Texas NSA Project

Assessing Texas Students' Automaticity Needed for STEM Success

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Admiral, Texas Navy
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Regional Director, Associated Chemistry Teachers of Texas

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UNT, Gateway Center, Denton, TX
Abstract

Failure to succeed in general chemistry has been linked to students' mathematics fluency. Data collected for a multi-institution study ($n = 2,127$ Year 1; $n = 1,886$ Year 2; $n > 700$ Year 3) evaluated the arithmetic and algebra skills of first-semester general chemistry students in Texas. Open-ended arithmetic and multiple-choice algebra assessments were administered to determine which students lacked arithmetic automaticity impacting their chance of being successful in general chemistry. Given current results, students' arithmetic skills without the use of a calculator, have a greater correlation with course averages than arithmetic skills when calculators are used and students' poor algebra skills may in turn also be due to their lack of automaticity.
The Gap
30-years of SAT: Texas v. USA
(Max score = 1600)

2017 U.S. SAT: 533 Evidence-Based Reading and Writing + 527 Math = 1060 Total (up 58 points)
2017 SAT: Texas = 1020 composite (Up 76 points)
Texas SAT: **Verbal/Reading v. Math**
(Max score = 1600)

2017 Texas New SAT: Reading & Writing = 513 (Up 47 points); Math = 507 (Up 29 points)
Now out of 2400! (FIRST TIME since 1990 language skills higher than math!)
Conversion: New SAT to Old

• 2016 SAT: Verbal/Reading = 466; Math = 478
• 2017 SAT Total = 1020 (increments of 10)
  – Rounded 513 to 510 (language);
     rounded 507 to 510 (math)
• ONLY Delaware, DC, Florida, Idaho, Maine, Michigan BELOW Texas!

Texas ranks #45 of the 50 states + DC!
Conversion: New SAT to Old

• 2016 SAT: Verbal/Reading = 466; Math = 478

• New out of 2400
  – Total = 1390 (the following sum = 1380!)
    • Critical Reading = 460
    • Writing = 450 Average language skills = 455 → trend down continues!
    • Math = 470 → trend down continues!

• ACT Equivalent (1200 on SAT = 25 on ACT)
  – Composite = 20
  – English/Writing = 18

URL: https://collegereadiness.collegeboard.org/sat/scores/understanding-scores/sat-score-converter
TSELA: Teacher Science Education Leadership Association (2015)
SAT: Texas v. USA
(Max score = 1600)

2017 U.S. SAT: 533 Evidence-Based Reading and Writing + 527 Math = **1060 Total (Up 58 points)**

2017 SAT: Texas = **1020 composite (Up 76 points)**
Congratulations!

Class of 2015 STAAR® end-of-course exam passing rate hits 90 percent

Among those students who haven’t passed all required tests, English II is the most common test that students are still trying to pass.

The remaining subjects include U.S. History, English I, Algebra I, and Biology.
Proficiency

“A real phenomenon we’re now seeing is that we have more and more students with a diploma, but we also know — look at test scores over the last few years — we’re not graduating more students who are proficient.”

Texas, we have a problem!

(We can no longer wait for “someone else” to do something, sooooooooo we need data!)
Implementation

• Rallied the troops
  – Nine instructors from six Texas institutions
    • IRB-approved investigation
  – North Texas Regional P-16 Council, Jean Keller (UNT)
  – THECB (Rex Peebles, Assistant Commissioner)
  – NSA: National Security Agency (Texas branch)
• Seek funding (ongoing!)
Current Situation

• Major roadblocks to STEM degrees
  – 30-60% of college students require remedial coursework in mathematics and science
  – Lack of success in foundational mathematics and chemistry (introductory, general and organic)

• THECB: 60x30 Strategic Plan
  – By 2030, 60% of 25-34 year olds hold a degree/certificate

• HB 2223 (Effective 9/1/2017!): Related to developmental coursework offered by public institutions of higher education under the Texas Success Initiative (TSI)
  – Wrapping developmental coursework into basic courses
THECB Chemistry Tuning Document
Motivation

