Infusing Demographic-Specific Applications into a Digital Logic Adaptive Learning System

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Agenda

1) Motivation – The STEM Workforce & Pipeline

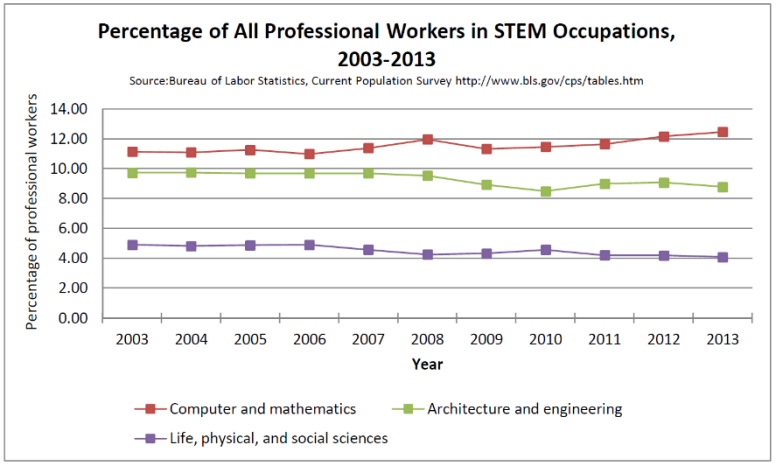
2) Personalized Learning

3) Demographic-Specific Content Can Stress Value

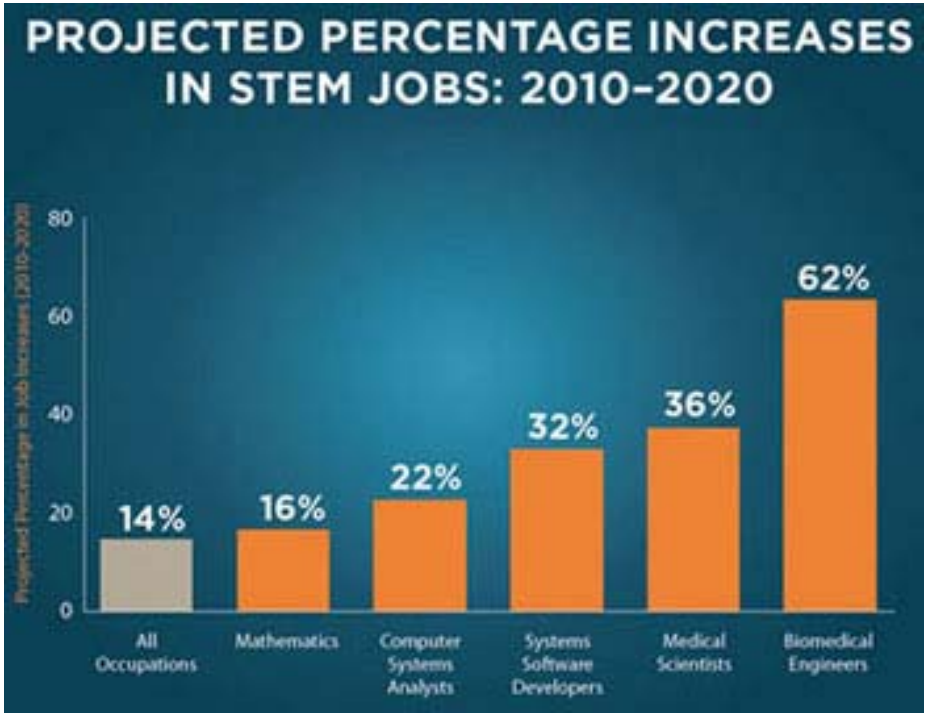
Motivation – The STEM Workforce

- **What is STEM anyway?**
  - STEM = Science, Technology, Engineering, and Math.
  - Defined as **"people who create knowledge".**
  - This doesn't include health practitioners.

- **Who are these STEM people?**
  - In 2013, there were 142M jobs in the US.
  - Of these, 8M were in STEM (1 of ~18).
    - 3.8M in Computers & Math
    - 2.85M in Architecture & Engineering
    - 1.35 in Science
  - That's 25% of the professional workforce.
  - That's 5% of the overall workforce



- **STEM Fuels the US economy**
  - STEM innovations account for 50% of the growth in U.S. economy.
  - Predicted growth rate through 2018 in STEM jobs (20.6%).
  - Predicted growth rate through 2018 in non-STEM jobs (10.1%).
  - Jobs are shifting from non-STEM to STEM.



