

# Multilevel analysis of student pathways to college

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# Pathways to college

- There has been a growing demand for college preparation over the past thirty years in the U.S. Currently, nine out of every ten U.S. high school sophomores intend to pursue postsecondary education.
- A major focus of education policy in the United States is improving both the quality and rigor of core courses taught in schools and ensuring that all students have access to these courses.

# High School Course-taking

- Course-taking patterns are both related to student and school background and linked with later attainment.
- Ethnic minorities, students from less affluent backgrounds, and public school students tend to take less rigorous courses while in HS than do their peers (Alexander and Cook, 1982; Finn, Gerber, and Wang, 2002; Hoffer, Greeley and Coleman, 1985).
- Students who take less rigorous courses are less likely to attain a college degree and do not do as well in the workforce as students who take more rigorous courses (Adelman 1999; Altonji, 1995; Hotchkiss and Dorsten; 1987).

# Focus of this study

- 1. Curricular landscape for contemporary American HS students.
  - What is their course-taking patterns in Mathematics, science, foreign language, and English?
  - Do these patterns vary across background characteristics of the student and the schools they attend?
- 2. Linkage between academic pathways and their preparation for postsecondary life.
  - What is the association between course-taking patterns with college entrance?
  - Do these patterns vary across their major?

# Data

- This study uses transcript data from the **Education Longitudinal Study (ELS: 2002)** to provide nationally representative information about the level of academic preparation the high school graduating class of 2003-04 had when leaving high school.
- ELS: 2002 is the most recent secondary school longitudinal study conducted by the **National Center for Education Statistics (NCES)** at the U.S. Department of Education.