    - Authors: U.S. Naval Academy & another instructor
    - Compared what students could do without and with the use of a calculator
This study can be replicated!
Learning Analytics

• “Measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs.” (Wiki definition)

• From educational data mining $\rightarrow$ develop a learner profile

• Use analyzed data to support students
  – Local level (individual universities, networked)
MUST-Know (Pilot) Study (2016-17)
[Mathematics: Understanding Skills and Thinking]
MUST-Know (Pilot) Study

• Research
  – Correlate arithmetic skills (without and with the use of a calculator) of general chemistry students \((n = 2,127)\) to final course grades

• Hypotheses
  – Students will do better when a calculator is used than when one is not.
  – There is a linear relationship between students’ arithmetic skills and course grades.
Math-Up Skills Test (MUST)

• Instrument (16 questions)
  – Validated, highly reliable ($KR-21 = .821$)
  – Two versions (no statistical difference determined)

• Given twice to each student (start of semester)
  – Without the use of a calculator
  – With the use of a calculator (different version)

• Topics assessed
  – multiplication, division, fractions, scientific notation, exponential notation, logarithms, square roots and balancing chemical equations
MUST (without calculator) & Course grade

MUST Score (all) v. Course Grade

Slope: $m = 1.58$

Mean (WITHOUT)  $7.36/16 = 46.0\%$
Mean (WITH)  $= 12.19/16 = 76.2\%$
Pilot Study (2016-2017)

• **Outcome**: general chemistry students' arithmetic skills are more correlated with course grades when calculators are not used than when calculators are used ($n = 2,127$)
  - $r = .451$ (WITHOUT)
  - $r = .402$ (WITH)

• **Conclusions**
  - Topics in need of improvement: division using exponential notation and base-10 logarithms
  - More emphasis should be placed on improving students' mathematics automaticity (without calculators!)
Publications

• ACS DivCHED ConfChem online conference
  – *Mathematics in Undergraduate Chemistry Instruction*, held from October 23 to November 27, 2017
  – ChemEders from all over world participated

Continue Study!
Networking for Science Advancement

Texas NSA Study

(Fall 2017 – Fall 2018)
NSA Team (2017-2019)
(All with IRB Approval)

• Diana Mason, UNT (retired)
• Collaborating researchers
  – Sue Broadway, UNT Adjunct
  – Anton Dubrovskiy, UHCL Assistant Professor
  – Ben Jang, TAMU-C, Regents Professor
  – Blain Mamiya, TSU Lecturer
  – Cynthia Powell, ACU Associate Professor
  – Bob Shelton, TAMU-SA Assistant Professor
  – Adrian Villalta-Cerdas, Sam Houston State Assistant Professor
  – Deborah Walker, UT Austin Lecturer
  – Rebecca Weber, UNT Lecturer
  – Vickie Williamson, TAMU Instructional Professor
Current Coverage (Over 40,000 mi$^2$)
## NSA Team Members’ Institutions

<table>
<thead>
<tr>
<th>Fall 2017-Fall 2018</th>
<th>Undergrad Enrollment (Pop Rank)</th>
<th>Hispanic Emerging &gt; 15%</th>
<th>Hispanic Serving &gt; 25%</th>
<th>Black + Hispanic*</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAMU (R1)</td>
<td>50,707 (#1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UT (R1: pre-ID’d at-risk grp)</td>
<td>40,492 (#2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSU (R2)</td>
<td>34,180 (#5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNT (R1)</td>
<td>31,405 (#6)</td>
<td>23.4%</td>
<td>36.0%</td>
<td></td>
</tr>
<tr>
<td>TAMU-C (R2)</td>
<td>12,490</td>
<td>19.7%</td>
<td>40.9%</td>
<td></td>
</tr>
<tr>
<td>Sam Houston</td>
<td>8,031</td>
<td>21.9%</td>
<td>40.1%</td>
<td></td>
</tr>
<tr>
<td>UHCL</td>
<td>5,798</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAMU-SA</td>
<td>5,417</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACU (private)</td>
<td>4,427</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*With other URMs, needs to be 50%+ to be MSI.

Added for Fall 2018: no data to date!