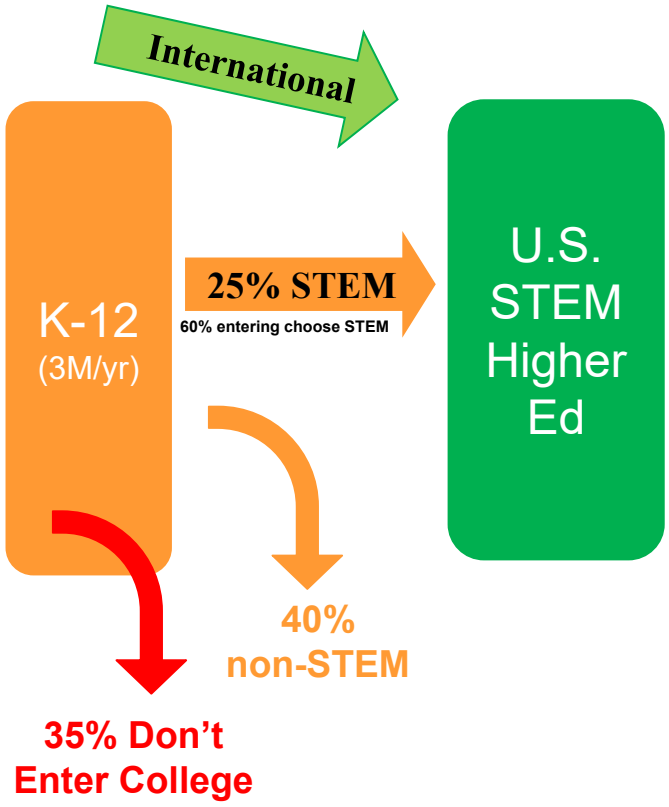
- **Are We Producing Enough STEM Grads To Meet the Demand?**
  - There are 8M STEM workers in the U.S. right now.
  - 9M+ by 2022.

Motivation – The STEM Workforce

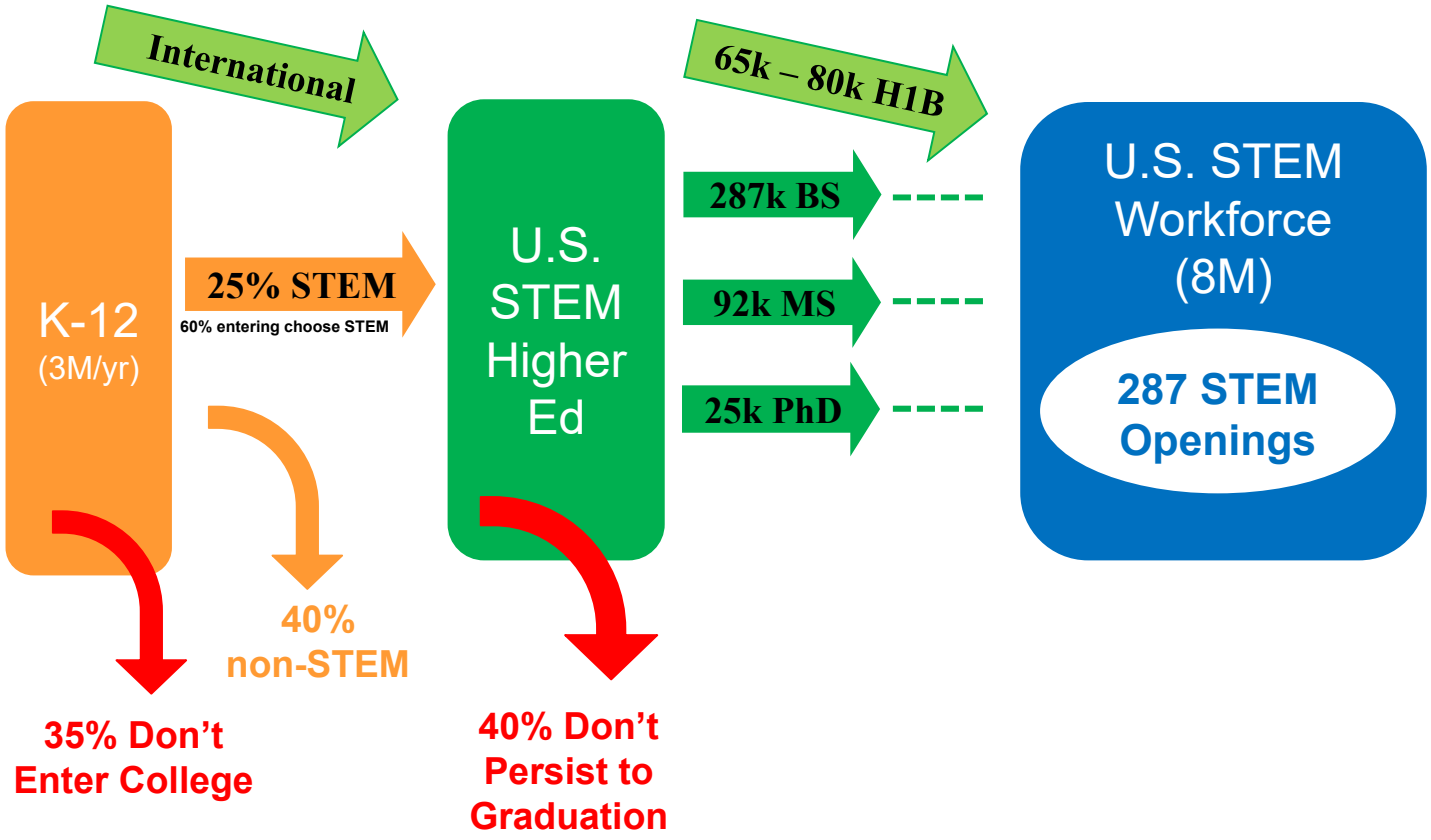
- **The Question requires looking at the entire pipeline**
  - Data can be difficult to find.
  - Different sources define STEM professions differently. We use NSF def.

