A's for All
(as Time and Interest Allow)

By: Dan Garcia, Armando Fox, Solomon Russell, Edwin Ambrosio, Neal Terrell, Mariana Silva, Matthew West, Craig Zilles, and Fuzail Shakir.

Presented By: Anagha Vadarevu   **Date: Wednesday April 5, 2023**
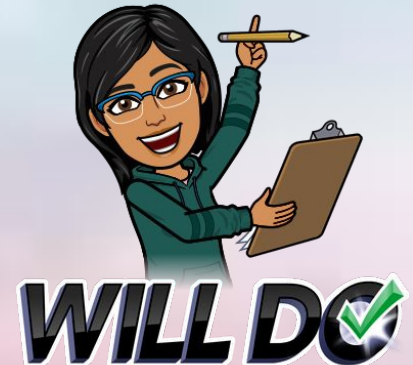
Agenda!

Introduction

- "A's for All (as time and interest allow)" is a position that states "it is increasingly possible to aim for a world in which students can achieve any grade (level of mastery) that they are willing to work for, even if some students take longer than others or require more practice to get there."
- Would have profound effects on:
  - Fairness
  - Equity
  - Participation in Computing
- The Goal(s) of the Paper:
  - Describe "A's for All [A4A] (as time and interest allow)"
  - Why it is worth pursuing and the mechanism to do so
 - Why now is a good time to do so

Background

- In early 2022, the community of international computing educators on the SIGCSE-MEMBERS mailing list of the ACM Special Interest Group in Computer Science Education was discussing the following topics:
  - Growth Mindset
  - Proficiency (aka mastery) learning
  - Grading for equity
  - Specifications grading
- These ideas are important towards [A4A] (as time and interest allow)
- The "A" line does not move rather students get the opportunity to achieve proficiency and earn any grade they are willing to put in the time and effort for
  - "fixed time, variable learning" to "fixed learning, variable time"
- Two scholars who advocate for this position: David MacKay and Alfie Kohn

Background

- "A's for All" requires:
  - Writing autograders for all course projects
  - Adopting technology that affords dynamic, randomized problem generation
    - For practice and multiple-choice exams
  - Changing policies and messaging so students know they will be fully supported (even if it takes them a little more time to learn the material and do the work)
- Most grading systems tend to assess students in a manner that is appropriate to their level of understanding of course content to date

- **Question to Group:** What does this imply if a student doesn't quite grasp a concept early on?

  - Magnified in later assessments

- This can be remedied by mastery learning as students must master earlier concepts before moving on to later ones
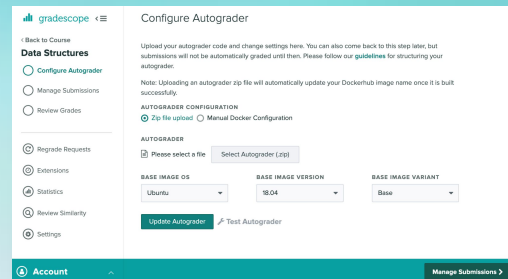
Background: What is A's for All

- "A's for All" doesn't water down proficiency needed to achieve an A
- Instead we provide multiple opportunities to show proficiency so students can revisit, correct, and continue to learn from their submitted work rather than viewing it as a score fixed in time
- Students can spend as much time and effort as they choose to achieve any desired level of mastery whether that is an "A" or a lower grade

Background: Why Should We Adopt A's for All

- Two Ideas: *Time-Based Learning* (TBL) and *Proficiency-Based Learning* (PBL)
- TBL - "*variable* learning in a fixed time", typically a term
- PBL - continuous practice until one demonstrates a certain threshold of knowledge and skills before advancing
  - High-Stakes Professional Licenses: Commercial Airline Pilot License
- PBL or "mastery learning" has roots in 1950s - 1960s when John Carroll stated that "aptitude is the amount of time required by the learner to attain mastery of a learning task"
- We want to build a positive classroom climate and student-to-student interaction that builds a supportive academic community
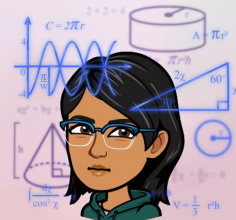
PBL:

Mechanism to Achieve A's for All

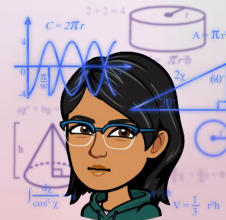Implementing *Proficiency-Based Learning* (PBL) requires a few technical ingredients:

> (1) The opportunity for students to get *as much practice as desired, with immediate and detailed feedback,* until they master a skill or concept. We propose to do this with parameterized question generators (PQGs), described below, including autograding.

