

Can Success in Calculus 1 Be Improved?

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Greater Birmingham Mathematics Partnership
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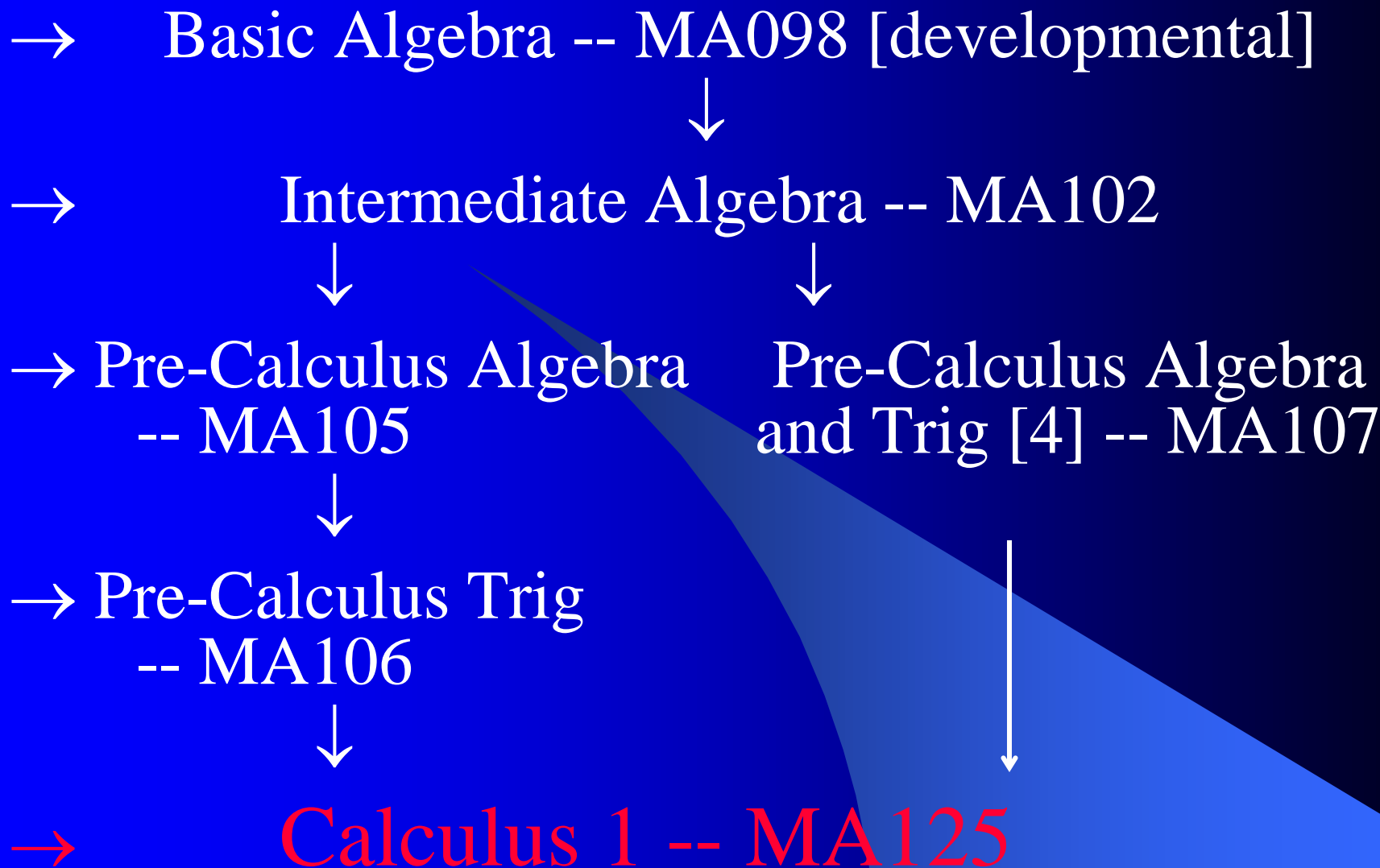
The opinions expressed herein are those of the author, and not necessarily those of the National Science Foundation.