Motivation – The STEM Workforce

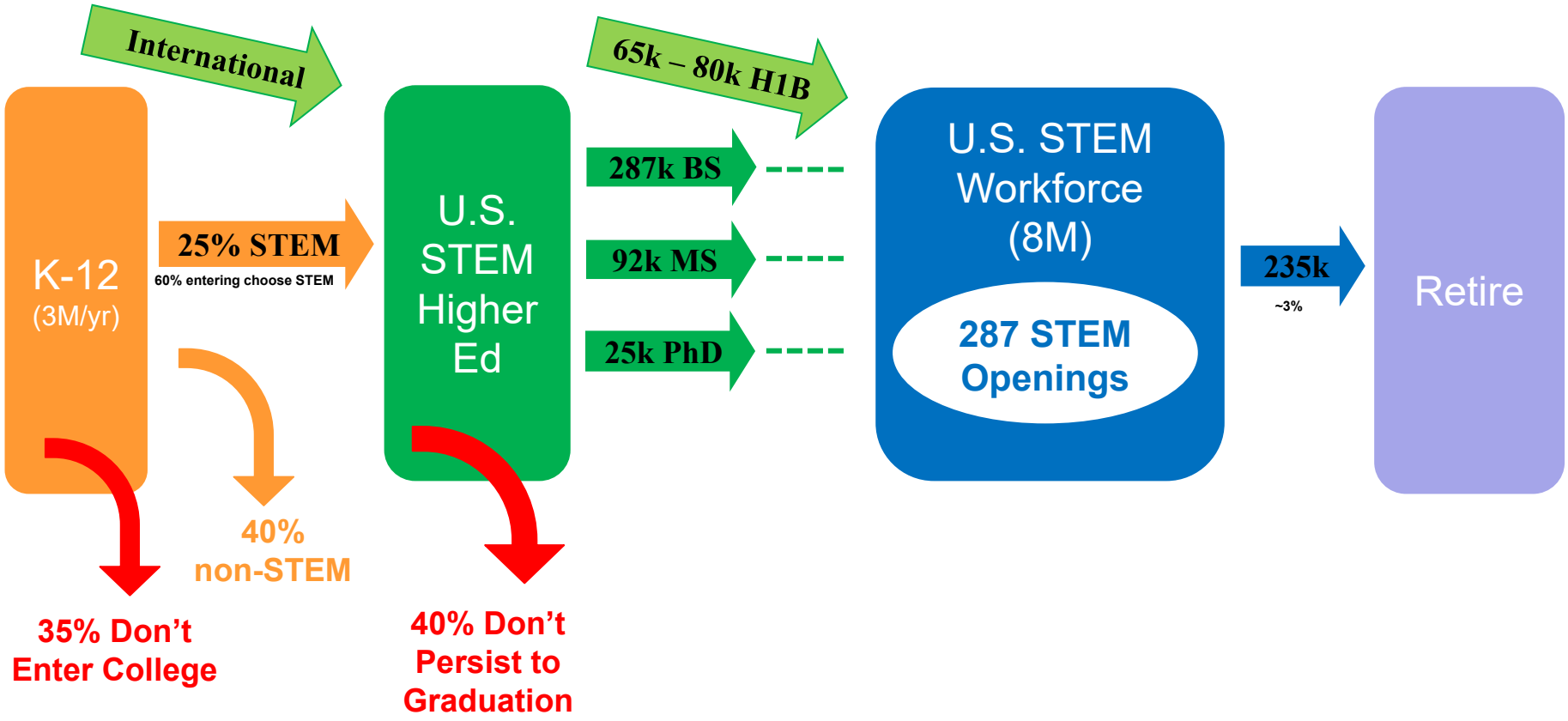
- **The STEM Pipeline**
  - Who enters U.S. higher education system?