**Goal:** Get all 37 Texas Public Universities on board!
Students in Study (Year 2)

- $n = 1,073$ (fall 2017); $n = 813$ (spring 2018)
- IRB permission
  - all eight institutions
  - all students
- Over 93% graduated from a Texas high school
  - Exposed to the same isomorphic curriculum (TEKS)
  - Passed the same high-stakes exit exams (STAARs)
NSA Protocol (Fall 2017-Spring 2018)  
[Assess: arithmetic and algebra]

• Collect data (no calculators)
  – Demographics
  – Instruments: each 20 questions, 15 min.,
    calculators not allowed
    • *MUST*: Math-Up Skills Test (assesses arithmetic)
    • **DAT**: Diagnostic Algebra Test (assesses algebra)

• Merge data from all institutions

Link to quiz: http://bit.ly/1HyamPc
  [Dahm and Nelson (co-authors): Calculations in Chemistry, WW Norton & Company]

**Made a similar version as our second version: Cooper, C. I.; Pearson, P. T.A (2012). Genetically Optimized Predictive System for Success in General Chemistry Using a Diagnostic Algebra Test. Journal of Science Education and Technology, 21(1), 197-205.
# Topics Addressed by MUST

<table>
<thead>
<tr>
<th>MUST Q</th>
<th>Concept</th>
<th>'17 Mean (SD) = 10.36(4.94)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>multiplication</td>
<td>0.67 (.47)</td>
</tr>
<tr>
<td>2</td>
<td>mult with powers of 10</td>
<td>0.59 (.49)</td>
</tr>
<tr>
<td>3</td>
<td>mult with powers of 10</td>
<td>0.65 (.48)</td>
</tr>
<tr>
<td>4</td>
<td>division</td>
<td>0.49 (.50)</td>
</tr>
<tr>
<td>5</td>
<td>0-power</td>
<td>0.70 (.46)</td>
</tr>
<tr>
<td>6*</td>
<td>division fraction by fraction</td>
<td>0.56 (.50)</td>
</tr>
<tr>
<td>7</td>
<td>division with powers of 10</td>
<td>0.30 (.46)</td>
</tr>
<tr>
<td>8</td>
<td>division with powers of 10</td>
<td>0.39 (.49)</td>
</tr>
<tr>
<td>9</td>
<td>fraction to decimal notation</td>
<td>0.64 (.48)</td>
</tr>
<tr>
<td>10</td>
<td>fraction to decimal notation</td>
<td>0.68 (.47)</td>
</tr>
<tr>
<td>11</td>
<td>gas law algebraic rearrange</td>
<td>0.49 (.50)</td>
</tr>
<tr>
<td>12</td>
<td>log</td>
<td>0.28 (.45)</td>
</tr>
<tr>
<td>13</td>
<td>log</td>
<td>0.25 (.43)</td>
</tr>
<tr>
<td>14</td>
<td>power of 10 squared</td>
<td>0.51 (.50)</td>
</tr>
<tr>
<td>15</td>
<td>power of 10 square root</td>
<td>0.35 (.48)</td>
</tr>
<tr>
<td>16*</td>
<td>division by 0 (undefined)</td>
<td>0.39 (.49)</td>
</tr>
<tr>
<td>17*</td>
<td>simplify fraction</td>
<td>0.73 (.44)</td>
</tr>
<tr>
<td>18*</td>
<td>decimal/fraction equivalents</td>
<td>0.42 (.49)</td>
</tr>
<tr>
<td>19</td>
<td>balancing equation</td>
<td>0.68 (.47)</td>
</tr>
<tr>
<td>20</td>
<td>balancing equation</td>
<td>0.59 (.49)</td>
</tr>
<tr>
<td>% Correct</td>
<td></td>
<td>51.8%</td>
</tr>
</tbody>
</table>

*added Fall 2017
MAYBE THIS IS A QUESTION THAT SHOULD BE LEFT TO THE PHILOSOPHERS.
Prior Knowledge
(Most Predictive Variable Known!)
Prior Knowledge

