Reorienting Assessments towards Mastery with PrairieLearn to achieve “A's for All”
Project Team

Dan Garcia  
UC Berkeley

Armando Fox  
UC Berkeley

Solomon Russell  
El Camino College

Edwin Ambrosio  
El Camino College

Neal Terrell  
CSU Long beach

Awards

- Enabling Institutional Change in Undergraduate STEM Education 2020-22
- Scaling Success to Expand Impact in STEM 2022-24
COVID-directed Teaching Exploration

“This is a moment of exploration…”
– Michael Dennin, UCI
Teaching & Learning with Empathy

“Empathy is appropriate all the time, not just during the pandemic”
– Cynthia Carter Ching, UCD
Learning as it usually happens

- In classrooms all over the world..
  - Students of various aptitude/preparation … get A-F grades
- Mantra: “Fixed Time, Variable Learning”
  - Huge problem for achieving equity goals

![Graphic by LilBabel]
Mastery Learning … The Big Idea

▪ Benjamin Bloom (1968)
  • Students must achieve a level of Mastery (e.g., 90% on quiz) on earlier material *before* they can move on to later material

▪ Mantra: “Fixed Learning, Variable Time”
Many have known this for years

“...Bloom showed that when students were allowed a little flexibility in the pace of their learning, the vast majority of students ended up performing extremely well... These two insights — that speed does not equal ability, and that there are no universally fast or slow learners — had actually been recognized several decades before Bloom's pioneering study.”

- Todd Rose, The End of Average
Mastery Learning … How to do it?
BIG Idea

Prior Preparation → Dynamic, Randomized, Problem Generation → Achievement

Practice until PROFICIENT
Four Key Movements in Education

Bloom’s Mastery Learning

Dweck’s Growth Mindset

Feldman’s Grading for Equity

Nilson’s Specifications Grading
Mastery Learning ... using

- Created at the University of Illinois
- Free!
- Open-source!
- Other Universities have adopted it as well...
- Rather than Questions, Question GENERATORS
PrairieLearn: Rich Question Generators

- Used for homework, projects, practice, or exams…
PrairieLearn: Random Generation!

- One question generator ... many questions!

Helps with academic integrity!
## Organizing Qs on PrairieLearn

<table>
<thead>
<tr>
<th>Title</th>
<th>QID</th>
<th>Topic</th>
<th>Tags</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bach was a good composer ...</td>
<td>functionComposition/v2</td>
<td>Function Ordering</td>
<td>formative quest easy radio release byao Fa18Q8 1V5120</td>
<td>v3</td>
</tr>
<tr>
<td>Beethoven was a good composer ...</td>
<td>functionComposition/v1</td>
<td>Function Ordering</td>
<td>formative quest easy radio release byao Fa18Q8 1V5120</td>
<td>v3</td>
</tr>
<tr>
<td>What goes in, must come out.</td>
<td>snap/domain-range/foo-CH</td>
<td>Domain/Range</td>
<td>formative quest hard checkbox alpha iortega Fa19Q4 5v5</td>
<td>v3</td>
</tr>
<tr>
<td>What goes in, must come out.</td>
<td>snap/domain-range/foo</td>
<td>Domain/Range</td>
<td>formative quest medium checkbox alpha iortega Fa19Q4</td>
<td>v3</td>
</tr>
<tr>
<td>Say it ain’t so...</td>
<td>snap/logical-procedures/set-command-say</td>
<td>Logical Procedures</td>
<td>summative quest medium blank beta set procedure global variable iortega Fa19Q8 4v4</td>
<td>v3</td>
</tr>
<tr>
<td>You’re invited to the swap meet!</td>
<td>snap/logical-procedures/swap-values</td>
<td>Logical Procedures</td>
<td>formative quest hard dropdown set procedure iortega Sp20Q7 1v2</td>
<td>v3</td>
</tr>
<tr>
<td>Inside, we’re (not) all the same!</td>
<td>snap/booleans/pugxy-predicate</td>
<td>Booleans</td>
<td>formative midterm hard radio alpha and not iortega</td>
<td>v3</td>
</tr>
</tbody>
</table>
Exams taken at home, or on campus

- “Computer-Based Testing Facility” (CBTF)
- Model at UIUC
- Staffed by campus
- Students drop in, take exam, leave
- Resolves the cheating concerns with exams taken at home
Innovation this allows (1/3)

- Instructors can go from “few high-stakes exams” to “higher frequency small-stakes quizzes”
- Students can retake exams with another variant until mastery
- Students can re-do projects until mastery, and deadlines soften

![Graph showing comparison between traditional and frequent exam schedules]
Pedagogical Benefits to Instructors

- More up-front effort to write QGs, amortizes
…some feel grades needed for “relative degree of success”.