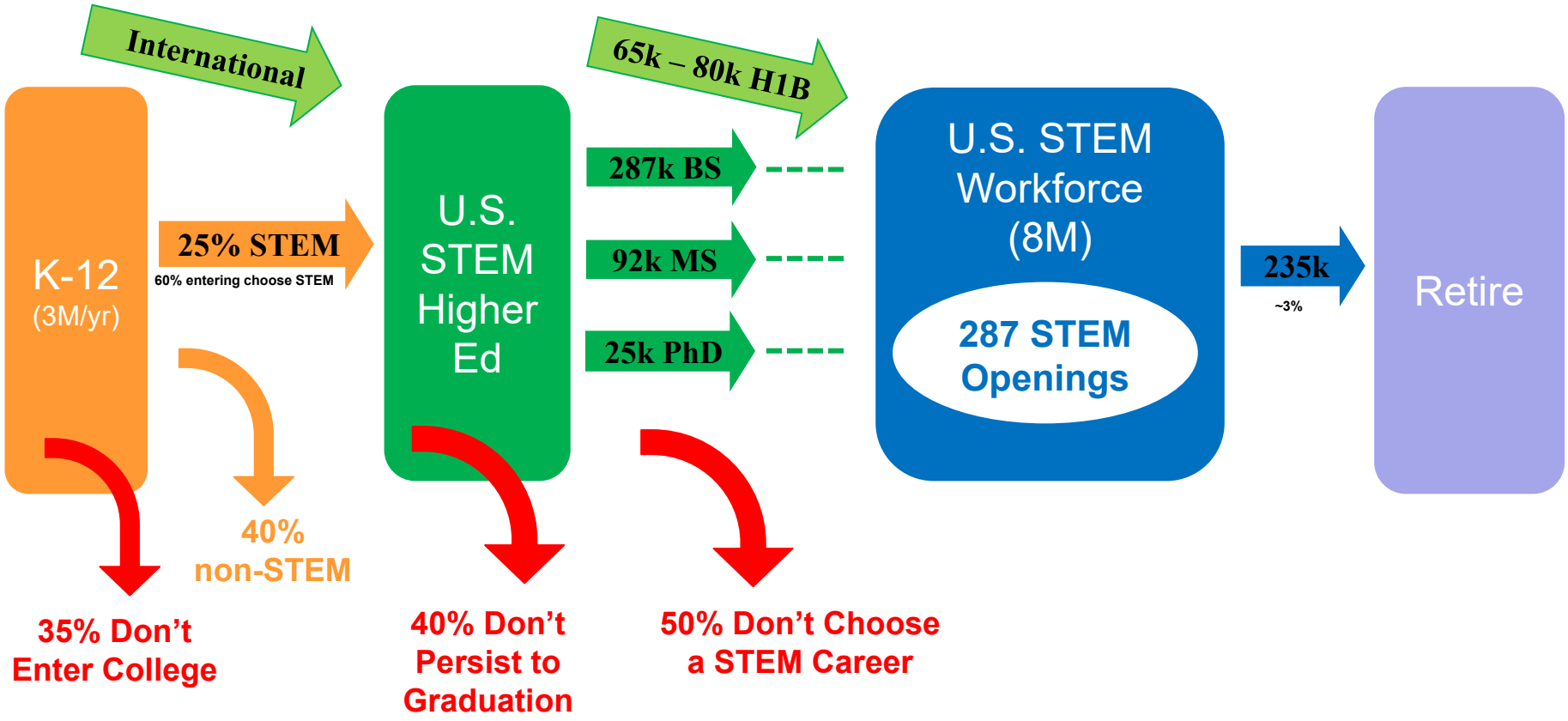
- **The STEM Pipeline**
  - Who obtains a STEM degree?