Thanks to William Bond for
Statistical Analysis
of 6 years of
student grade data
in pre-calculus and calculus 1

Mathematics Service Goals

- Increase number of STEM majors
- STEM = Science, Technology, Engineering, and Mathematics
- Mathematics requirements:
 - Biology -- through Calculus 1
 - Chemistry -- through Calculus 2
 - Engineering -- through Calculus 3 + DE
 - Computer Science -- though Calculus 2 + two

Pre-Calculus Sequence at UAB



Computer Assisted Instruction in Pre-Calculus at UAB

● PROS

- Actively engaged with material
- More time spent on task
- On-demand help in math lab
- High tech and high touch

● CONS

- Algorithmic learning
- Emphasis on memorization
- Computation rather than thought
- Tenuous connection with Quantitative Literacy

Placement of Freshmen

- First-time Freshmen are placed into a mathematics course based upon their best ACT Mathematics sub-score
- Higher high school GPA offsets lower ACT
- Thus, ACT sub-score ranges overlap for “adjacent” courses
- 27 or higher places student into Calculus 1 (MA125) regardless of GPA
- With ACT of 25, student may place into MA105, 106, 107 or 125 depending upon GPA (and advice re trigonometry)

Placement of Freshmen

ACT Math Subscore	High School GPA	UAB Math Course
≥ 20	≥ 2.5	MA 102 Intermediate Algebra
≥ 21	na	
≥ 22	≥ 3.5	MA 105 Precalculus Algebra
≥ 23	≥ 3.0	
≥ 24	≥ 2.5	
≥ 25	na	
≥ 24	≥ 3.5	MA 107 Precalculus Algebra/Trig
≥ 25	≥ 3.0	
≥ 26	≥ 2.5	
≥ 27	na	
≥ 25	≥ 3.5	MA 106 Precalculus Trigonometry
≥ 26	≥ 3.0	
≥ 27	na	
≥ 25	≥ 3.5	MA 125 Calculus I
≥ 26	≥ 3.0	
≥ 27	na	

First-Time Freshmen -- MA125

1st Grade in MA125 for students whose 1st course at UAB was MA 125					
F+W	D	C	B	A	Total
190	22	175	300	428	1115
17.0%	2.0%	15.7%	26.9%	38.4%	100%
19.0%		81.0%			
Mean (4 point scale)			2.6762		
Standard Deviation			1.43191		

First-Time Freshmen -- MA125

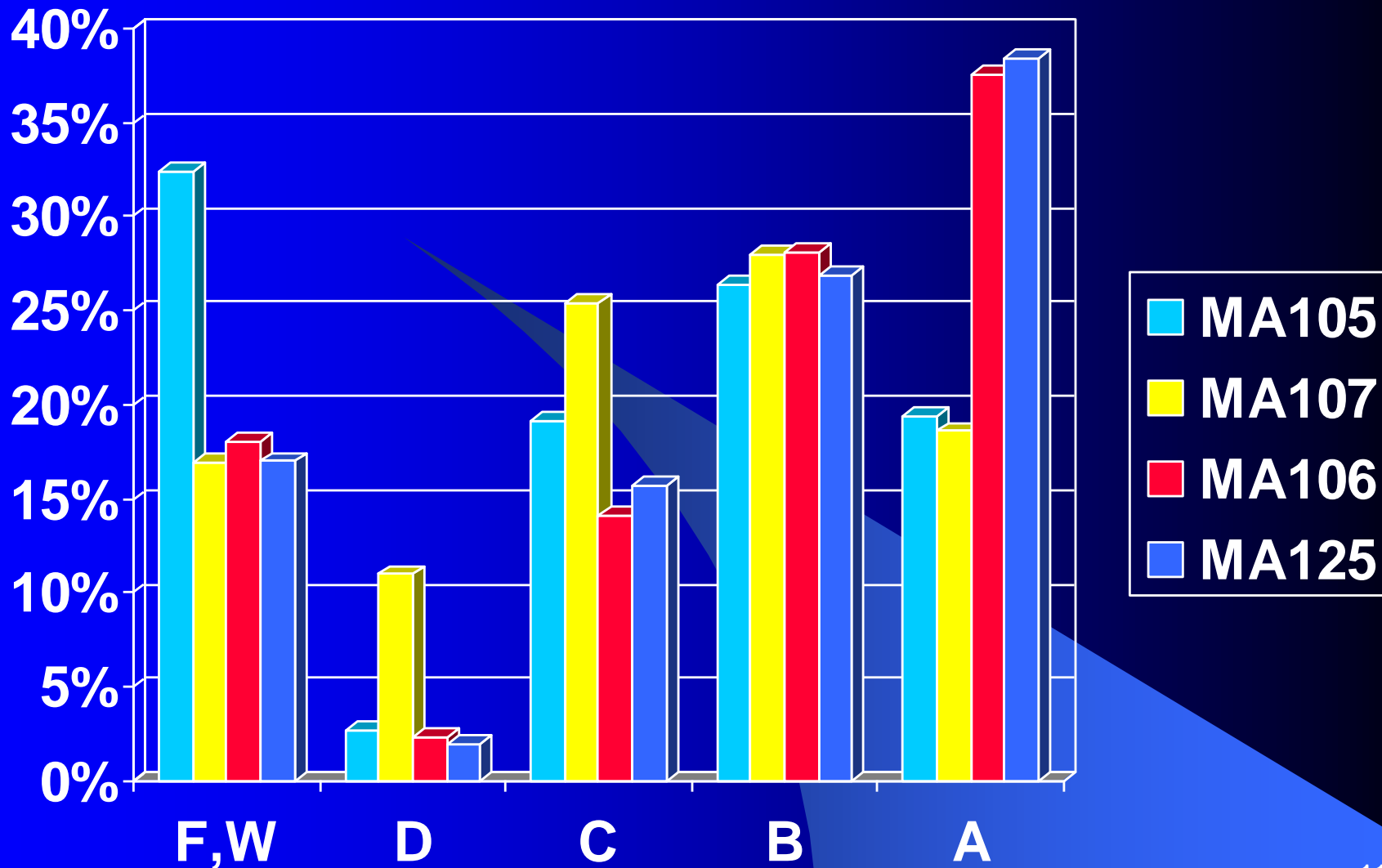
- The placement of freshmen into MA125 appears to be working well
- 81% earn A, B, or C
 - There is a ceiling effect: $\#A > \#B > \#C$
- Distribution is still bimodal
 - 17% earn F or W