Mechanism to Achieve A's for All

Implementing *Proficiency-Based Learning* (PBL) requires a few technical ingredients:

(2) A way for instructors and students to track what the student has and has not yet mastered in the course material. Our proposed mechanism for doing this is a software-backed *concept map* that graphically represents the knowledge and skills in a course and the dependencies among them.

Mechanism to Achieve A's for All

Implementing *Proficiency-Based Learning* (PBL) requires a few technical ingredients:

(3) Business process automation so that instructors can rapidly generate targeted assessments that focus on what a given student doesn't know, and more importantly, help manage the administrative details of resolving Incomplete grades and other processes that may rub up against institutional policies (which we discuss in the next section).
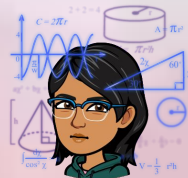
Mechanism to Achieve A's for All

(1) The opportunity for students to get *as much practice as desired, with immediate and detailed feedback,* until they master a skill or concept. We propose to do this with parameterized question generators (PQGs), described below, including autograding.

Many opportunities for Practice:

- PBL: students work as long as it takes on different problems until they achieve proficiency on a particular skill or concept
- Proposal: Move towards *question generators*
  - provide a parameterized "framework" for generating a number of variants of the same underlying question, in particular when some aspects of the question can be randomized
- Paper builds on PrairieLearn(PL) an open-source platform developed at the University of Illinois at Urbana-Champaign (UIUC) for mastery based online exercises in stem courses
- PL provides a framework that randomizes questions and can also autograde
  - Examples:
    - Database Joins: create multiple tables and randomize elements and parameters used in SELECT or JOIN clauses
    - Combinational Logic: randomize gate types and input values while still displaying the combinational circuit in a Web browser
- PL has been used in many STEM disciplines (CS, Engineering, Math, Statistics, Chemistry, Nutrition) other departments have also started to use it
- After creating one question type the learning curve for creating new question instances of that type is far lower
- PrairieLearn is the best platform for achieving "A's for All"

Prairie Learn

Find Input from Output: Value of serial conditional expressions (initial value)

Input a value for the variable y so that the variable x is the integer 24 after the code executes.

y = | 6 | ❓

```
x = y
if x != 12:
    x *= 2
if x == 12:
    x *= 2
```
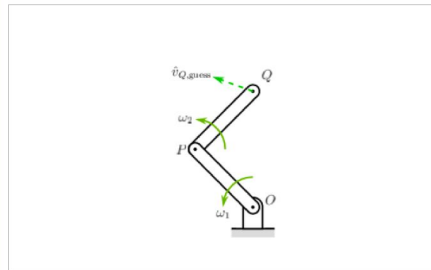
Save & Grade **Save only** **New variant**

Correct answer

Submitted answer correct: 100%
Submitted at 2020-10-25 03:38:35 (CDT)
ⓘ hide ^

Score: 10/10 (100%)

#5-14. Two-bar velocity direction, graphical (twoBarVDir)

Two equal-length rods are connected with pin joints at O and P as shown. The angular velocities are $\vec{\omega}_1 = \omega_1 \hat{k}$ for rod OP and $\vec{\omega}_2 = \omega_2 \hat{k}$ for rod PQ, and these satisfy $\omega_1 < 0$ and $\omega_2 = -2\omega_1$.

Draw the direction of the velocity of point Q on the figure.

Submit for points **Submit for practice**

Homework 5

Mastery: **16%**
16%
HW Score: **0%**

Question #5-14

Recommend:
Correct: 1.47%
Incorrect: -0.09%
Attempts: 0

Do a different question
Previous question
Next question

PQ3.6. Build a stars program

Build a Python program that prints 190 asterisks on one line.
Not every block will be necessary in your answer, but you do need to indent your blocks correctly.

Drag from here:

```
i += 1
```
```
while i <= 760:
```
```
i = 0
```
```
print('*', end='')
```
```
while i < 190:
```
```
while i < 760:
```
```
while i <= 190:
```
```
print('*')
```
```
i += 4
```

Construct your solution here:

Mechanism to Achieve A's for All

(2) A way for instructors and students to track what the student has and has not yet mastered in the course material. Our proposed mechanism for doing this is a software-backed *concept map* that graphically represents the knowledge and skills in a course and the dependencies among them.