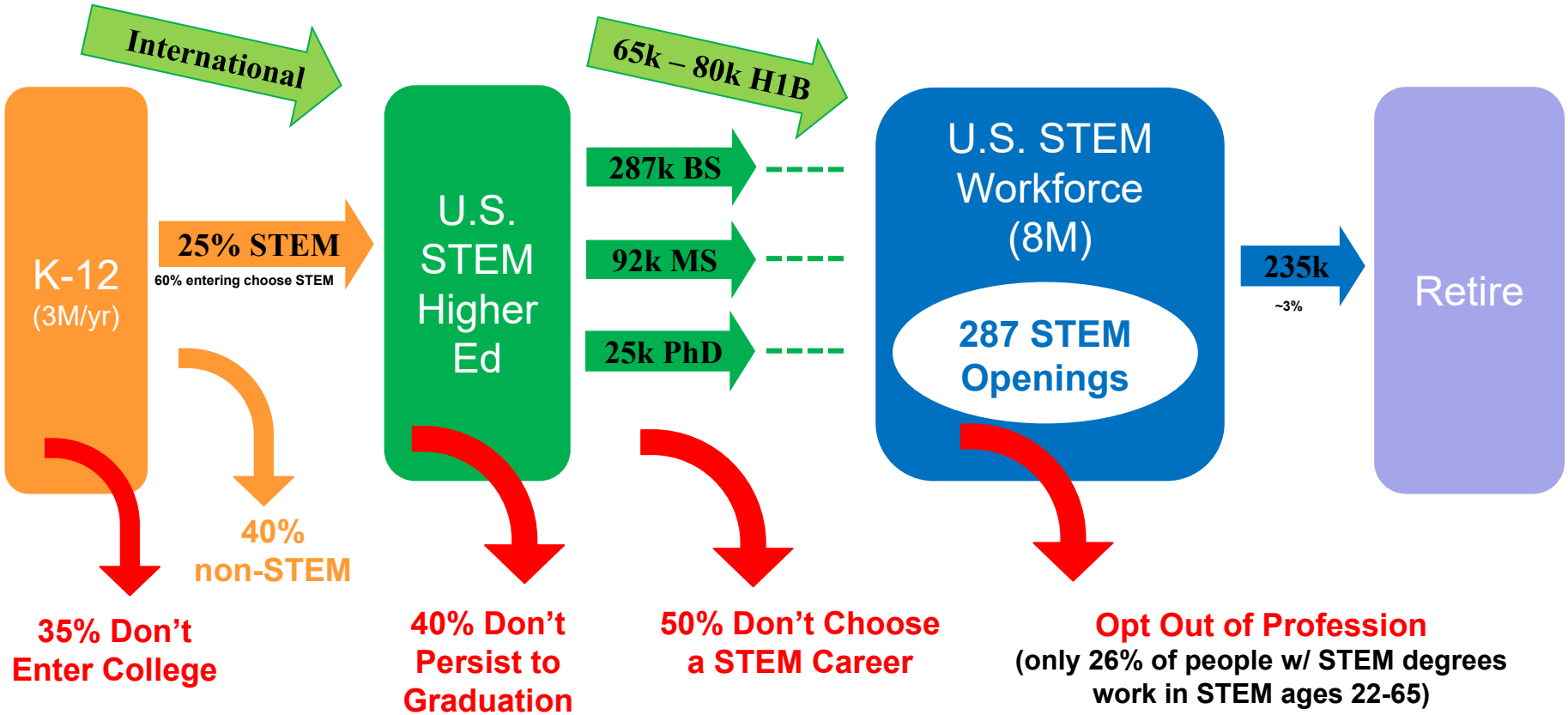
- **The STEM Pipeline**
  - Including retirement completes the flow diagram. Looks like we are fine?