First-Time Freshman - Pre-calc

Comparison of MA125 Grade Distribution Based on First UAB Math Course

Course	F+W	D	C	B	A
MA125	17.0%	2.0%	15.7%	26.9%	38.4%
MA098	61.4%	3.9%	18.8%	11.9%	3.9%
MA102	42.2%	9.8%	20.6%	18.1%	9.3%
MA105	32.4%	2.7%	19.1%	26.4%	19.4%
MA107	16.9%	11.0%	25.4%	28.0%	18.6%
MA106	18.0%	2.3%	14.1%	28.1%	37.5%

First-Time Freshman - Pre-calc



First-Time Freshman - Pre-calc

Comparison of MA125 Grades Based on First UAB Math Course

Course	Number	Mean	StdDev	Signif
MA125	1115	2.6762	1.43191	-----
MA098	101	0.9307	1.28263	0.000
MA102	204	1.4265	1.42098	0.000
MA105	299	1.9766	1.54011	0.000
MA107	118	2.2034	1.33691	0.326
MA106	128	2.6484	1.45586	0.836

Pre-Calculus Entry \rightarrow Calculus 1

- General trend: the higher level pre-calculus you enter, the better your first grade in MA125
- Threshold effect: difference loses significance between MA102 and MA106/107
- Critical threshold is MA105