Concept Map:

- Graphically represents all the knowledge and skills and conceptual dependencies in a course
- Created by course staff
- Can be shared with students and also can be programmatically color-coded when the concepts have be mastered
- Mastery: Green
- Suggestion on What to Work on Next: Yellow
- Concepts Not Yet Met: Gray

CSCA20 Fall 2022:

The grading scale for each component is as follows:

- N = Not Yet (more work is required to demonstrate competency in this component)
- C = Competency (student has demonstrated competency in this component)
- M = Mastery (student has demonstrated mastery in this component)
- E = Extension (student has gone beyond basic requirements of the component showing initiative and passion in extending their work)

Mechanism to Achieve A's for All

Business Process Automation Support:

- Instructors need a way to generate a targeted assessment that lets students demonstrate proficiency on concepts where they were previously weak
- Proficiency must be noted (for example, update concept map)
- Potentially affects the student's grade even retroactively
  - ("second chance exams" or "clobber policies")
- If assessment tools, concept map tools, the gradebook, and potentially even the campus LMS worked together most of this could be automated
- Authors taking advantage of PrairieLearn's openness to build exactly these integrations

CSCA20 Fall 2022:

Base Grade:	Minimum Requirement to guarantee base grade
50%	Demonstration of C on all core components
60%	Demonstration of C on all core and advanced components
70%	Demonstration of M on all core components, C on all advanced components
80%	Demonstration of M on all core and advanced components
>80%	Grades above 80 will be based on Demonstration of extension which will be primarily available from the project

Challenges Regarding Mechanisms to Achieve A's for All

Onboarding and Institutional Support

- Students:
  - Utilize New PBL Tools for Homework, Exams, and Practice
- Instructors and TAs:
  - "thinkPBL" such as thinking about question "stems" that can be used for the question generator
- Onboarding materials and hands-on training is being developed
- Institutional Support speeds integration of new learning tools
- Fortunately open-source tools that are easy to deploy makes it possible to demonstrate positive results
- The aspirational goal that the authors mention is over time to receive an email from the Department Chair asking: "Why *didn't* everyone get an A?"

Policies to Achieve A's for All

Should all work for the class be finished before the term ends or can students work after the term is over?

- Main Idea: "All or Something" , improvements can be achieved within existing policy frameworks

Figure 1: Our proficiency learning model, a key component necessary for "A's for All (as time and interest allow)".
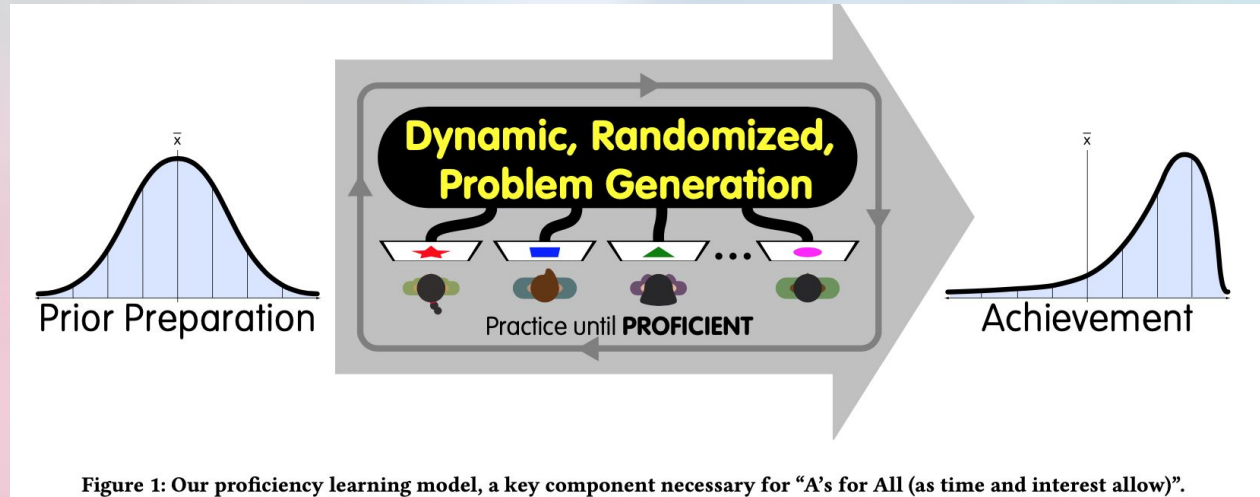
Policies to Achieve A's for All