• High School Chemistry
  – AP/IB
  – PAP
  – Regular
  – None

• Mathematics
  – Calculus I or II (or higher)
  – PreCal
  – Developmental and College Algebra
  – Not enrolled in a mathematics course
Prior Chemistry Course Knowledge

• High School Chemistry noting highest level completed (n = 1,064, *nine not disclosed*)
  – AP + IB = 240 (22.6%)
  – PAP = 536 (50.4%)
  – Regular = 276 (25.9%)
  – None = 12 (1.1%)

• Over 98% have had at least one course in chemistry!
# High School Chemistry Prior Knowledge

<table>
<thead>
<tr>
<th>HS Chem</th>
<th>( n = 1,064 )</th>
<th>Course Avg (( SD ))</th>
<th>MUST (( SD ))</th>
<th>DAT (( SD ))</th>
<th>PreCal +</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP/IB</td>
<td>240</td>
<td>84.6 (11.3)</td>
<td>12.2 (4.6)</td>
<td>16.7 (3.2)</td>
<td>166/240 = 69.2%</td>
</tr>
<tr>
<td>Pre-AP</td>
<td>536</td>
<td>79.8 (12.9)</td>
<td>10.4 (4.8)</td>
<td>15.7 (3.4)</td>
<td>357/536 = 66.6%</td>
</tr>
<tr>
<td>Regular</td>
<td>276</td>
<td>76.3 (13.8)</td>
<td>8.9 (4.9)</td>
<td>14.7 (3.6)</td>
<td>138/276 = 50.0%</td>
</tr>
<tr>
<td>None</td>
<td>12</td>
<td>71.2 (13.8)</td>
<td>6.2 (3.5)</td>
<td>13.1 (5.2)</td>
<td>6/12 = 50.0%</td>
</tr>
</tbody>
</table>
High School Course Background

High School Chemistry Background (Fall 2017)

- Course Avg
- MUST
- DAT
- PreCal +
Fall 2017 MUST vs. Course Average

\[ y = 1.5036x + 62.198 \]

\[ R^2 = 0.9321 \]
MUST v. Course Average Regression (Fall 2017)

\[ y = 1.4285x + 65.044 \]

\[ R^2 = 0.2909 \]
Combined MUSTs vs. Course Average

\[
y = 0.8324x + 65.544 \\
R^2 = 0.9375
\]
## Course Averages by Mathematics

<table>
<thead>
<tr>
<th>Grade</th>
<th>Cal I or II n (avg %)</th>
<th>PreCal n (avg %)</th>
<th>Col Alg n (avg %)</th>
<th>Prob/Stat n (avg %)</th>
<th>None/Dev n (avg %)</th>
<th>No Report n (avg %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>103 (93.5%)</td>
<td>138 (94.1%)</td>
<td>48 (92.5%)</td>
<td>8 (92.7%)</td>
<td>10 (91.9%)</td>
<td>1 (89.3%)</td>
</tr>
<tr>
<td>B</td>
<td>99 (84.6%)</td>
<td>117 (83.7%)</td>
<td>79 (83.5%)</td>
<td>14 (84.6%)</td>
<td>17 (83.7%)</td>
<td>1 (81.6%)</td>
</tr>
<tr>
<td>C</td>
<td>51 (73.9%)</td>
<td>90 (73.7%)</td>
<td>81 (73.2%)</td>
<td>17 (73.7%)</td>
<td>17 (74.5%)</td>
<td>1 (73.6%)</td>
</tr>
<tr>
<td>D</td>
<td>12 (64.5%)</td>
<td>35 (63.3%)</td>
<td>43 (64.3%)</td>
<td>7 (64.3%)</td>
<td>9 (63.3%)</td>
<td>3 (65.7%)</td>
</tr>
<tr>
<td>F</td>
<td>11 (53.5%)</td>
<td>15 (50.5%)</td>
<td>28 (49.9%)</td>
<td>9 (42.0%)</td>
<td>9 (44.1%)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>276 (83.8%)</td>
<td>395 (82.0%)</td>
<td>279 (75.8%)</td>
<td>55 (72.8%)</td>
<td>62 (73.8%)</td>
<td>6 (65.7%)</td>
</tr>
</tbody>
</table>