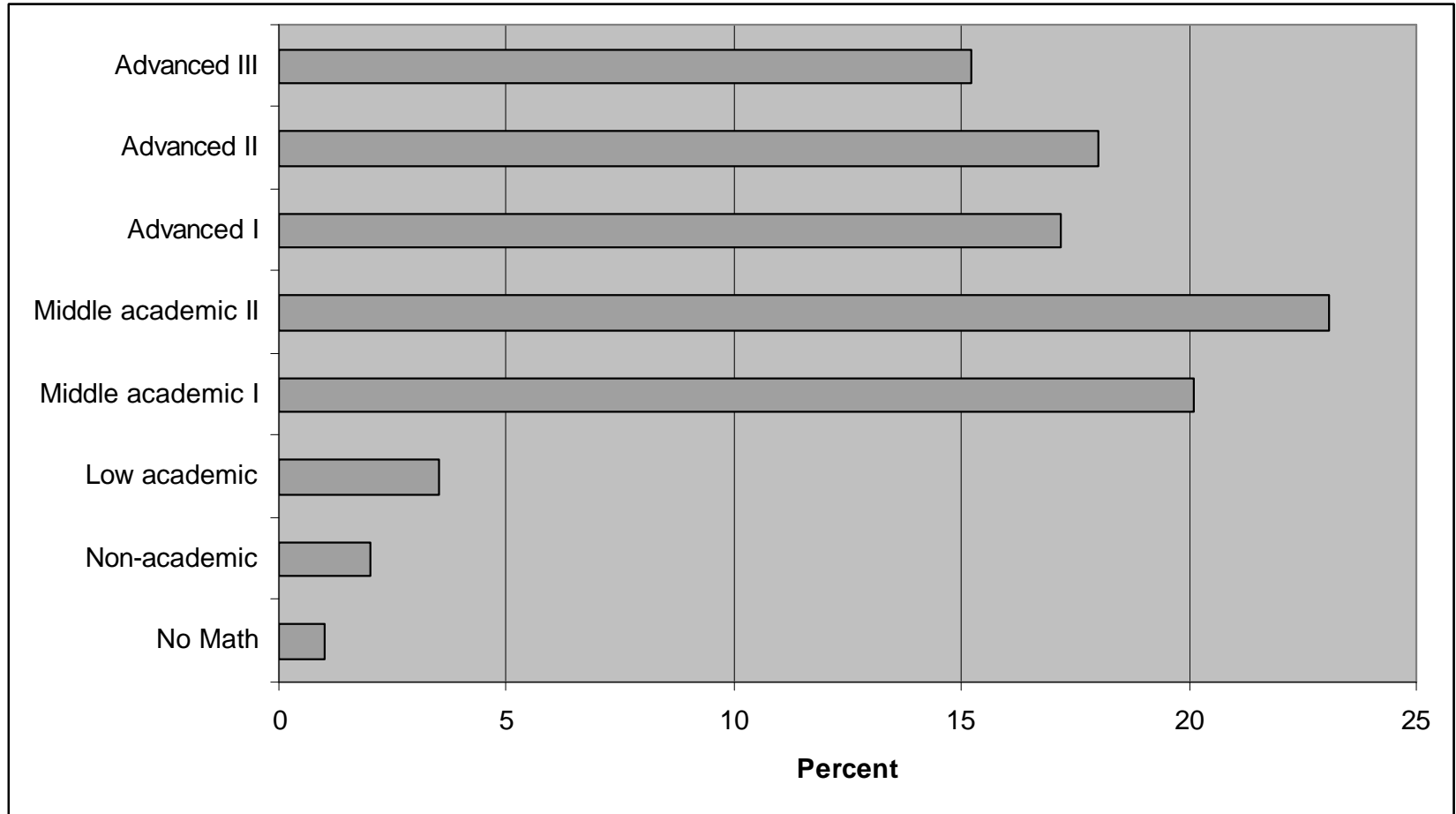
# Measuring High School Course-taking

- Academic pipeline measure which measures the highest level of coursework completed in different subjects.
- Academic pipelines organize transcript data in different subjects into levels based on the normal progression and difficulty of courses within these subject areas.
- It permits comparisons of graduates who completed courses at each level in a given year who reach each of the levels, as well as comparisons among different graduating classes.

# Mathematics pipeline

- Burkam and Lee (2003) developed mathematics and science pipeline measures.
- 1. **No mathematics**: students who completed either no coursework in mathematics or only basic or remedial-level mathematics.
- 2. **Non-academic**: nonacademic courses (general, basic skills, consumer mathematics)
- 3. **Low academic**: Highest completed course is pre-algebra; algebra I (part I), or algebra I (part II)
- 4. **Middle academic I** (Algebra I/ Geometry level)
- 5. **Middle academic II** (Algebra II level)
- 6. **Advanced mathematics I** (Trigonometry/Algebra III level)
- 7. **Advanced mathematics II** (Pre-calculus level)
- 8. **Advanced mathematics III** (Calculus level): Highest completed course is Advanced Placement (AP) calculus; calculus; or calculus/analytical geometry.

# Percentage of high school graduates who completed mathematics courses by highest level of coursework completed: class of 2004

