Success of CSULB Students in Introductory Mathematics and Statistics Courses

Jen-Mei Chang, Dana Hooten, Tangan Gao, Kris Slowinski, Tianni Zhou
College of Natural Sciences and Mathematics

1. Why introductory mathematics/statistics?

2. Data analysis of Early Start Mathematics Program and GE B2 QR/Mathematics courses led to improved placement and targeted student support in redesign project

3. Conclusions and recommendations
### CSULB NON-COMPLETION OF COURSES

**AY 16-17:**
- 2,462 COURSES
- 284,090 ENROLLED STUDENTS
- 19,403 D, F, WU GRADES (6.8%)  

### CSULB TOP 100 “NON-PASSING” COURSES

**AY 16-17:**
- 100 COURSES
- 86,882 ENROLLED STUDENTS
- 9,875 D, F, WU GRADES (11.4%)  

### IN THIS GROUP

**AY 16-17:**
- 13 COURSES IN MATH
- 8,001 ENROLLED STUDENTS
- 1,763 D, F, WU GRADES (22.0%)  

### Grades Distribution

<table>
<thead>
<tr>
<th></th>
<th>TOTAL # OF GRADES</th>
<th>UNIV SHARE</th>
<th>D+F+WU GRADES</th>
<th>D+W+2U GRADES</th>
<th>NON COMPLETION RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSULB</td>
<td>284090</td>
<td>100.00%</td>
<td>19403</td>
<td>100.00%</td>
<td>6.83%</td>
</tr>
<tr>
<td>CLA</td>
<td>97633</td>
<td>34.37%</td>
<td>7573</td>
<td>39.03%</td>
<td>7.76%</td>
</tr>
<tr>
<td>CHHS</td>
<td>52057</td>
<td>18.32%</td>
<td>1972</td>
<td>10.16%</td>
<td>3.79%</td>
</tr>
<tr>
<td>CNSM</td>
<td>33780</td>
<td>11.89%</td>
<td>4501</td>
<td>23.20%</td>
<td>13.32%</td>
</tr>
<tr>
<td>COTA</td>
<td>32143</td>
<td>11.31%</td>
<td>1179</td>
<td>6.08%</td>
<td>3.67%</td>
</tr>
<tr>
<td>COE</td>
<td>28244</td>
<td>9.94%</td>
<td>1735</td>
<td>8.94%</td>
<td>6.14%</td>
</tr>
<tr>
<td>CBA</td>
<td>27092</td>
<td>9.54%</td>
<td>2109</td>
<td>10.87%</td>
<td>7.78%</td>
</tr>
<tr>
<td>CED</td>
<td>10012</td>
<td>3.52%</td>
<td>255</td>
<td>1.31%</td>
<td>2.55%</td>
</tr>
<tr>
<td>UNIV</td>
<td>3129</td>
<td>1.10%</td>
<td>79</td>
<td>0.41%</td>
<td>2.52%</td>
</tr>
</tbody>
</table>

**SOURCE:** CSU CO DASHBOARD  

---

**Size of a circle = impact**

---

**Long Beach State University**

A California State University Campux
Current Mathematics Pathways

MAPB 1
  /    \
MAPB 7  MAPB 11
  \
MATH 115  \\
/     \  /  \\  \\
GE MATH  MATH 113  MATH 111  MATH 122  MATH 123
STAT 108 
MATH 103
Current Mathematics Pathways

MAPB 1

- MAPB 7
- MAPB 11

GE MATH STAT 108 MATH 103

MATH 115
MATH 113
MATH 111
MATH 122
MATH 123

EO 1110 COURSE REDESIGN 2017-18

COURSE REDESIGN 2012-16
**SUMMARY AND RECOMMENDATIONS**

• EARLY START COMBINED WITH ADAPTIVE LEARNING IS VERY EFFECTIVE IN IMPROVING STUDENTS’ PREPARATION AND PLACEMENT

• STUDENTS WHO START MATH SEQUENCE IN MAPB (PARTICULARLY STEM MAJORS) ARE AT INCREASED RISK FOR ATTRITION OR GRADUATING LATE

• FIRST MATH FRESHMAN COURSE PREDICTS MAJOR-SWITCHING PATTERNS (MAPB VS 113 VS CALCULUS)

• HS GPA AND SAT CORRELATE WITH FRESHMAN SUCCESS IN ALGEBRA

---

**COURSE REDESIGN 2012-16**

- MAPB 1
- MAPB 7
- MAPB 11

**GE MATH**
- STAT 108
- MATH 103

**MATH 115**

**MATH 113**

**MATH 111**

**MATH 122**

**MATH 123**

**EO 1110 COURSE REDESIGN 2017-18**
Student success builds upon students’ success in their first (and introductory) Mathematics/Statistics courses!