Scenario One: "A's for Some" with unit synchronization

- Four-unit course broken up into four 1-unit pieces
- Instructor allows students to work *within* a unit, soft assignment deadlines, second- and third-chance exams, and so on
- Everyone must synchronize by the *end* of the unit before the next one begins
- Grades become permanent in the gradebook
- MacKay calls these "consolidation periods" and is the first step to balancing the instructor's synchronization needs with student learning pace preferences

Policies to Achieve A's for All

Scenario Two: "A's for Some" due to term constraints

- Instructor allows students to learn the material at an "A" level but is prevented from any work completed after the end of the term from being recognized for grading purposes

- It is called A's for Some as not all students may be able to reach the "A" level by the end

- Instructors can do the following to make their classes more equitable:
  - Transition from grading on a curve to an absolute scale
  - Provide autograders with no hidden test cases for *all* projects, students then know what it takes to receive full credit and can choose to persevere until they have earned it
  - Soften assignment deadlines yet have a balance
  - Reorganize the Concept Map to help students stay with the regular class pace
  - Make all exams cumulative
  - Move syllabus language to reaching proficiency on *topics*

Policies to Achieve A's for All

Scenario Three: "A's for All" via "Incomplete" Grades

- Students have reached the end of the term, not all have achieved the level of proficiency they wanted, and they have time and interest to continue working and learning
- Instructor enters an **Incomplete (I)** in the grade book
- Once student turns in work the I is resolved
- Student Academic Interns could help and with appropriate pedagogy training they could become TAs
- Registrar at UC Berkeley suggests to introduce a new grading category "Not Yet Proficient (NYP)" or "Not Yet Done (NYD)"
- Attempting to create an API with UC Berkeley Registrar's IT team that would update NYD grades when students finish

Policies to Achieve A's for All

Scenario Four: "A's for All" via *Variable* Units

- Students have reached the end of the term, not all have achieved the level of proficiency they wanted by the end of the term, and they have time and interest to continue working and learning
- Change course from fixed to variable credit hours or units
- Instructor would clearly designate what each of the four units entails and students can move through the course as if they were taking four separate one-unit courses consecutively in one term
- Policy Flexibility is needed for students to come and finish more units in a subsequent semester
- Course can be changed from a quiet, synchronous, four-unit course, with one recommended "pace" to a chaotic mix of students entering with 0- 1-, 2-, or 3- units completed and working at many paces
- Could be possible at a large University where multiple TAs could handle all the different situations (can be challenging for a smaller class)
- More transparency in student performance with regard to course concepts so can have A, A, B, A or A,A,B,B

Policies to Achieve A's for All

Scenario Five: "A's for All" via *Grade Clobber*

- Students have reached the end of the term and given the grade they have earned at the final checkpoint similar to "A's for Some" due to term constraints
- However, students are allowed to continue to work on autograde projects and retake randomized summative assessments on their own, or with staff support
- When the automated system determines that a new level of proficiency has been reached the earlier lower grade is overwritten ("clobbered") by the newer grade
- Example: A senior who finally understands recursion thanks to (say) an internship could have their freshman (or first-year) CS1 grade bump up from a "B" to an "A"
- By supporting exam grade clobbering the student's class grade reflects what they know and can do by *the end of class*
- This policy allows a student's grade to reflect what they know and can do *now*

Conclusion

- "A's for All" is about fixed learning in variable time with long-standing ideas from education research and with the potential to substantially improve fairness and equity in computing education
- Aspirational vision, yet not one that is entirely out of reach
- Technical tools to support the *mechanisms* of A's for All are now widely available
- Some adjustments to policy may be needed
- Most Importantly: The transition from an "all or nothing" vision to an "all or something" collection of practices that we can find places in our educational efforts starting immediately

Questions?
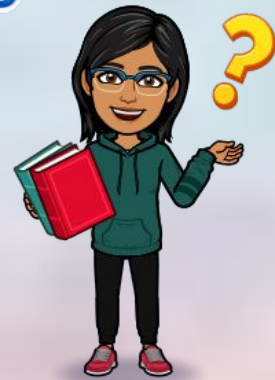
Activity: Four Corners!