- **The STEM Pipeline – The off roads are the concern.**
  - Some STEM graduates don't enter the field after getting a degree.



- **The STEM Pipeline – The off roads are the concern.**
  - People leave the workforce at an alarming rate.



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    - The percentage of BS degrees awarded to women in this area decreased from 23% to 18% between 2004 and 2014.

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    - The percentage of BS degrees awarded to women in this area decreased from 23% to 18% between 2004 and 2014.
  - Women are 45% more likely than their male peers to leave the STEM industry within their first year. By age 35, 52% of women employed in STEM leave the field (Hewlett, 2008).

- **Why do people leave STEM? It depends on the student.**

1) COGNITIVE

- Our intellectual skills.
- The first thing we think of when we talk about “learning”.

2) AFFECTIVE

- Our feelings (attitudes, motivation, willingness to participate, value of what is being learned).
- Heavily influences success of cognition.

3) PSYCHOMOTOR

- Motor skills.
- Cognition is underlying component, but practice-makes-perfect.

- **Why do people leave STEM? It depends on the student.**

Motivation = Expectancy x Value

More than just wanting good grades & lots of money…

- Will a student "choose" a STEM degree
- Will the student put in the time necessary to achieve graduation.
- Will the person "choose" a STEM profession.
- Will the professional "choose" to stay in STEM.

(Atkinson 50's 60's, Eccles 80's)

- **Why do people leave STEM? It depends on the student.**

Motivation = Expectancy x Value

Beliefs about one's own ability and chances for success.

(Atkinson 50's 60's, Eccles 80's)

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Beliefs about the importance of the tasks.

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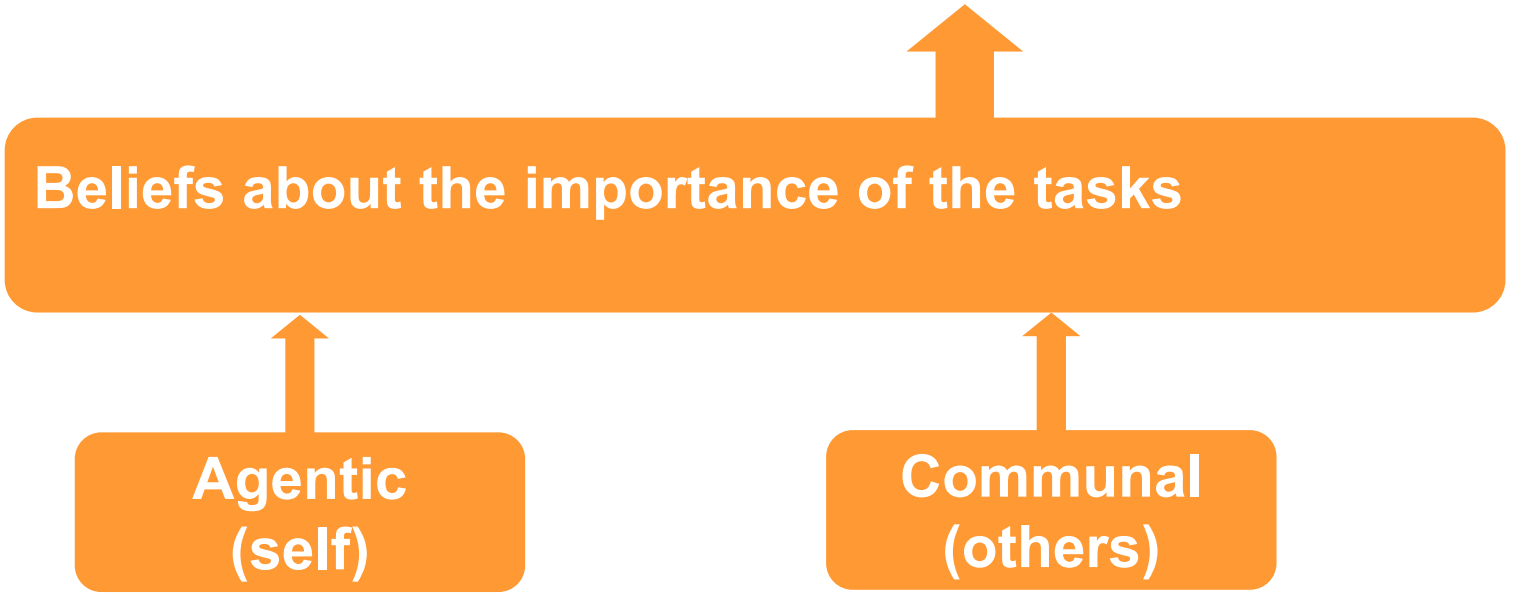

