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Understanding the Dynamics of Student Achievement

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Three Things That Are Important to Me



I am a Methodologist Who Studies Methods, Correlates of Achievement, and am concerned with Best Practices for Teaching. Today I will Combine Those 3 Things into this Presentation

- 1) Sound Methodology is important -
Moderated Profile Analysis
- 2) Mathematics Course Taking and its Relation to
Mathematics Achievement and to Achievement Gaps
- 3) A Model of Learning to Put Things into Perspective

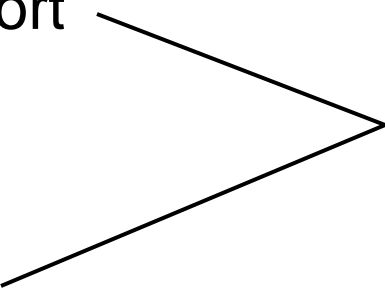


Acknowledgements



Mathematics Course-Taking and Profile Analysis

Ernest Davenport
Mark Davison
Yi-Chen Wu
Alicia Ayodele

A diagram consisting of four lines that originate from the right side of each name listed on the left and converge towards a single point on the left side of the text 'University of Minnesota'.

University of Minnesota

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Chi-Keung Chan - Hong Kong Shue Yan University



The Problem of Differences in Mathematics Achievement



- Mathematics Course Taking
 - Number of Courses vs Content of Courses
- Proper Methodology (Can't Study what we can't adequately operationalize so that it can be studied)
 - Profile Analysis
 - Moderated Profile Analysis
- Learning Models



What is a Profile and How Does it Relate to Diagnoses



For a given individual's vector of scores

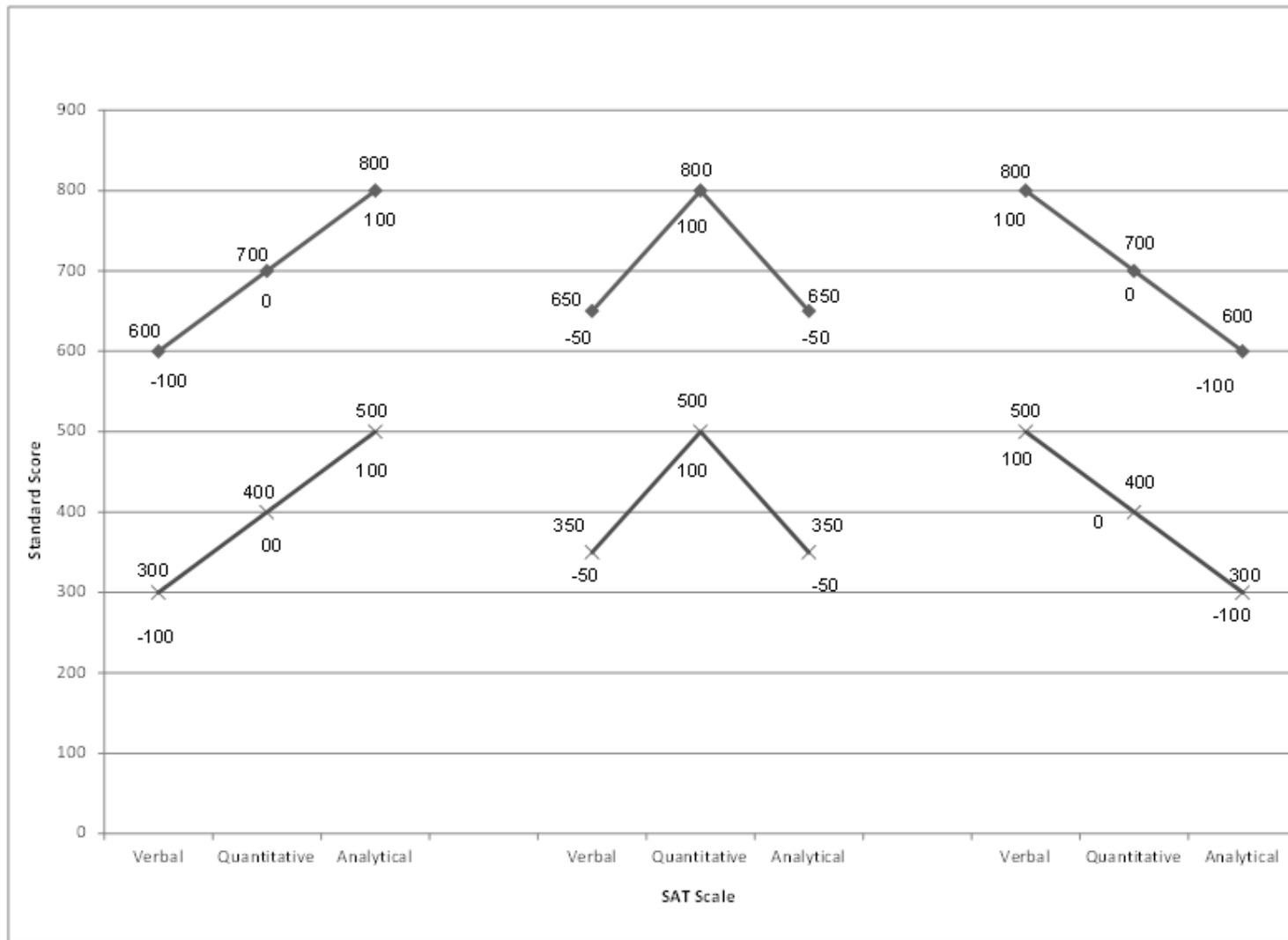
- 1) Elevation (mean)
- 2) Variability
- 3) Pattern

