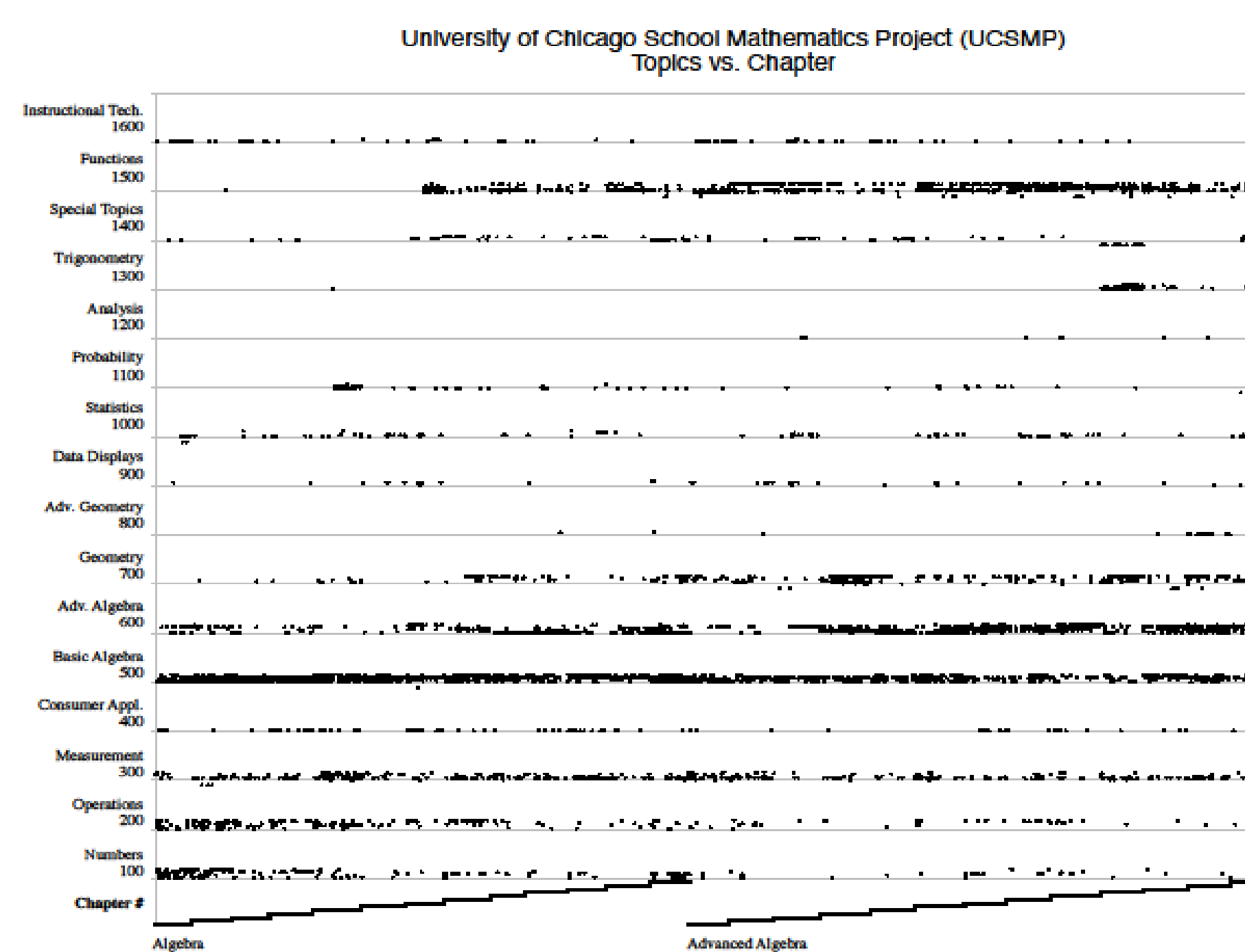
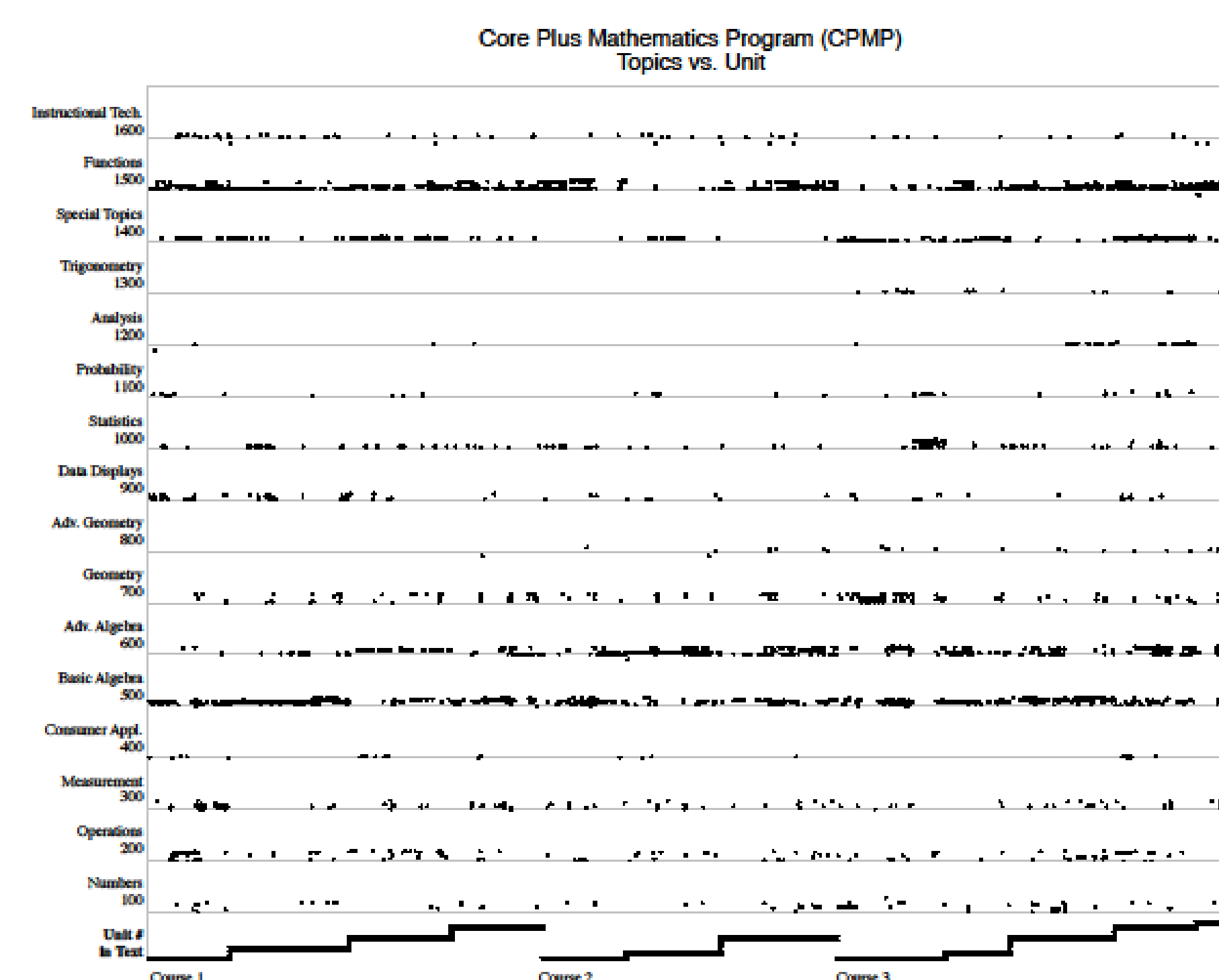
## Preliminary Findings –Cognitive Behaviors