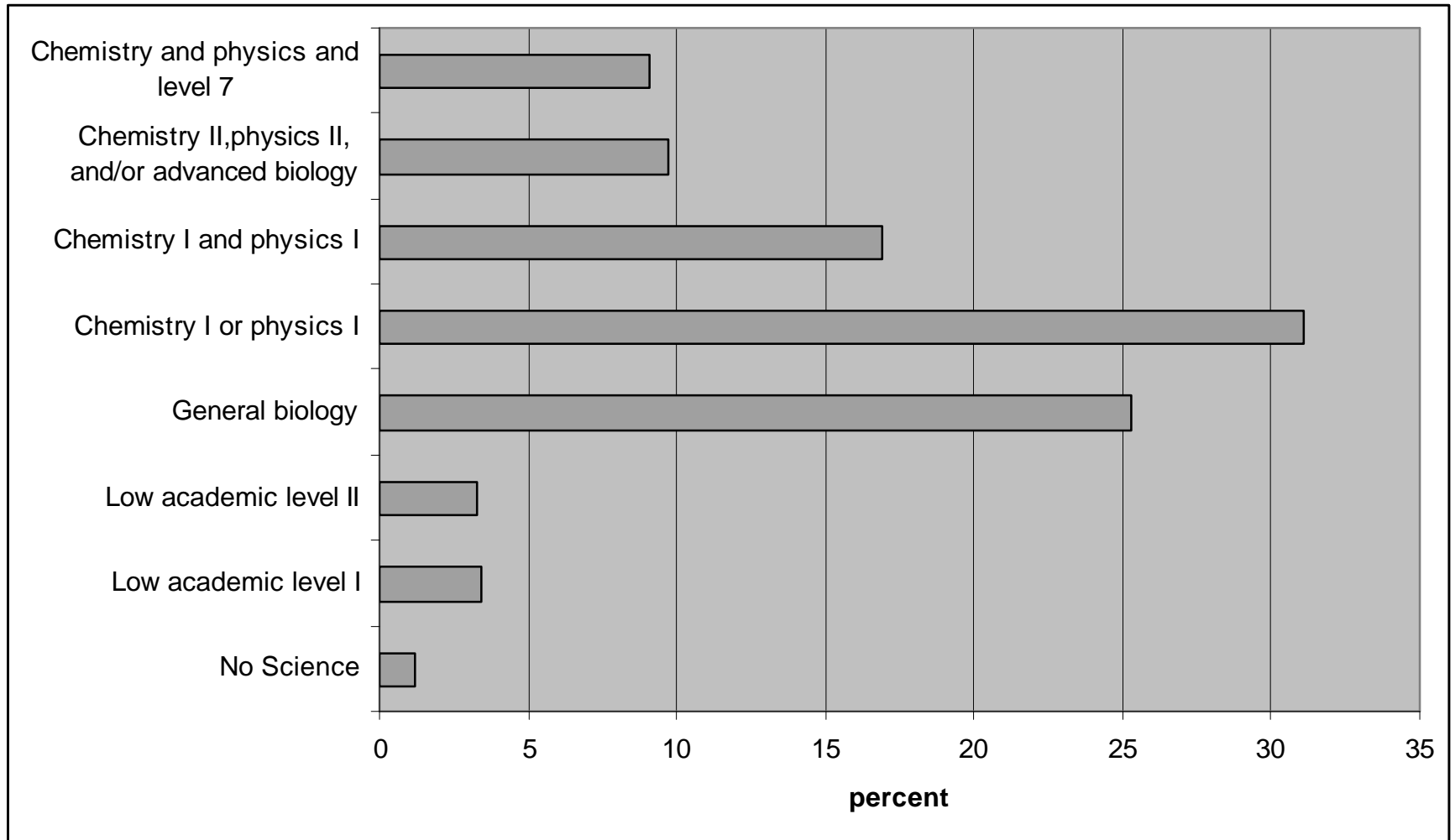




# Science pipeline

- 1. **No science**: students who completed either no coursework in science or only basic or remedial-level science.
- 2. **Low academic level I**: Primary physical science (physical science , earth science or unified science)
- 3. **Low academic level II**: Secondary physical science and basic biology (astronomy, geology, environmental science, oceanography, general physics, basic biology I, consumer or introductory chemistry)
- 4. **General biology**: Highest completed course is general biology I; secondary life science (including ecology, zoology, marine biology, and human physiology); or general or honors biology II.
- 5. **Advanced level I: Chemistry I or Physics I**: Highest completed course is introductory chemistry, chemistry I, organic chemistry, physical chemistry, consumer chemistry, general physics, or physics I.
- 6. **Advanced level II: Chemistry I and Physics I**
- 7. **Advanced level III: Chemistry II or Physics II or Advanced Biology**: Highest completed course is advanced biology, International Baccalaureate (IB) biology II, IB biology III, AP biology, field biology, genetics, biopsychology, biochemistry and biophysics, botany, cell and molecular biology, microbiology, anatomy, and miscellaneous specialized areas of life sciences, chemistry II, IB chemistry II, IB chemistry III, AP chemistry, physics II, IB physics, AP physics B/C.
- 8. **Advanced level IV: Chemistry and physics and level 7**