Majority of students \((276 + 395/1,073 = 62.5\%)\) currently are enrolled in pre-cal or higher (groups A and B) and have a B average.
MUST Without Calculator
(Fall 2017)
Most-missed Example Problems

• Division with exponential notation:

\[
\frac{9.0 \times 10^{-18}}{2.0 \times 10^{-5}} \quad \frac{10^5 \times 10^{23}}{10^{-1} \times 10^{-6}}
\]

• Logs: Determine the base-10 log of: 1000 = _____ and 0.001 = _____

• Power of 10 square root: \( \sqrt{64 \times 10^{-12}} \)

• *Division by 0: If A = B, evaluate \( \frac{A}{A - B} \)

*New question for fall 2017
DAT: Algebra Skills

Slope: $m = 1.39$
DAT (Fall 2017)

**DAT v. Course Average Regression (Fall 2017)**

- Linear equation: $y = 1.8599x + 50.798$
- $R^2 = 0.2519$
DAT Without Calculator
(Fall 2017)
### Data \((n = 1,073)\)

<table>
<thead>
<tr>
<th>Fall 2017</th>
<th>(n)</th>
<th>MUST (Range 8-12)</th>
<th>DAT (Range 14-18)</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>A&amp;M</td>
<td>476</td>
<td>12.24</td>
<td>16.98</td>
<td>82.04</td>
</tr>
<tr>
<td>UTX</td>
<td>161</td>
<td>11.29</td>
<td>15.37</td>
<td>85.60</td>
</tr>
<tr>
<td>ACU</td>
<td>108</td>
<td>10.14</td>
<td>16.27</td>
<td>81.92</td>
</tr>
<tr>
<td>UNT</td>
<td>232</td>
<td>8.11</td>
<td>14.42</td>
<td>74.36</td>
</tr>
<tr>
<td>TSU</td>
<td>58</td>
<td>6.02</td>
<td>11.88</td>
<td>73.53</td>
</tr>
<tr>
<td>A&amp;M-SA</td>
<td>38</td>
<td>3.74</td>
<td>10.63</td>
<td>65.02</td>
</tr>
<tr>
<td><strong>Avg (SD)</strong></td>
<td><strong>1,073</strong></td>
<td><strong>10.36(4.94)</strong></td>
<td><strong>15.61(3.53)</strong></td>
<td><strong>79.84(13.09)</strong></td>
</tr>
</tbody>
</table>
Correlations & Effect Sizes

Course average ($SD$) = 79.84 (13.09)

<table>
<thead>
<tr>
<th></th>
<th>Max = 20 points</th>
<th>Correlation to Avg</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUST</td>
<td>10.36 = 51.95%</td>
<td>.539</td>
<td>.291</td>
</tr>
<tr>
<td>DAT</td>
<td>15.61 = 78.05%</td>
<td>.502</td>
<td>.252</td>
</tr>
</tbody>
</table>

**All t-tests:** MUST:DAT, MUST:CourseAvg, and DAT:CourseAvg, $p < .05$ (statistically different)

**Correlation ($r$):** MUST:DAT = .744, $r^2 = .553$  
**Cohen’s $d$ = 1.023** (large effect size)

**Effect Size DAT:Course Avg** = .0465 (very small: 0 chance of predicting average from DAT)

**Effect Size MUST:Course Avg** = 1.16 (High) [1.2 is VERY high] indicating that there is a 69% chance (or greater) of predicting course average from MUST (arithmetic skills)
First-generation status

• Did parents/grandparents complete a college or university degree? (NSF definition)
  – Asked as two separate questions

• First-generation students by definition = 273/1,073 = 25.4%
  – 30.8% are employed on or off campus
## Educational Background of Family