MA105 vs MA106 vs MA107

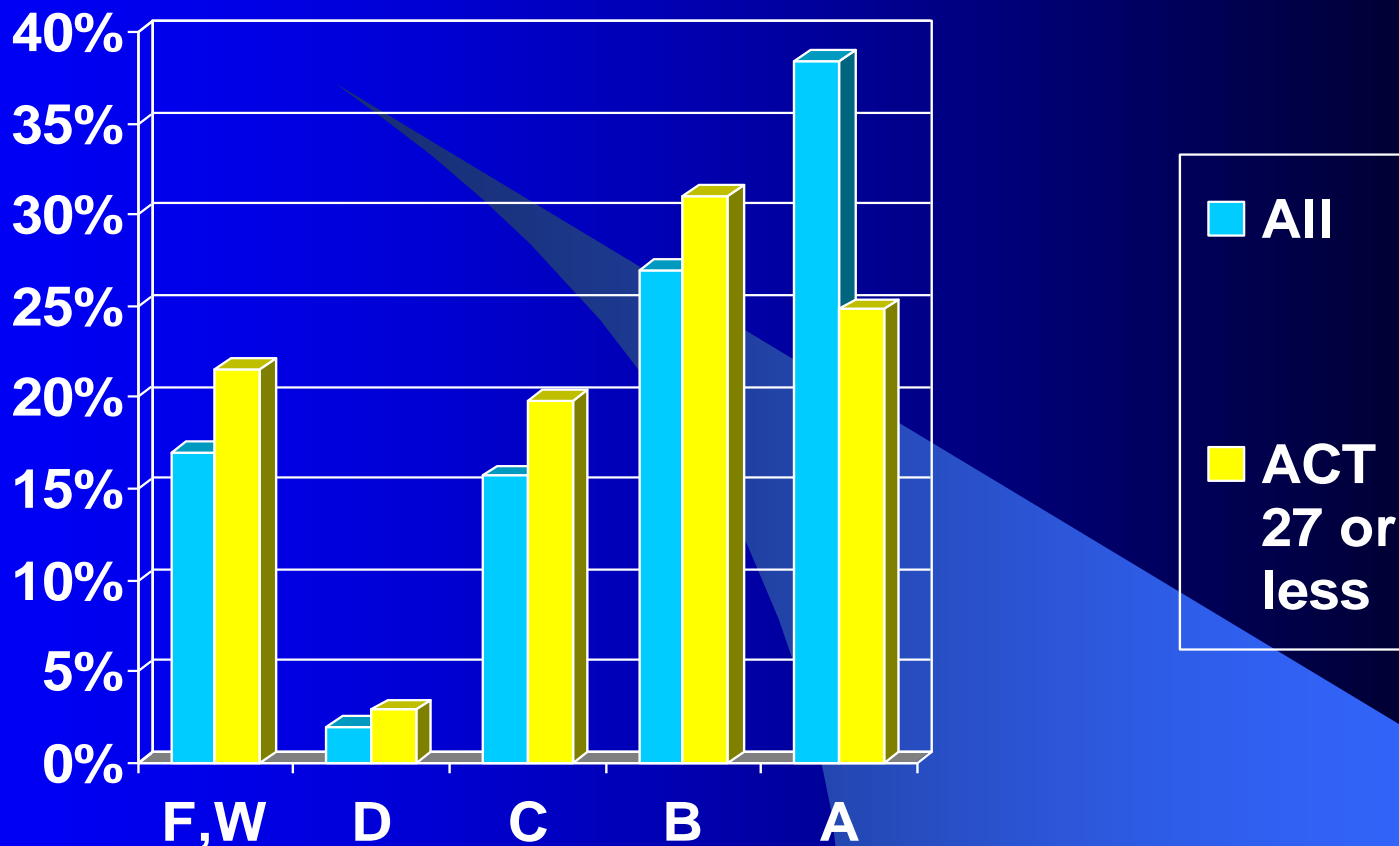
Pairwise Comparison of Grade in MA125 Based On First UAB Math Course

Course	Number	Mean	Std Dev	Signif
MA105	299	1.9766	1.54011	0.000
MA106	128	2.6484	1.45586	
MA105	299	1.9766	1.54011	0.137
MA107	118	2.2034	1.33691	
MA106	128	2.6484	1.45586	0.013
MA107	118	2.2034	1.33691	

Weakest of the Strong versus Strongest of the Weak

- Students who just “barely” place into Calculus 1:
 - Math ACT of at most 27 (& at least 25)
 - “Weakest of the strong”
- Students who place above MA102 (Intermediate Algebra) but below Calculus 1
 - Math ACT at least 22
 - “Strongest of the weak”

Grade distributions of MA125 grades for freshman who placed directly into calculus: whole group versus those whose math ACT was 27 or less

