

# Expanding Enrollment in Advanced Placement and More Challenging Courses: An Application of Predictive Analytics

Robert H. Meyer, University of Wisconsin-Madison & Education Analytics

Curtis Jones, University of Wisconsin-Milwaukee

Grant Sim, University of Wisconsin-Madison

*Association for Education Finance and Policy Annual Conference*

March 17, 2017

# The Challenge of Increasing Advanced Placement Opportunities for Urban Students

- This work developed from a larger project with a large urban school district.
- District leadership was committed to increasing enrollment in AP.
- We learned that roughly half of AP courses resulted in students earning either a D or F.
- Only 25% of AP course participants took the AP exam and only 10% of those taking the exam earned a 3 or better.
- The challenge to increasing AP enrollment is how to do so in a way that doesn't set more students up to fail.

# Project Objectives

- Develop and use predictive analytics tools to identify students who would be predicted to succeed in high school courses that are more advanced than they might otherwise take
  - Focus: Advanced Placement (AP) courses:
    - English Language Arts
    - Mathematics
    - Science
    - Social Studies
- Provide district with list of students who were predicted to succeed in 11<sup>th</sup> grade AP courses

# Data

- Longitudinal transcript data for grades 9-12 for 4 recent cohorts of students
- Courses in four academic subjects (mathematics, science, English/language arts, and social studies/history)
- Courses classified at 4 different levels, with classifications determined separately in each grade
- Test scores in math and reading
- Attendance rate: unexcused absences

# Student Characteristics in District

Characteristic	Cohort			
	2010-11	2011-12	2012-13	2014-15
<b>% Female</b>	48.5	49.0	48.8	50.7
<b>% Asian</b>	5.3	5.9	5.4	7.0
<b>% Black</b>	61.9	63.5	62.9	60.7
<b>% Hispanic</b>	20.1	19.8	19.8	20.8
<b>% White</b>	12.3	10.8	12.3	12.9
<b>% Other Race/Ethnicity</b>	3.3	3.5	3.8	4.9
<b>% Free/Reduced Lunch</b>	87.4	90.0	90.5	88.7
<b>% ELL</b>	11.1	12.9	12.8	10.2
<b>% Special Education</b>	23.0	23.8	25.5	28.1

# Student Achievement and Absenteeism

Mean of Characteristic	Cohort			
	2010-11	2011-12	2012-13	2014-15
H1 MAP Math	219	221	222	218
H2 MAP Math	222	224	226	N/A
H3 MAP Math	225	227	221	N/A
H1 MAP Reading	213	213	215	209
H2 MAP Reading	215	216	217	N/A
H3 MAP Reading	217	217	213	N/A
H1 Unexcused Absence Rate	10.1	8.2	12.1	12.4
H2 Unexcused Absence Rate	9.1	13.8	13.2	N/A
H3 Unexcused Absence Rate	14.9	15.0	15.1	N/A

# Analysis Steps

- Data reduction: construct course level categories: 1 – 4
  - Substantially reduces the number of course options in a given subject
- Studied course level transitions
  - There is some mobility – up and down – across course levels
  - This allows us to estimate the efficacy of up-level mobility
- Construct prediction model of course grade in H3 for each level (with primary focus on level 4) for each subject area
  - Using H2 predictors
  - Using H1 predictors
- Identify students with high probability of success in level 4 courses

## Number of Enrolled AP Courses in 2009-14, by Grade/High School (H) Level

Number of AP Courses	Grade Level				
	H1	H2	H3	H4	Total
1	119	726	1297	969	3111
2	0	74	621	380	1075
3	2	16	294	190	502
4	0	1	40	53	94
5	0	0	2	15	17
6	0	0	0	4	4
7	0	0	0	1	1