<table>
<thead>
<tr>
<th>Family Group</th>
<th>n = 1,073</th>
<th>Course Avg (SD)</th>
<th>MUST (SD)</th>
<th>DAT (SD)</th>
<th>PreCal +</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both gens: Yes</td>
<td>420</td>
<td>82.7 (11.5)</td>
<td>11.4 (5.0)</td>
<td>16.4 (3.3)</td>
<td>280/420 = 67.1%</td>
</tr>
<tr>
<td>Parents Y; Grands N</td>
<td>217</td>
<td>80.0 (12.7)</td>
<td>10.3 (4.9)</td>
<td>15.7 (3.5)</td>
<td>137/217 = 63.1%</td>
</tr>
<tr>
<td>One Y; Other DK</td>
<td>130</td>
<td>79.1 (14.8)</td>
<td>9.8 (4.5)</td>
<td>15.3 (3.4)</td>
<td>79/130 = 60.8%</td>
</tr>
<tr>
<td><strong>Both gens: No</strong></td>
<td>273</td>
<td>76.1 (13.6)</td>
<td>9.2 (4.8)</td>
<td>14.6 (3.7)</td>
<td>157/273 = 57.5%</td>
</tr>
<tr>
<td>Unknown</td>
<td>33</td>
<td>76.8 (14.9)</td>
<td>8.6 (5.0)</td>
<td>14.4 (3.7)</td>
<td>15/33 = 45.4%</td>
</tr>
</tbody>
</table>

Abbreviations: gens = generations; Y = Yes; N = No, DK = Don't Know.
Over 98% of students have had at least one high school chemistry course.
By University
Who gets the best students?

Targeted **MUST** scores: Below Average < 8, **Average** = 8-12, Above Average > 12

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>A&amp;M</th>
<th>UTX</th>
<th>ACU</th>
<th>UNT</th>
<th>TSU</th>
<th>TSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Avg</td>
<td>335</td>
<td>82  = 17.2%</td>
<td>26  = 16.1%</td>
<td>36  = 33.3%</td>
<td>116 = 50.0%</td>
<td>44  = 75.9%</td>
<td>31  = 81.6%</td>
</tr>
<tr>
<td>Average</td>
<td>346</td>
<td>152 = 31.9%</td>
<td>79  = 49.0%</td>
<td>33  = 30.6%</td>
<td>67  = 28.9%</td>
<td>9   = 15.5%</td>
<td>6   = 15.8%</td>
</tr>
<tr>
<td>Above Avg</td>
<td>392</td>
<td>242 = 50.8%</td>
<td>56  = 34.8%</td>
<td>39  = 36.1%</td>
<td>49  = 21.1%</td>
<td>5   = 8.6%</td>
<td>1   = 2.6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,073</td>
<td>476</td>
<td>161</td>
<td>108</td>
<td>232</td>
<td>58</td>
<td>38</td>
</tr>
</tbody>
</table>

Targeted **DAT** scores: Below Average < 14, **Average** = 14-18, Above Average > 18

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>A&amp;M</th>
<th>UTX</th>
<th>ACU</th>
<th>UNT</th>
<th>TSU</th>
<th>TSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Avg</td>
<td>296</td>
<td>67  = 14.1%</td>
<td>48  = 29.8%</td>
<td>22  = 20.4%</td>
<td>92  = 39.7%</td>
<td>38  = 65.5%</td>
<td>29  = 76.3%</td>
</tr>
<tr>
<td>Average</td>
<td>511</td>
<td>237 = 49.8%</td>
<td>87  = 54.0%</td>
<td>55  = 50.9%</td>
<td>66  = 28.4%</td>
<td>17  = 29.3%</td>
<td>9   = 23.7%</td>
</tr>
<tr>
<td>Above Avg</td>
<td>266</td>
<td>172 = 36.1%</td>
<td>26  = 16.1%</td>
<td>31  = 28.7%</td>
<td>34  = 14.7%</td>
<td>3   = 5.2%</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,073</td>
<td>476</td>
<td>161</td>
<td>108</td>
<td>232</td>
<td>58</td>
<td>38</td>
</tr>
</tbody>
</table>
Average Student Profile

• Both parents and grandparents have degrees
• Graduated from high school in Texas
  – Chemistry: Pre-AP
• Does not work
• First time to take general chemistry I
• Classification: Freshman (born between 1995-2005)
• STEM major
• Enrolled in Pre-calculus
• Pre-tests
  – MUST Score (arithmetic skills) = 8-12/20 (average)
  – DAT Score (algebra skills) = 14-18/20 (average)
• Course average = 80%
• Plans to take second semester general chemistry
Letter Grades