What is Predictive?

Cronbach, L. J., & Gleser, G. (1953).



Profile vs. Level – What’s Predictive?



Criterion Profile Analysis - CPA



Davison and Davenport (2002) proposed a two stage, linear, multiple regression procedure for empirically investigating the predictive power of profile patterns versus profile level defined over an observed score profile



Moderated Profile Analysis



Normal Prediction Equation:

$$Y'_{pz} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_KX_K$$

Davison and Davenport, 2002 show

$$Y'_{pz} = b_0 + b_1 Cov(X, b) + b_2\bar{X}$$

Normal moderated regression for two groups

$$Y'_{pz} = \sum_v \beta_v X_{pv} + \sum_v \omega_v z X_{pv} + a_F z + a_R$$

Moderated Profile Analysis for two groups

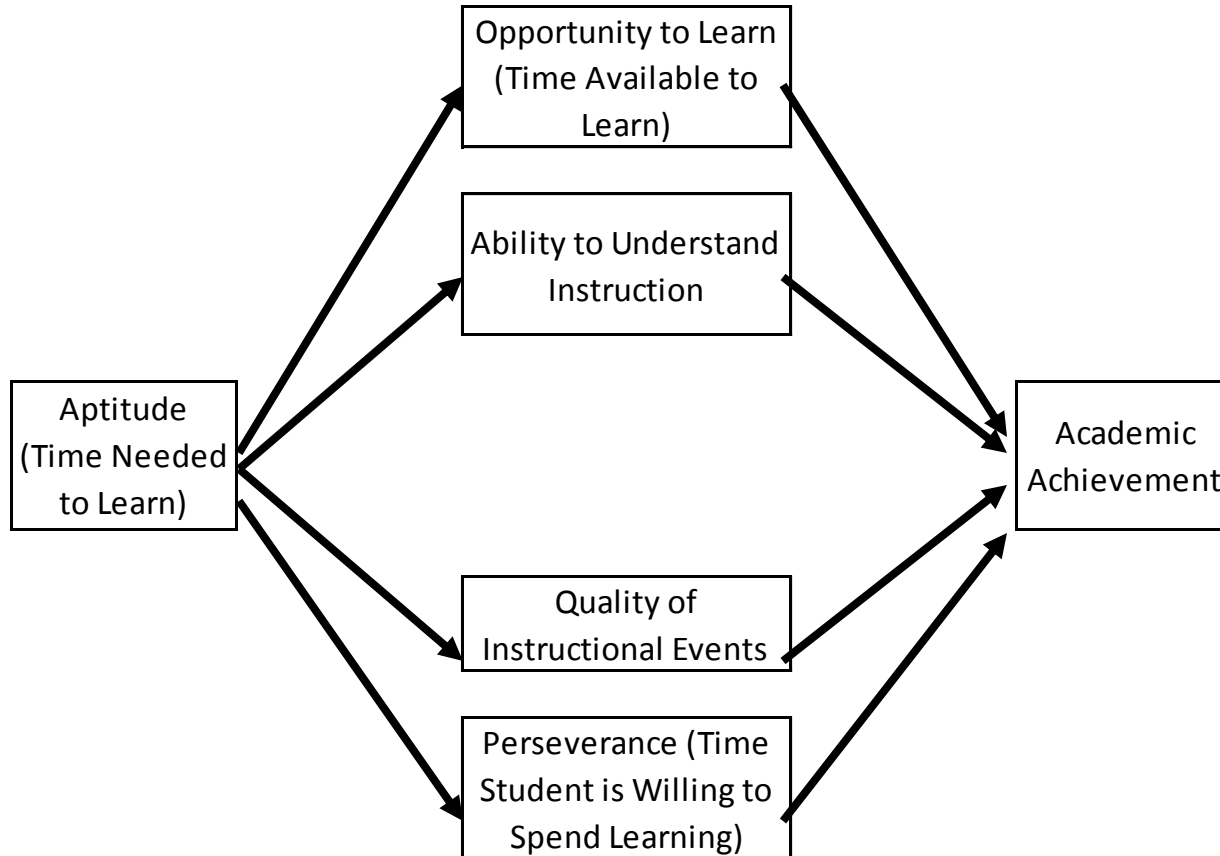
$$Y'_{pz} = \beta_R \bar{X}_p + (\beta_F - \beta_R) z \bar{X}_p + V Cov_{pR} \\ + Vz(Cov_{pF} - Cov_{pR}) + (a_F - a_R)z + a_R$$