# AP Courses Taken in H3 in 2009-14, by School and Student Enrollment

Course Name	Schools		Students	
	N	%	N	%
AP United States History	15	24.59	818	6.29
AP English Language and Composition	14	22.95	751	5.78
AP Physics 1	16	26.23	445	3.42
AP Biology	12	19.67	275	2.12
AP Chemistry	7	11.48	206	1.58
AP English Literature and Composition	19	31.15	189	1.45
AP Studio Art: 2-D Design	7	11.48	147	1.13
AP United States Government and Politics	10	16.39	122	0.94
AP Spanish Language	8	13.11	122	0.94
AP Psychology	7	11.48	114	0.88
AP Environmental Science	6	9.84	101	0.78
AP Calculus AB	7	11.48	89	0.68

## AP Courses Taken in H3 in 2009-14, by School and Student Enrollment, continue

Course Name	Schools		Students	
	N	%	N	%
AP Art History	4	6.56	75	0.58
AP Physics B	2	3.28	28	0.22
AP Spanish Literature	3	4.92	24	0.18
AP World History	3	4.92	21	0.16
AP French Language	1	1.64	17	0.13
AP Statistics	3	4.92	15	0.12
AP French Literature	1	1.64	8	0.06
AP Macroeconomics	1	1.64	7	0.05
AP Microeconomics	1	1.64	7	0.05
AP Music Theory	1	1.64	7	0.05

# Typical English Courses by Level and Year of High School

Level	H1	H2	H3
First	Strategic Reading	English 9	English 10
Second	English 9	Creative Writing, English 10	English 11
Third	Communications Media, Short Fiction	American Authors, Composition	Honors English 11
Fourth	Honors English 9	Honors English 10	AP English Lit. Comp., AP English Lang. Comp.

# Typical Mathematics Courses by Level and Year of High School

Level	H1	H2	H3
First	Math Investigations	Algebra, Math Investigations	Geometry
Second	Algebra	Geometry	Transition to College Math
Third	Geometry	Honors Geometry	Algebra 2 and Trig.
Fourth	Honors Algebra	Algebra 2 and Trig.	Pre-Calculus

# Typical Social Studies Courses by Level and Year of High School

Level	H1	H2	H3
First	World Geography	World Geography	Citizenship
Second	Citizenship	Citizenship, World History, World Studies	Economics, U.S. History
Third	U.S. History, World History, World Studies	U.S. History	Psychology, Sociology
Fourth	Honors World History	AP World History	AP U.S. History

# Typical Science Courses by Level and Year of High School

Level	H1	H2	H3
First	Earth Science, Environmental Science	Physical Science	Biology 1
Second	Physical Science	Biology 1	Chemistry 1
Third	Biology 1	Chemistry 1	Biology 2, Human Physiology Anatomy
Fourth	Chemistry 1, Honors Biology	Honors Chemistry, Physics 1	AP Biology, AP Chemistry, Physics 1

# Science Course Level Paths from H2 to H3 in First Three Cohorts

H2 Level	H3 Level				
	First	Second	Third	Fourth	Total
First	572	404	60	25	1,061
Second	916	2,655	367	209	4,147
Third	301	1,068	436	615	2,420
Fourth	27	198	171	362	758
Total	1,816	4,325	1,034	1,211	8,386

# Science Course Level Paths from H1 to H3 in First Three Cohorts

H1 Level	H3 Level				
	First	Second	Third	Fourth	Total
First	55	68	10	2	135
Second	1,155	2,410	423	173	4,161
Third	513	1,593	469	876	3,451
Fourth	25	141	101	159	426
Total	1,748	4,212	1,003	1,210	8,173