12% gap when needing 2 or more developmental courses
Data analysis of Early Start Mathematics Program and GE B2 QR/Mathematics courses led to improved placement and targeted student support in redesign project.
Student Success
One’s ability to accomplish their current and future academic, personal, and professional goals through the development of knowledge, a sense of responsibility, and a connection to the university and wider community.

Academic Success
Course completion, subsequent course completion, accurate course placement, transferring of content knowledge, on-time graduation.

ESM: Early Start Mathematics
Intended for incoming students who do not demonstrate readiness for college-level math to begin developmental work during the summer before coming to the CSU.

ALEKS: Assessment and LEarning in Knowledge Spaces
PPL: Placement, Preparation and Learning
2017 Early Start Mathematics Program at CSULB

3-unit
(ESM 3, 21, 33)

1-unit
(ESM 1, 11)
Successful program completion

On target to “lose” 98.5% or 318 students in 2017 while, in fact, 115 were lost. The new format w/PPL saved 203 students at least one semester of dev math at CSULB.

Historic Failure Rate

\[ y = 0.015x - 29.27 \]

\[ R^2 = 0.9375 \]
Course Outcomes

**CR:** advance to the next level

- **30 - 45:** dev math level 1 → dev math level 2
- **46 or higher:** dev math level 2 → GE math

**RP:** satisfied the CSU ESM requirement, but do not advance to the next level

**NC:** did not complete CSU ESM requirement, fall admission is jeopardized

<table>
<thead>
<tr>
<th>Week</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7/10</td>
<td>7/11</td>
<td>7/12</td>
<td>7/13</td>
<td>7/14</td>
<td>7/15</td>
<td>7/16</td>
</tr>
<tr>
<td></td>
<td><em>Take the initial proctored assessment</em> Work in ALEKS for a minimum of 5 hours between class meetings. Visit the tutoring center for additional support.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7/17</td>
<td>7/18</td>
<td>7/19</td>
<td>7/20</td>
<td>7/21</td>
<td>7/22</td>
<td>7/23</td>
</tr>
<tr>
<td></td>
<td><em>Continue working in ALEKS; take unproctored assessment for practice</em> Work in ALEKS for a minimum of 5 hours between class meetings. Visit the tutoring center for additional support.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7/24</td>
<td>7/25</td>
<td>7/26</td>
<td>7/27</td>
<td>7/28</td>
<td>7/29</td>
<td>7/30</td>
</tr>
<tr>
<td></td>
<td><em>Continue working in ALEKS; take unproctored assessment for practice</em> Work in ALEKS for a minimum of 5 hours between class meetings. Visit the tutoring center for additional support.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7/31</td>
<td>8/1</td>
<td>8/2</td>
<td>8/3</td>
<td>8/4</td>
<td>8/5</td>
<td>8/6</td>
</tr>
<tr>
<td></td>
<td><em>Take the final proctored assessment</em> Visit the tutoring center for additional support.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Successful ESM completion & subsequent course completion lead to improved placement in the 1st GE B2 course at CSULB

CR in dev math level 1

Enrolled in dev math level 2

Passed

109

78

41

52.6% Completion rate with PPL vs. 70% Completion rate without PPL

Inaccurate placement with PPL cut score of 30 for dev math level 2

BUT, dev math courses are GONE under EO 1110

CR in dev math level 2

Enrolled in a GE Math

Passed

40

18

13

72.2% Completion rate with PPL vs. 75.11% Completion rate without PPL

Accurate placement with PPL cut score of 46 for entry-level GE Math/QR courses
Targeted student support in GE B2 redesign

Graphics Key:

- Bottleneck course
- Eliminated under EO 1110
- Created under EO 1110
- Undergoing course redesign under EO 1110

Dev math level 1

- Dev math level 2 for non-STEM
- Intro to Stats
- Quantitative Reasoning
- Co-requisite for Intro to Stats
- Co-requisite for QR

Dev math level 2 for STEM
- Pre-Calculus Algebra
- Co-requisite for Pre-Calculus Algebra
- Business Calculus, Liberal Studies Math, Calculus
- Co-requisite for Business Calculus, Liberal Studies Math
Placement of GE B2 courses with ALEKS PPL

**ESM PPL ≥ 46**
Without co-requisite
- Quantitative Reasoning
- Intro to Stats
- Business Calculus, Business Statistics, Liberal Studies Math
- 1-semester Pre-Calculus Algebra

**ESM PPL < 46**
With co-requisite
- Quantitative Reasoning
- Intro to Stats
- Business Calculus, Business Statistics, Liberal Studies Math
- 1-year Pre-Calculus Algebra