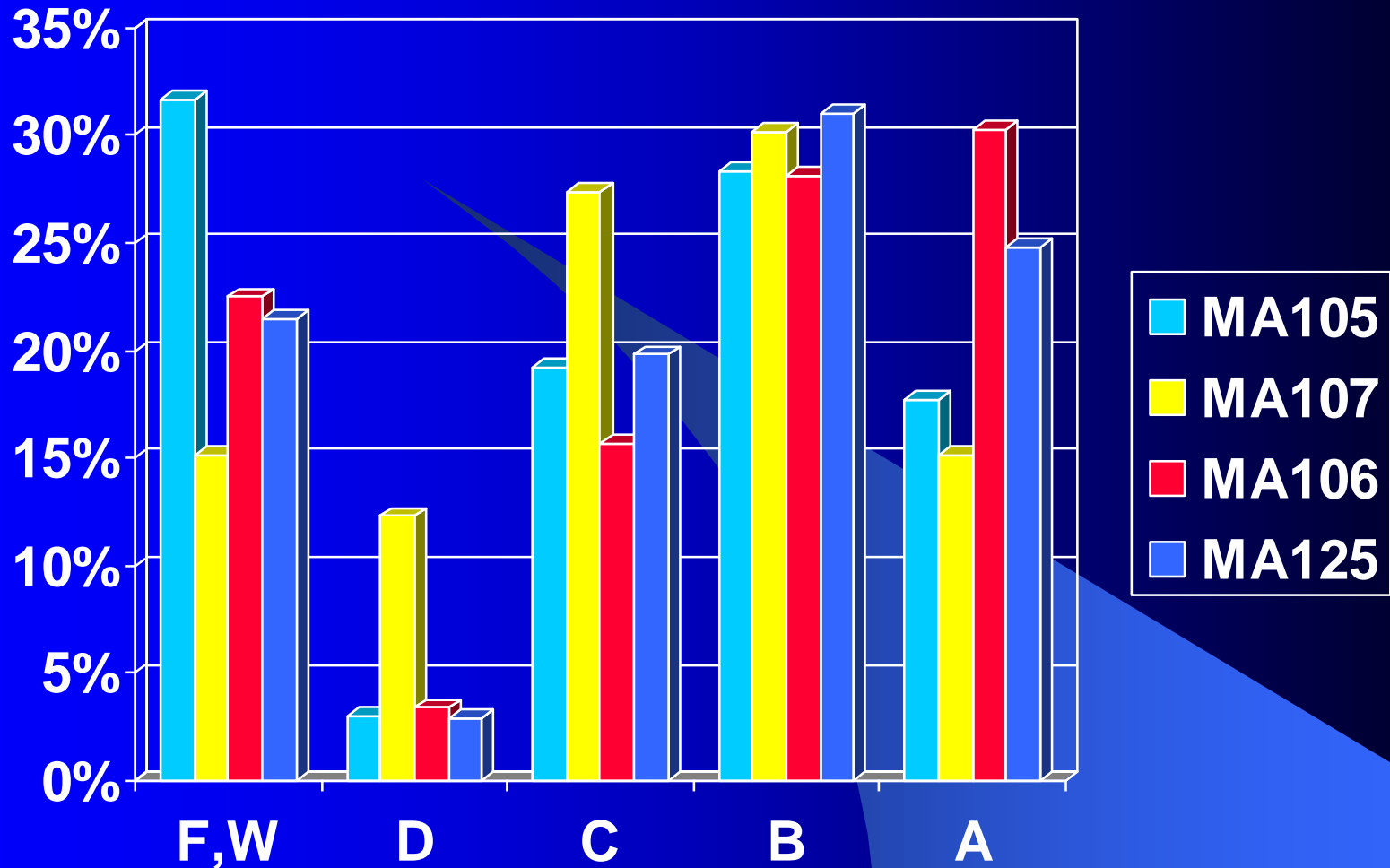


Weakest of the Strong versus Strongest of the Weak

Comparison of MA125 Grade Distribution Based on First UAB Math Course for Freshman With a 27 or Less on ACT Math Sub-score

Course	F+W	D	C	B	A
MA125	21.5%	2.9%	19.8%	31.0%	24.8%
MA105	31.7%	3.0%	19.2%	28.3%	17.7%
MA107	15.1%	12.3%	27.4%	30.2%	15.1%
MA106	22.5%	3.4%	15.7%	28.1%	30.3%

Comparison of MA125 Grade Distribution Based on First UAB Math Course for Freshman With a 27 or Less on ACT Math Sub-score



Weakest of the Strong versus Strongest of the Weak

Freshmen Whose Math ACT Sub-score Is At Most 27				
Course	Number	Mean	Std Dev	Signif
MA125	525	2.3467	1.44023	-----
MA105	265	1.9736	1.51609	0.001
MA107	89	2.1792	1.27090	0.229
MA106	106	2.4045	1.51297	0.728

By Math ACT Subscore

Grade in MA125: MA125 1st Course vs MA105 1st Course, Broken Down by ACT Math Subscore

Course	ACT Math	Number	Mean	StdDev	Signif
MA125	≤ 27	525	2.3467	1.44023	-----
MA105	22	32	1.7813	1.66044	0.068
	23	70	1.8286	1.42413	0.005
	24	71	2.3239	1.48107	0.901
	25	41	1.6098	1.53098	0.002

Cautions

- Grade distributions are not normal, so parametric statistics may miss significant differences
- Non-parametric analysis is warranted:
 - Wilcoxon Signed Ranks Test
 - Kolmogorov-Smirnov Test

Conclusions

- MA105, Pre-Calculus Algebra, appears to be a critical threshold course
- There are anomalies in MA105 data
- Further detailed study of MA 105 data is warranted
- Plans to study moving additional resources to MA105 instruction may be warranted