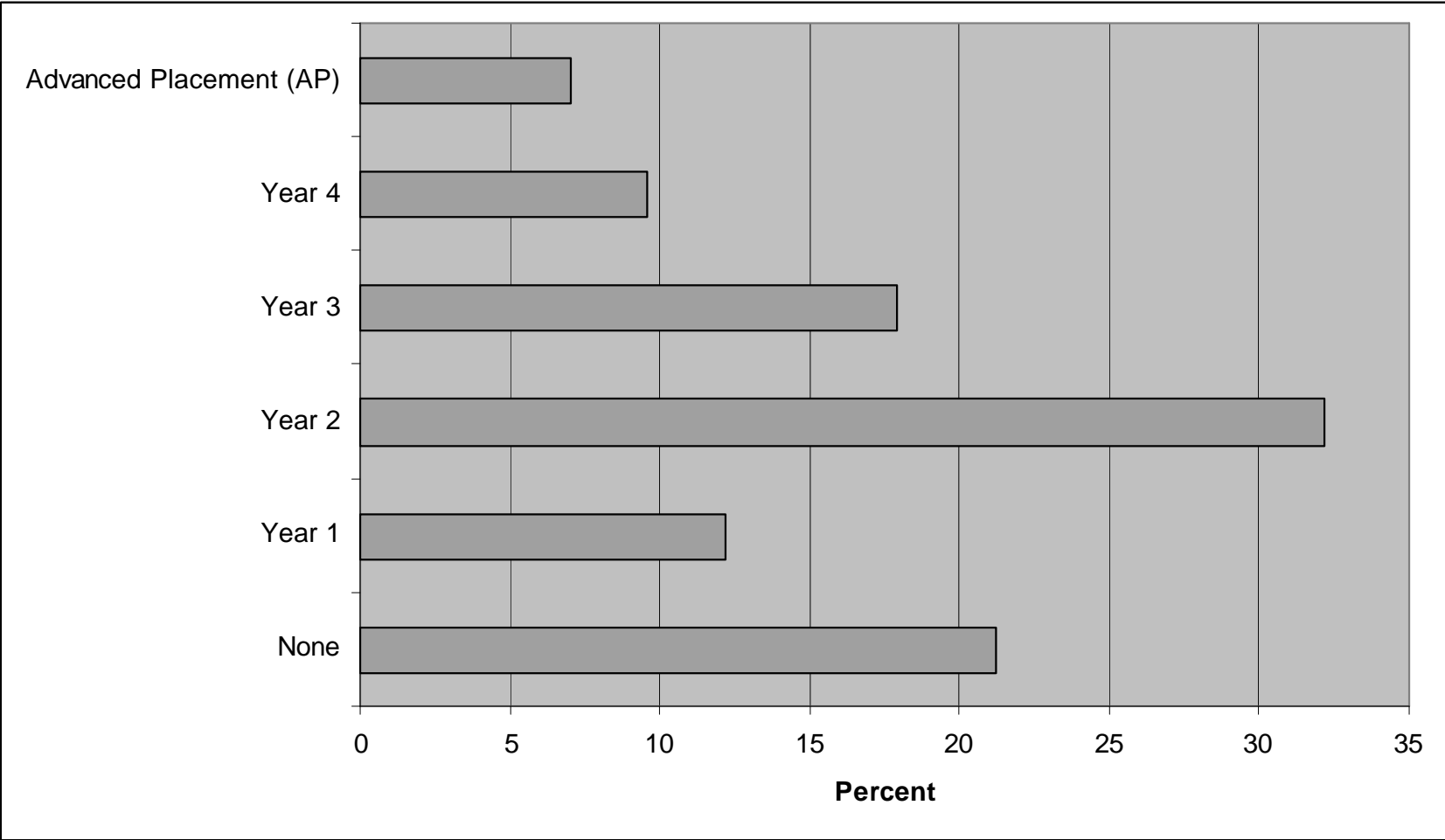
# Percentage of high school graduates who completed science courses by highest level of coursework completed: class of 2004