Pie charts indicate differences in the percentage of items in each curriculum for each cognitive dimension.



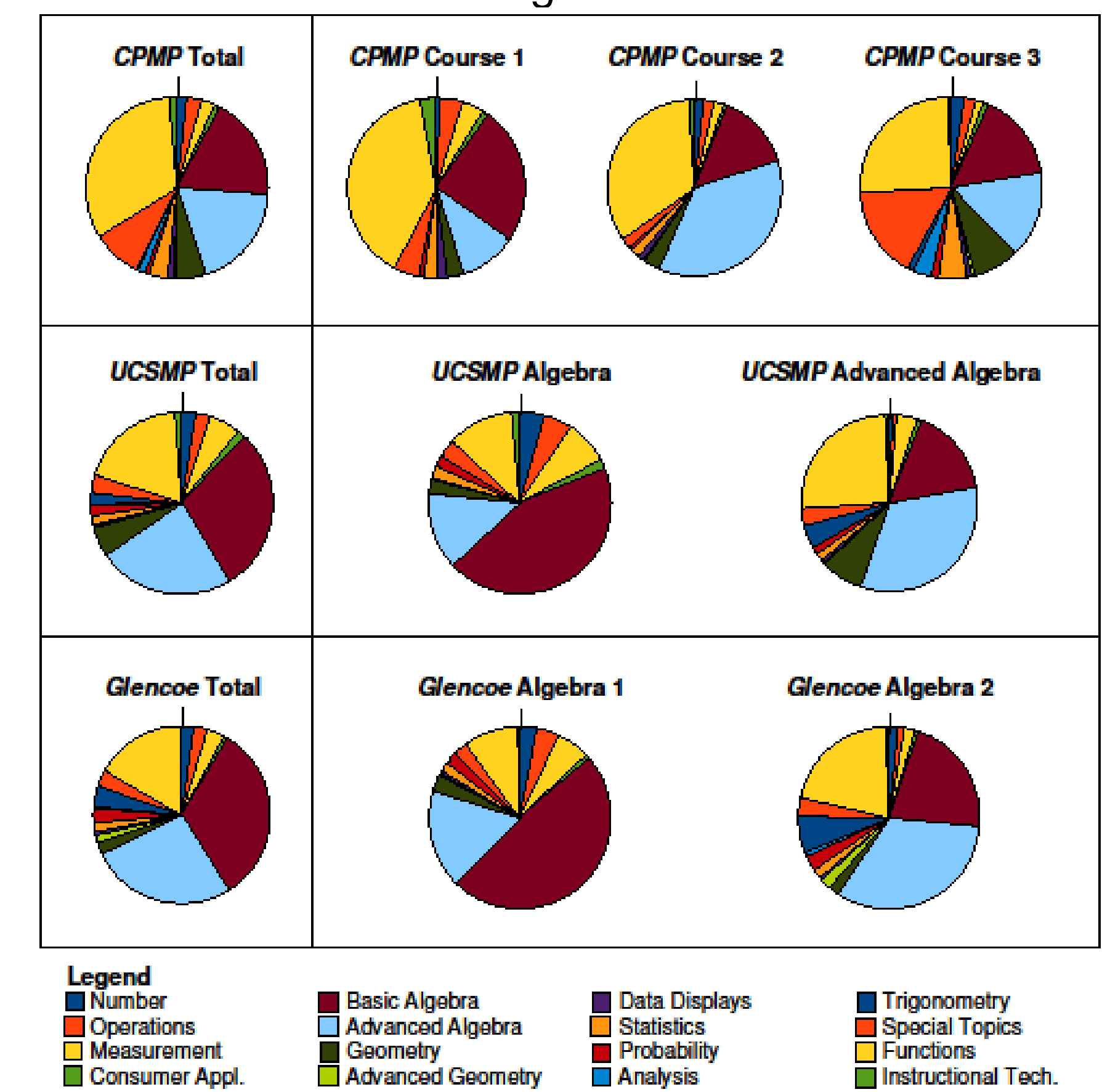
## Preliminary Findings – Content vs. Time

Plots of topic codes as a function of "time" (which is represented as the unit/chapter in the textbook) reveal differences in density, distribution, and sequencing of content topics.



## Preliminary Findings – Distribution of Content

Pie charts show the percentages of items in 16 content areas, arranged clockwise in numerical order starting from the tick mark.



## Next Steps

Use highly-specialized software, originally developed for ecologists, for analyzing massively multivariate data with very sparse matrices. (Richard Furnas, Cornell University biometrician)

## Conclusion

There is tremendous variation in the algebra content of commercially available high-school textbooks, which translate into quite different opportunities for students to learn algebra. This analysis does not tell us how these differences differentially impact student learning.