Carroll's Model of Learning (Fairly Individualistic)

Carroll, J. B. (1963). A model of school learning. *Teachers College Record*, 64, 723-733.

Carroll, J. B. (1989). The Carroll Model: A 25-year retrospective and prospective view. *Educational Researcher*, 18, (1), 26-31.



Down to Specifics



- Mathematics Achievement and Course-Taking



Average Number of Carnegie Units of Math Taken



	1982	1987	1990	1994	1998	2000	2005
	Graduates	Graduates	Graduates	Graduates	Graduates	Graduates	Graduates
Am Indian	2.35	2.98	3.04	3.11	3.10	3.29	3.53
Asian	3.15	3.71	3.52	3.66	3.62	3.96	3.90
Black	2.61	2.99	3.20	3.23	3.42	3.54	3.71
Hispanic	2.33	2.81	3.13	3.28	3.28	3.42	3.49
White	2.68	3.01	3.13	3.36	3.40	3.56	3.69
Total	2.63	3.01	3.15	3.33	3.40	3.56	3.67

What do We See Here?

What Don't We See Here?



What Is Predictive?

- Level – Amount
- Pattern - Content



Step 1 Regression

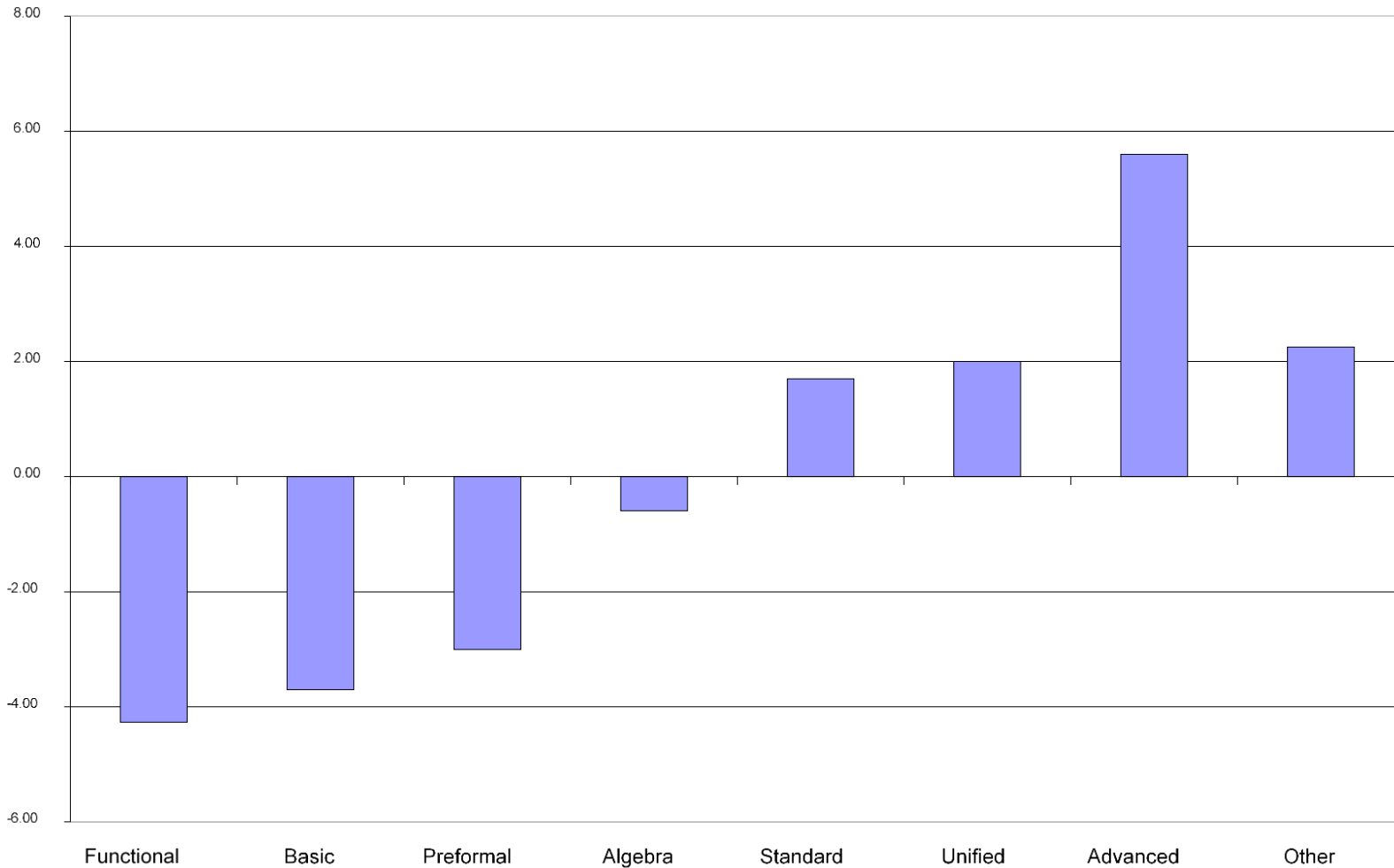


Course Category	Unstandardized Regression Weights	Standard Error*	T*	Advanced Course Pattern
Intercept	45.30	0.36	125.96	
Functional Basic	-3.59	0.69	-5.20	-4.27
Preformal	-3.02	0.30	-10.09	-3.70
Algebra	-2.32	0.16	-14.50	-3.00
Standard	0.09	0.26	0.34	-0.59
Unified	2.38	0.12	19.94	1.70
Advanced	2.67	0.19	13.91	2.00
Other	6.28	0.14	45.65	5.60
	2.94	0.22	13.56	2.26

$R^2 = 57.4\%$



A Picture of A Successful Profile



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Examples



Category	Sub 1	Sub 2	Sub 3	Sub 4
Functional			2.50	
Basic			1.50	1.00
Algebra				
Standard	1.33	2.00		1.00
Unified				1.00
Advanced	1.67	4.00		
Amount	3.00	6.00	4.00	3.00
Content	1.44	3.23	-2.03	0.00