Agree

Disagree

A frequently asked question from the paper will be placed along with its corresponding answer. Please move to a sector of the room that suits your opinion. Please be prepared to explain why once you do.

Strongly Agree

Strongly Disagree

Activity: Four Corners!

Agree   **Disagree**

> *Q: How does a student learn time-management skills in a class with no deadlines?* A: Needing extra time for an assignment does not necessarily result from poor time management skills. We would rather see a student take extra time to complete their work at an "A" level than submit incomplete or rushed "B/C"-level work to meet a deadline.

Strongly Agree   **Strongly Disagree**

Activity: Four Corners!

Agree   **Disagree**

> Q: *If under-resourced students need more time with a course, won't they be overwhelmed to finish that course's Incomplete (for no credit) while taking a full load the next term?* A: First, they might be able to finish the Incomplete during the break between terms. Also, institutional support for this initiative is key, with students allowed to take a lower minimum course-load if they're finishing Incompletes.

Strongly Agree   **Strongly Disagree**

Activity: Four Corners!

Agree

Disagree

> **Q:** *With the emphasis on tracking proficiency in individual skills and concepts, how do you assess a student's high-level cumulative learning? (There's more to playing basketball than knowing how to pass, dribble, and shoot – you have to put them together in the right way.)* **A:** Like any methodology, PBL shouldn't be used in isolation; group activities, project-based learning, etc. remain an integral part of a well-designed "A's for All" course. Concept maps should include high-level cumulative learning objectives that are assessed with appropriate activities; computer-based testing is not the only source of proficiency evidence.

Strongly Agree

Strongly Disagree

Activity: Four Corners!

Agree

Disagree

> **Q:** *My exam questions don't easily lend themselves to question generators; they are carefully scripted and authored, without room for meaningful randomization. How can I give students extra chances on exams without them gaming the questions?* **A:** With a large enough question pool, computer-based testing software can build near-infinite variations of an exam. The questions themselves don't need to have many variants if an exam is configured to use question pools. It is a lot of effort, but transferring years' worth of your best questions into testing software will give you the variance you need to allow retries in your class.

Strongly Agree

Strongly Disagree

Activity: Four Corners!

Agree   **Disagree**

> *Q: How to staff the next semester if a ton of students don't finish? Is that fair to the followup instructor? It might even be an unfunded mandate. A:* MOOC-level automation can help a lot, along with for-credit Academic Interns who can support them. Many students may only need to finish one or two elements, and can complete them over the break (or during the summer). At the very least, we recommend connecting with downstream instructor(s) to align to the same vision.

Strongly Agree   **Strongly Disagree**

Activity: Four Corners!

Q: How do you incent students to do their work on time when there are no deadlines? **A:** Our preferred message is "there is a standard-pace deadline, but it's *always* OK if you need more time". One best practice we have found is to require students to fill in a form whenever they need any assignment extension, where they specify how much time they need. Any extension request of fewer than seven days is granted, no questions asked. Any extension request of greater than seven days triggers a 1-on-1 appointment with a TA who checks in with the student, makes sure they have access to physical- or mental-health services, and listens to their situation. At the end of the conversation, the student is assured the extension has been granted.

Activity: Four Corners!

Agree   **Disagree**

> Q: *Haven't instructors advocated that there should be some penalty for not getting things on the first exam (because otherwise they treat the first exam as a "practice" and never start, thereby "burning" an exam that could have been used?)* A: With enough retake exams (with enough randomness) in the back pocket, and infinite retries, that doesn't become an issue.

Strongly Agree   **Strongly Disagree**

Activity: Four Corners!

Agree

Disagree

> **Q:** *Is it really equitable to force under-resourced students to take an extra year to graduate if that's what results from a slower pace through the program?* **A:** We should consider whether a student who graduates in 5 years with all A's has been better served than if they had graduated in 4 years with a mix of B's and C's. Additionally, any interventions already in place at an institution for helping under-resourced students should remain equally effective in an "A's for All" classroom.

Strongly Agree

Strongly Disagree

References:

- *Dan Garcia, Armando Fox, Solomon Russell, Edwin Ambrosio, Neal Terrell, Mariana Silva, Matthew West, Craig Zilles, and Fuzail Shakir. 2023. A's for All (As Time and Interest Allow). In Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2023). Association for Computing Machinery, New York, NY, USA, 1042–1048. https://doi.org/10.1145/3545945.3569847*

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Thank You