# Foreign Language pipeline

- 1. None: students who completed no coursework in foreign language.
- 2. Year 1 (1 year of 9th-grade instruction) or less: Graduate completed no more than either a full Carnegie unit (1 academic year of coursework) of 9th grade (year 1) foreign language instruction or half a Carnegie unit of 10th grade (year 2) foreign language instruction.
- 3. Year 2 (1 year of 10th-grade instruction) or less
- 4. Advanced level I: Year 3 (1 year of 11th-grade instruction) or less
- 5. Advanced level II: Year 4 (1 year of 12th-grade instruction) or less
- 6. Advanced level III: AP Instruction

# Percentage of high school graduates who completed foreign language courses by highest level of coursework completed: class of 2004



# English pipeline

- English pipeline measures are more difficult to develop because there is no common or easily defined set of sequence for English language and literature courses.
- Advanced English course taken at the Advanced Placement/International Baccalaureate (AP/IB) level. For example, if a student earned more than 1 unit of total Carnegie units in AP/IB English courses, we coded as advanced English courses taken.
- Only 14.2% of 2004 high school graduates completed AP/IB English courses

# Description of Variables

- Student-level independent variables
  - Ethnicity
  - Gender
  - Prior achievement (Math, Reading)
  - SES
- School-level independent variables
  - School mean SES
  - % 10<sup>th</sup> graders in college prep program
  - % 10<sup>th</sup> graders are LEP or non-English proficient
  - % 10<sup>th</sup> graders receive free/reduced-price lunch
  - % full-time teachers are certified
  - # of full-time math, science, English, foreign language teachers
  - % of 2003 graduates went to 4-year colleges

# Results of Multilevel logistic models of Mathematics Course taking: Student-level

(Ref category = Algebra II)

	Calculus	Pre-calculus	Trigonometry	Algebra I	Non/Low
Male	<b>0.44</b>	<b>0.5</b>	<b>0.63</b>	<b>0.72</b>	<b>1.37</b>
Asian	<b>4.77</b>	<b>2.34</b>	<b>1.46</b>	<b>1.27</b>	<b>0.52</b>
African American	<b>2.74</b>	<b>2.32</b>	<b>2.1</b>	<b>1.86</b>	<b>0.8</b>
Hispanic	<b>1.74</b>	<b>1.54</b>	1.03	1.18	<b>0.47</b>
Other	0.92	0.81	<b>0.73</b>	0.95	0.73
SES	<b>1.81</b>	<b>1.57</b>	<b>1.36</b>	<b>1.2</b>	<b>0.85</b>
Math	<b>9.54</b>	<b>5.2</b>	<b>2.39</b>	<b>1.77</b>	<b>0.51</b>
Reading	<b>1.56</b>	<b>1.38</b>	<b>1.42</b>	<b>1.23</b>	<b>0.83</b>

# Results of Multilevel logistic models of Mathematics Course taking: School-level

(Ref category = Algebra II)