# Model of Level 4 Grades in H3 given H2 Predictors

Parameters Estimates (Std. Err.)				
Variable	Subject			
	English	Mathematics	Science	Social Studies
Intercept	-2.949*** (0.528)	-2.936*** (0.854)	-2.081*** (0.547)	-3.908*** (0.599)
MAP Math Score	0.002 (0.002)	0.010** (0.004)	0.011*** (0.002)	0.007** (0.003)
MAP Reading Score	0.014*** (0.003)	0.007 (0.004)	0.005 (0.003)	0.016*** (0.003)
Unexcused Absence Rate	-2.614*** (0.531)	-5.368*** (0.836)	-1.799** (0.606)	-2.681*** (0.643)
Level 1	-0.337 (0.740)	N/A	0.306 (0.478)	0.456 (0.531)
Level 3	0.293 (0.341)	-0.197 (0.532)	-0.355* (0.161)	-0.102 (0.232)
Level 4	0.174 (0.167)	-0.109 (0.378)	-0.413* (0.191)	-0.799*** (0.198)
Course Grade	0.537*** (0.044)	0.563*** (0.111)	0.307*** (0.055)	0.345*** (0.045)
Level 1 x Course Grade	0.029 (0.294)	N/A	-0.128 (0.196)	-0.290 (0.187)
Level 3 x Course Grade	0.008 (0.110)	0.117 (0.165)	0.087 (0.065)	0.103 (0.079)
Level 4 x Course Grade	0.017 (0.056)	0.067 (0.118)	0.118 (0.072)	0.325*** (0.069)
Model R <sup>2</sup>	0.324	0.448	0.278	0.350

# Model of Level 4 Grades in H3 given H1 Predictors

Parameter Estimates (Std. Err.)				
Variable	Subject			
	English	Mathematics	Science	Social Studies
Intercept	-2.586*** (0.566)	-2.531*** (0.967)	-0.935 (0.630)	-4.590*** (0.662)
MAP Math Score	0.005* (0.003)	0.018*** (0.004)	0.010*** (0.003)	0.010*** (0.003)
MAP Reading Score	0.012*** (0.003)	-0.002 (0.005)	0.001 (0.003)	0.016*** (0.003)
Unexcused Absence Rate	-4.331*** (0.705)	-10.117*** (1.508)	-0.935 (0.726)	-1.324 (0.894)
Tier 1	N/A	N/A	N/A	1.057** (0.338)
Tier 3	-0.290 (0.624)	-0.698 (0.358)	-0.253 (0.180)	-0.345 (0.218)
Tier 4	-0.062 (0.173)	0.038 (0.322)	-0.746** (0.283)	0.302 (0.241)
Course Grade	0.392*** (0.032)	0.403*** (0.076)	0.224** (0.064)	0.374*** (0.048)
Level 1 x Course Grade	N/A	N/A	N/A	-0.243* (0.120)
Level 3 x Course Grade	0.117 (0.207)	0.178 (0.112)	0.132 (0.070)	0.047 (0.072)
Level 4 x Course Grade	0.020 (0.061)	-0.072 (0.105)	0.266** (0.102)	-0.193* (0.084)
Model R <sup>2</sup>	0.239	0.288	0.206	0.247

## Students Predicted to Succeed in H3 Level 4 Course in 2016-2017 Given Different Thresholds

Subject	Threshold: Probability of Success		
	>50%	>60%	>70%
English	20.3%	12.6%	6.3%
Math	18.6%	13.2%	8.2%
Science	26.1%	16.0%	7.9%
Social Studies	22.9%	14.4%	7.0%

- Note to us: On that previous slide we indicate that 15% of students (for which we can compute predictions) would succeed in a Level 4 science course. Grant and I will add in some #s to put that in perspective; that is, how many students typically take a Level science course. We have those numbers and just need to grab them.

# District use of predictive analytics to organize AP course planning process

- We are continuing to work with the district to embed these results within the school course planning process.
- All schools received lists of students with their expected performance in advanced classes.
- It turned out that there were more students not taking AP who would be expected to do well than there were who were taking AP that were expected to struggle.
- Schools are instructed to use the information as a recruitment tool and also to identify students likely to need support if they are going to succeed in AP. The data should not be used to exclude students from AP.
- Although not many reported using the data last year, more are expected to use it this year.
- There has been a clear trend in the last year that more students are taking AP and that their grades have improved.