Math 8	71.62	69.04	38.38	41.99
Math 12	66.31	67.58	35.13	45.44



What is Predictive



	Amount	Content
Individual Contribution	22.0%	57.0%
Unique Contribution <i>over and Above</i>	0.4%	35.4%

$R^2 = 57.4\%$



Effect Size Differences – More Related to Achievement than Number of Courses



	Math_8	Math_12	Amount	Content
Ethnic				
Am. Indian	-1.10	-1.17	-0.14	-0.93
Asian	0.09	0.20	0.13	0.23
Black	-0.75	-0.81	-0.02	-0.47
Hispanic	-0.63	-0.57	-0.25	-0.41



Moderated* Profile Results



- Whites were the Reference Group
- Asians are the only group that could be completely explained by Level and Content
- Other ethnic groups (Black, Hispanic, Native American) also had an ethnic effect
- Blacks and Hispanics additionally had significant Content Moderated Effects



What Does This Suggest?



- World Complex – one size may not fit all (course amount and content differentially predictive – I have given a Methodology to show this).
- Minorities often come to high school with large discrepancies (e.g. Math 8). One Cannot Simply Manipulate Course-taking without addressing prior differences
- Carroll's Model Can Aid in Addressing Discrepancies.



Addressing Discrepancies via Carroll's Model (Most Given in Terms of Time)



- Factors External to a Student
 - Time
 - Opportunity
 - Quality of Instruction

- Factors Internal to a Student
 - Student Ability
 - Preseverance



Carroll continued



- Best Practice would consist of designing educational systems that addresses and exploits these factors so that each student would maximize their learning.



Thank You!



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