	Calculus	Pre-calculus	Trigonometry	Algebra I	Non/Lo w
Public	0.77	<b>0.72</b>	0.73	<b>0.66</b>	<b>3.96</b>
4-yr college	<b>1.34</b>	<b>1.24</b>	<b>1.28</b>	<b>1.06</b>	<b>0.94</b>
College prep	<b>1.58</b>	<b>1.51</b>	<b>1.5</b>	<b>1.16</b>	<b>1.12</b>
Teachers Help	<b>1.14</b>	<b>1.1</b>	<b>0.96</b>	<b>0.98</b>	<b>1.04</b>
Parents Help	<b>1.04</b>	<b>1.17</b>	<b>1.17</b>	<b>1.08</b>	<b>1.06</b>
Full-time teachers	0.99	<b>1.06</b>	<b>1.09</b>	0.96	0.96
Full-time counselors	<b>1.11</b>	<b>1.01</b>	<b>1.04</b>	<b>1.04</b>	<b>1.07</b>



# Results of Multilevel logistic models of Science Course taking : Student-level

(Ref category = CHEM 1/ PH1)

	CHEM 2& PH2	CHEM 2/ PH2	CHEM 1& PH1	Gen Bio	Second ary	No/Prim ary
Male	<b>1.05</b>	<b>0.83</b>	<b>1.18</b>	<b>1.44</b>	<b>1.64</b>	<b>2.14</b>
Asian	<b>3.14</b>	<b>1.61</b>	<b>1.5</b>	<b>0.46</b>	<b>0.35</b>	0.81
African American	<b>1.15</b>	0.72	1.12	<b>0.62</b>	<b>0.25</b>	<b>0.62</b>
Hispanic	0.78	<b>1.07</b>	1.06	<b>0.7</b>	<b>0.45</b>	<b>0.67</b>
Other	1.22	0.86	1.17	0.95	1.27	0.78
SES	<b>1.25</b>	<b>1.09</b>	<b>1.08</b>	<b>0.79</b>	<b>0.69</b>	<b>0.63</b>
Math	<b>3.51</b>	<b>1.24</b>	<b>1.8</b>	<b>0.63</b>	<b>0.48</b>	<b>0.43</b>
Reading	<b>1.27</b>	<b>1.24</b>	1.06	<b>0.74</b>	<b>0.59</b>	<b>0.56</b>

# Results of Multilevel logistic models of Science Course taking : School-level

(Ref category = CHEM 1/ PH1)

	CHEM 2& PH2	CHEM 2/ PH2	CHEM 1& PH1	Gen Bio	Second ary	No/Prim ary
Mean SES	<b>1.28</b>	0.8	<b>1.28</b>	0.94	1.08	1.24
Public	<b>1.34</b>	1.04	<b>0.89</b>	<b>1.35</b>	<b>1.77</b>	<b>9.41</b>
4-yr college	<b>1.31</b>	<b>1.12</b>	<b>1.07</b>	<b>1.35</b>	<b>0.74</b>	<b>0.61</b>
Teachers Help	<b>1.11</b>	<b>1.17</b>	0.97	1.02	1.01	0.87
Full-time teachers	<b>1.18</b>	0.99	<b>1.14</b>	1	0.94	0.9

## Results of Multilevel logistic models of Foreign Language Course taking : Student-level (Ref category = Year 1-2)

	AP	Year 4	Year 3	None
Male	<b>0.41</b>	<b>0.48</b>	<b>0.6</b>	<b>1.74</b>
Asian	<b>1.44</b>	<b>1.18</b>	<b>1.29</b>	<b>1.8</b>
African American	0.86	0.85	1.12	<b>0.63</b>
Hispanic	<b>5.6</b>	<b>1.6</b>	<b>1.47</b>	<b>0.63</b>
Other	0.67	0.69	0.87	<b>1.38</b>
SES	<b>1.13</b>	<b>1.25</b>	<b>1.12</b>	<b>0.74</b>
Math	<b>2.44</b>	<b>1.86</b>	<b>1.62</b>	<b>0.61</b>
Reading	<b>1.6</b>	<b>1.53</b>	<b>1.27</b>	<b>0.66</b>