**Calculus PPL ≥ 80**
- Engineering Calculus 1

**Calculus PPL ≥ 70**
- Biology Calculus 1

- Explore interest during the 1st semester and get GE credit.
- Students are encouraged to switch to non-STEM concentrations if receiving C or lower.
Placement of GE B2 courses (mostly Algebra) with high school GPA and Math SAT
Success in Algebra depends on HS GPA and Math SAT

![Math 113 Pre-Calculus Algebra Fall 2016](chart)

- 591 students:
  - 421 (71%) passed
  - 170 (29%) failed
Predictive Model with Logistic Regression

- Estimate the probability of a student pass Math 113 based on his/her high school GPA and math SAT scores

- The estimated logistic regression model based on Fall 2016 data is

  \[ \logit (\hat{p}_i) = -10.544 + 2.08 \times GPA_i + 0.0077 \times SAT_i \]

  OR

  \[ \hat{p}_i = \frac{e^{-10.544 + 2.08 \times GPA_i + 0.0077 \times SAT_i}}{1 + e^{-10.544 + 2.08 \times GPA_i + 0.0077 \times SAT_i}} \]

- Built the model based on Fall 2016 data
- Applied the model to the Fall 2017 data
- Made prediction of each student who took the class in Fall 2017
Case Summaries

<table>
<thead>
<tr>
<th></th>
<th>High School GPA</th>
<th>Math SAT</th>
<th>Pass Math 113 in Fall 2017 (actual Outcome)</th>
<th>Predicted Probability of pass Math 113 in Fall 2017</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.30</td>
<td>560</td>
<td>Fail</td>
<td>0.656</td>
<td>Pass</td>
</tr>
<tr>
<td>2</td>
<td>3.12</td>
<td>590</td>
<td>Pass</td>
<td>0.622</td>
<td>Pass</td>
</tr>
<tr>
<td>3</td>
<td>3.55</td>
<td>630</td>
<td>Pass</td>
<td>0.846</td>
<td>Pass</td>
</tr>
<tr>
<td>4</td>
<td>2.84</td>
<td>540</td>
<td>Pass</td>
<td>0.385</td>
<td>Fail</td>
</tr>
<tr>
<td>5</td>
<td>4.03</td>
<td>570</td>
<td>Pass</td>
<td>0.904</td>
<td>Pass</td>
</tr>
</tbody>
</table>

If predicted probability ≥ 0.5, then predict PASS; otherwise, predict FAIL

- **Sensitivity**: proportion of students who passed the class that are correctly identified as such
- **Specificity**: proportion of students who failed the class that are correctly identified as such
- **1-sensitivity (false negative)**: proportion of students who predicted to fail the class but passed
- **1-specificity (false positive)**: proportion of students who predicted to pass the class but failed

Predicted outcome changes for different cutoff values.
Area Under the Curve (AUC) of the Receiver Operating Characteristics (ROC) indicated that the model has a fairly good discriminant performance.
Proposed Math 113 Placement Criteria:

\[(\text{HSGPA} \geq 3.5) \text{ AND } (\text{SAT} \geq 500)\]

OR (SAT ≥ 570)

OR (ALEKS 46 – 69)
Placement of GE B2 courses

**ESM PPL ≥ 46**
- Without co-requisite
  - Quantitative Reasoning
  - Intro to Stats
  - Business Calculus, Business Statistics, Liberal Studies Math
  - 1-semester Pre-Calculus Algebra
  - [(HSGPA ≥ 3.5) AND (SAT ≥ 500)]

**ESM PPL < 46**
- With co-requisite
  - Business Calculus, Business Statistics, Liberal Studies Math
  - Quantitative Reasoning
  - Intro to Stats
  - Pre-Calculus Algebra

**Calculus PPL ≥ 80**
- Engineering Calculus 1

**Calculus PPL ≥ 70**
- Biology Calculus 1

- Explore interest during the 1st semester and get GE credit.
- Students are encouraged to switch to non-STEM concentrations if receiving C or lower.
• EARLY START COMBINED WITH ADAPTIVE LEARNING IS VERY EFFECTIVE IN IMPROVING STUDENTS’ PREPARATION AND PLACEMENT

• STUDENTS WHO START MATH SEQUENCE IN MAPB (PARTICULARLY STEM MAJORS) ARE AT INCREASED RISK FOR ATTRITION OR GRADUATING LATE

• FIRST MATH FRESHMAN COURSE PREDICTS MAJOR-SWITCHING PATTERNS (MAPB VS 113 VS CALCULUS)

• HS GPA AND SAT CORRELATE WITH FRESHMAN SUCCESS IN ALGEBRA

• ALEKS PPL PLACEMENT AND TARGETED SUPPORT IMPROVE STUDENT SUCCESS IN CALCULUS