Identify the potential D/F students at the beginning of semester (or before) and provide them with the HIPs needed to improve their math-sense!
## Predictability of MUST Ranges

<table>
<thead>
<tr>
<th>MUST Range</th>
<th>$n$</th>
<th>Average ($SD$) ($SE$)</th>
<th>$n$ with Average &lt; 69.5% ( % in MUST range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above average (&gt; 12)</td>
<td>392</td>
<td>87.05 (8.85) (0.45)</td>
<td>12 (3.06%)</td>
</tr>
<tr>
<td>Average (8-12)</td>
<td>347</td>
<td>80.42 (10.90) (0.59)</td>
<td>45 (12.97%)</td>
</tr>
<tr>
<td>Below average (&lt; 8)</td>
<td>334</td>
<td>70.85 (13.71) (0.75)</td>
<td>123 (36.82%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1073</td>
<td>79.86 (13.02) (0.40)</td>
<td>180 (16.78%)</td>
</tr>
</tbody>
</table>
Year 3
Changes

• DAT dropped
• QR (quantitative reasoning) added
• New demographics to emphasize building better successful student profile
  – Narrow down ethnicity categories
  – Language proficiency added
• Non-cognitive survey added
  – Higher Education Expectations
    • Motivational, Emotional, and Social
Quantitative Reasoning (Fall 2018)
Most Missed QR Arithmetic

5. 0.8% means:
   a. 8 out of 100  b. 0.8  c. 8.0  d. 0.08  e. \frac{0.8}{100}
Most Missed QR Word Problems

14. Let $U_A = \frac{r}{1-U_B}$. Solve this equation for $U_B$ in terms of $U_A$ and $r$.
   
   a. $\frac{r-U_A}{r}$  
   b. $\frac{r-U_A}{U_A}$  
   c. $\frac{1-r}{U_A}$  
   d. $\frac{U_A-r}{r}$  
   e. $\frac{U_A-r}{U_A}$

11. In a certain company there are 3 times as many men working as women. What is the fraction of employees that are female?
   
   a. $\frac{1}{3}$  
   b. $\frac{3}{10}$  
   c. $\frac{2}{3}$  
   d. $\frac{3}{4}$  
   e. $\frac{1}{4}$
17. The attached gauge shows the power output of a small motor up to one-half horsepower (hp). Express the power output shown by the gauge in horsepower (hp), simplifying any fractions. Assume that the sections are evenly spaced.

\[
\begin{align*}
0 \text{ hp} & \quad \frac{1}{2} \text{ hp} \\
a. \frac{2}{9} & \quad b. \frac{3}{4} & \quad c. \frac{3}{8} & \quad d. \frac{3}{16} & \quad e. \frac{4}{3}
\end{align*}
\]
19. Choose the answer that best describes a comparison between the number of students from the Midwest and the number of International students.

**Home Region Entering Class 2010**

- New England: 43%
- International: 4%
- West: 13%
- South: 5%
- Midwest: 6%
- Mid Atlantic: 26%
- Southwest: 3%

a. The number of students from the Midwest is 2% more than the number of International students.
b. Twice as many students came from the Midwest as from International locations.
c. There are 25 more students from the Midwest than from International locations.
d. The number of International students is 25% more than the number from the Midwest.
e. The number of students from the Midwest is 50% more than the number of International students.
Shared Responsibility
Where is the breakdown?

Novice
Motivation
Relevance
Subject Matter
Competency
Expert
Shared Responsibility

- Prior Knowledge
- Novice
  - Relevance
  - Motivation
- Expert
  - Competency
- Subject Matter
Shared Responsibility
Is “Systems Thinking” the missing Meaningful Engagement?
Texas Connects Us
What’s Next?

• Next add?
  – TOLT (Test on Logical Thinking)

• Increase number of Texas institutions participating
  – Interested?
Acknowledgments

Many thanks to the Networking for Science Advancement (NSA) Team for contributing to this statewide project—maybe the first of its kind in the nation!