## Results of Multilevel logistic models of Foreign Language Course taking : School-level (Ref category = Year 1-2)

Mean SES	<b>1.77</b>	<b>1.42</b>	<b>1.4</b>	1
Public	<b>2.85</b>	1.07	<b>1.32</b>	1.41
College prep	<b>1.65</b>	<b>1.24</b>	<b>1.31</b>	<b>0.8</b>
Counselors Help	<b>1.14</b>	<b>1.15</b>	1.07	0.99
Teachers Help	<b>1.27</b>	0.92	<b>1.06</b>	<b>1.1</b>
Full-time teachers	<b>1.27</b>	<b>1.36</b>	<b>1.25</b>	1.01

# Results of Multilevel logistic models of English Course taking (Ref category = No AP/IB)

	AP/IB
<b>Male</b>	<b>0.33</b>
<b>Asian</b>	<b>2.68</b>
<b>African American</b>	1.17
<b>Hispanic</b>	0.95
<b>Other</b>	1.11
<b>SES</b>	<b>1.61</b>
<b>Math</b>	<b>2.67</b>
<b>Reading</b>	<b>2.7</b>
<b>Public</b>	<b>2.07</b>
<b>College Prep</b>	<b>1.46</b>
<b>Counselors Help</b>	<b>1.11</b>
<b>Teachers Help</b>	<b>1.15</b>

# Course taking and postsecondary educational outcomes

- Given the differences in course taking patterns, differences in postsecondary educational outcomes are not surprising.
- Among students who graduated and enrolled in college, how do their high school course taking patterns in mathematics, science, foreign language and English affect their postsecondary institution types (4yr –highly selective, moderately selective, 4yr-inclusive, 2yr or less)?

# Selectivity of postsecondary institution

- IPEDS institutional level and Carnegie institutional selectivity measure.
- (1) Highly selective 4-year institution (corresponds to 25th percentile ACT-equivalent scores of greater than 21)
- (2) Moderately selective 4-year institution (corresponds to 25th percentile ACT-equivalent scores of 18 to 21)
- (3) Inclusive, 4-year institution (corresponds to 25th percentile ACT-equivalent scores of less than 18)
- (4) Other 4-year institution
- (5) Two-year institution; and
- (6) Less-than 2-year institution.

## *Results of Multinomial Logistic models of Mathematics Course-taking By Major*

	All		Business		Health		STEM		Other	
Highest course	<i>OR</i>	<i>p</i>	<i>OR</i>	<i>p</i>	<i>OR</i>	<i>p</i>	<i>OR</i>	<i>p</i>	<i>OR</i>	<i>P</i>
Highly selective										
Calculus	37.87	***	40.72	***	48.97	***	44.45	***	20.83	***
Pre-calculus	24.05	***	36.24	***	11.85	***	8.78	**	8.84	***
Trigonometry	7.39	***	6.11	†	3.77	†	4.47	†	2.85	***
Algebra II	4.26	***	2.94		2.02		1.23		-	***
Algebra I / Geometry®	-	-	-	-	-	-	-	-	.17	
Pre-algebra or lower	0.95		0.00	.	0.00	***	0.56		.07	
SES	2.16	***	2.68	***	2.27	***	1.41	*	2.10	***
Math	1.71	***	2.12	**	2.15	**	1.49	†	1.52	**
Reading	1.93	***	1.69	*	1.41	†	1.73	**	1.06	***