“A school’s ultimate mission, apparently, is not to help everyone learn but to rig the game so that there will always be losers. This makes no sense in any context.”

– Alfie Kohn, “Why Can’t Everyone Get A’s?”
Innovation this allows (3/3)

- **A’s for All** (as time and interest allow)
  - The bar for what it takes to earn an A does not change!
  - The belief that EVERY student can succeed in our program
  - Critical for sense of belonging for introductory courses!
  - Students finish course afterwards OR get A on 1,2,3-units
A’s for Some due to term constraints

- At end of term, grade is finalized, but can still...
  - Switch from curved to absolute grading
  - Allow higher performance on a later exam to “clobber” an earlier lower score, and/or offer second-chance exams
  - Soften assignment deadlines through auto-graders
  - Stop thinking about grading as a “bag of points”, but use mastery of topics
A’s for All without term constraints

(1/3) “Incomplete” model

- At end of term, put in “Incomplete”
- Student completes it later, just like sick student
  - Support student with TAs in subsequent semesters
  - Allow students to lower minimum units, extend graduation
  - Perhaps create new grading category
    - Instead of “Incomplete” … “Not Yet Proficient” (NYP)
  - Automate the course completion, grade updates
    - Registrar might open up an API to allow NYP grade changes
A’s for All *without* term constraints

(2/3) “Variable Unit” model

- At end of term, give A for 0-4 units
- Change the course to be variable unit
- Student is able to complete more units later
  - Same post-course issues as with incomplete/NYP grade
- Transparency
  - Need to be very public about what is in each unit
  - Might change depending on the semester? Confusing!
  - Need impedance matching with downstream courses
A’s for All *without* term constraints

(3/3) “Grade Override” model

- At the end of term, *put A-F grade in (as usual)*
- Allow the student to complete work later
  - When work is done, grade “clicks” to the next one up
  - The student’s grade moves from
    - Standard: “what you knew at each midterm”
    - With term constraints: “what you knew at final exam”
    - This one: “what you knew at current time”
A’s for All
(as time and interest allow)

...has the potential to make the biggest difference in equity than anything else in our lifetimes...
Institutional Barriers CSULB & ECC

• Restrictions on “I” grades
• Restrictions on retaking classes after “C”s
• Administration might not favor “no term constraints”
• CSU-wide emphasis on 4-year graduation rates
  • Long prerequisite chains especially problematic
  • But… is a 4-year graduation with “C”s really better than 5-year with “A”s?
ECC Results

• ECC CSCI 7: Beauty & Joy of CS Principles
  • 27 students, 69 UC Berkeley developed questions

• ECC CSCI 8: Foundations of Data Science
  • 40 students, 83 ECC developed questions

• ECC CSCI 14: Intro to Python
  • 12 students, 15 CSU Long Beach developed questions
ECC Results

“Being able to practice different variants allowed me to really assess my knowledge. It tested whether I really knew the material, and I wasn't just getting lucky by guessing.”

“If I hadn't fully understood one part of a concept the variant would cover another which in some cases I did and in others I didn't. Either way it was useful in understanding the whole concept by addressing individual parts and learning that material in the process.”
ECC Scaling the Work

- **AB 705**
  - Requires that community colleges maximize the probability that a student will enter and complete transfer-level coursework in English and math within a one year timeframe
  - Students can place themselves in transfer-level Math and English courses
  - Data shows students are more successful retaking transfer courses than progressing through remedial coursework
ECC Scaling the Work

- Introduction to Statistics is our largest course
  - Over 1,500 students enrolled in Spring 2021
  - 20 of the 45 sections required a publisher’s online assessment tool & book bundle at ~ $85 / student
  - Students pay > $50k/semester on publisher’s materials

- Can PrairieLearn provide similar functionality?
ECC Scaling the Work

- Scaling to Statistics
- Recreate online tools w/ PL
  - 3 Math professors
  - 5 Students (current and former ECC)
- Targeting 3 textbooks
- Piloting in spring 2023
Institutional Collaboration

- Sharing resources
- Research group
  - A unique experience for Community College students
- Dissemination of Findings
- Coordination of efforts
Q & A