## *Results of Multinomial Logistic models of Science Course-taking By Major*

	All		Business		Health		STEM		Other	
	<i>OR</i>	<i>p</i>	<i>OR</i>	<i>p</i>	<i>OR</i>	<i>p</i>	<i>OR</i>	<i>p</i>	<i>OR</i>	<i>p</i>
<b>Highest course</b>										
<b>Highly selective</b>										
<b>Chem 2 and phys 2</b>	<b>4.67</b>	<b>***</b>	<b>2.78</b>	<b>†</b>	<b>10.50</b>	<b>***</b>	<b>6.83</b>	<b>***</b>	<b>3.40</b>	<b>***</b>
<b>Chem 2/phys 2/ Adv Bio</b>	<b>1.70</b>	<b>***</b>	<b>1.53</b>		<b>1.82</b>	<b>†</b>	<b>2.46</b>	<b>*</b>	<b>1.47</b>	
<b>Chem 1 and phys 1</b>	<b>2.34</b>	<b>***</b>	<b>3.99</b>	<b>***</b>	<b>2.49</b>	<b>*</b>	<b>1.89</b>	<b>†</b>	<b>2.04</b>	<b>**</b>
<b>Chem 1 or phys 1 (Ref)</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>General biology</b>	<b>0.26</b>	<b>***</b>	<b>0.29</b>	<b>*</b>	<b>0.24</b>	<b>*</b>	<b>0.20</b>	<b>**</b>	<b>0.27</b>	<b>***</b>
<b>Secondary physical sci</b>	<b>0.21</b>		<b>0.00</b>	<b>***</b>	<b>0.00</b>	<b>***</b>	<b>0.29</b>		<b>0.22</b>	
<b>Primary physical or less</b>	<b>0.06</b>	<b>***</b>	<b>0.00</b>	<b>***</b>	<b>0.00</b>	<b>***</b>	<b>0.06</b>	<b>*</b>	<b>0.07</b>	<b>*</b>
<b>SES</b>	<b>2.12</b>	<b>***</b>	<b>2.64</b>	<b>***</b>	<b>2.02</b>	<b>***</b>	<b>1.37</b>	<b>*</b>	<b>2.04</b>	<b>***</b>
<b>Math</b>	<b>2.52</b>	<b>***</b>	<b>3.12</b>	<b>***</b>	<b>2.76</b>	<b>***</b>	<b>2.06</b>	<b>**</b>	<b>2.18</b>	<b>***</b>
<b>Reading</b>	<b>1.94</b>	<b>***</b>	<b>1.71</b>	<b>**</b>	<b>1.40</b>		<b>1.66</b>	<b>**</b>	<b>1.06</b>	<b>***</b>

## *Results of Multinomial Logistic models of Foreign Language Course-taking By Major*

	All		Business		Health		STEM		Other	
Highest course	OR	p	OR	p	OR	p	OR	p	OR	p
Highly selective										
AP Instruction	7.42	***	4.15	**	7.32	***	5.67	***	7.08	***
Year 4 or less	6.89	***	20.64	***	8.94	***	16.20	***	5.45	***
Year 3 or less	2.66	***	4.44	***	4.50	***	1.14		2.59	***
Year 2 or less (Ref)		-	-	-	-	-	-	-	-	-
None	0.80		1.01		1.50		0.53	†	0.69	
SES	2.10	***	2.51	***	2.04	***	1.40	*	2.08	***
Math	3.11	***	3.32	***	3.53	***	2.54	***	2.50	***
Reading	1.72	***	1.66	**	1.46	†	1.65	**	1.05	***

## *Results of Multinomial Logistic models of English Course-taking By Major*

	All		Business		Health		STEM		Other	
Highest course	OR	p	OR	p	OR	p	OR	p	OR	p
Highly selective										
AP/IB courses	6.05	***	4.98	***	4.50	***	5.24	***	7.05	***
None (Ref)	-	-	-	-	-	-	-	-	-	-
SES	2.17	***	2.66	***	2.17	***	1.50	**	2.12	***
Math	3.40	***	3.74	***	3.95	***	2.93	***	2.69	***
Reading	1.67	***	1.70	**	1.43	†	1.44	*	1.05	***

# Policy Implications

- High schools differ in their ability to help students prepare for and enroll in four-year colleges and universities.
- Some schools are far more likely than others to have severe shortages of college preparatory courses and properly trained teachers for these courses.
- Differentiating among specific major when examining patterns of “gate keeper” courses students take will give us more enriched information that could be used to promote successful postsecondary experiences for students.