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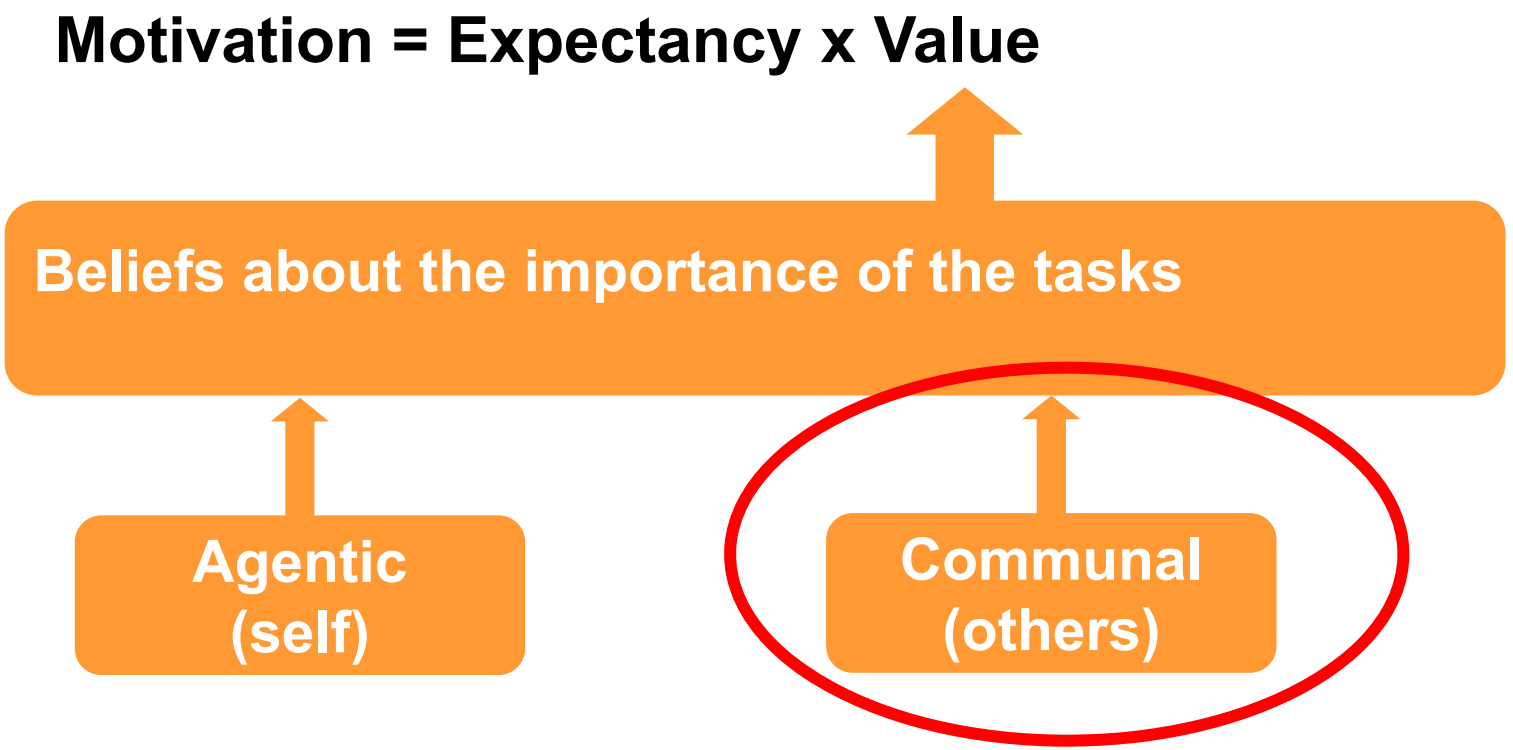
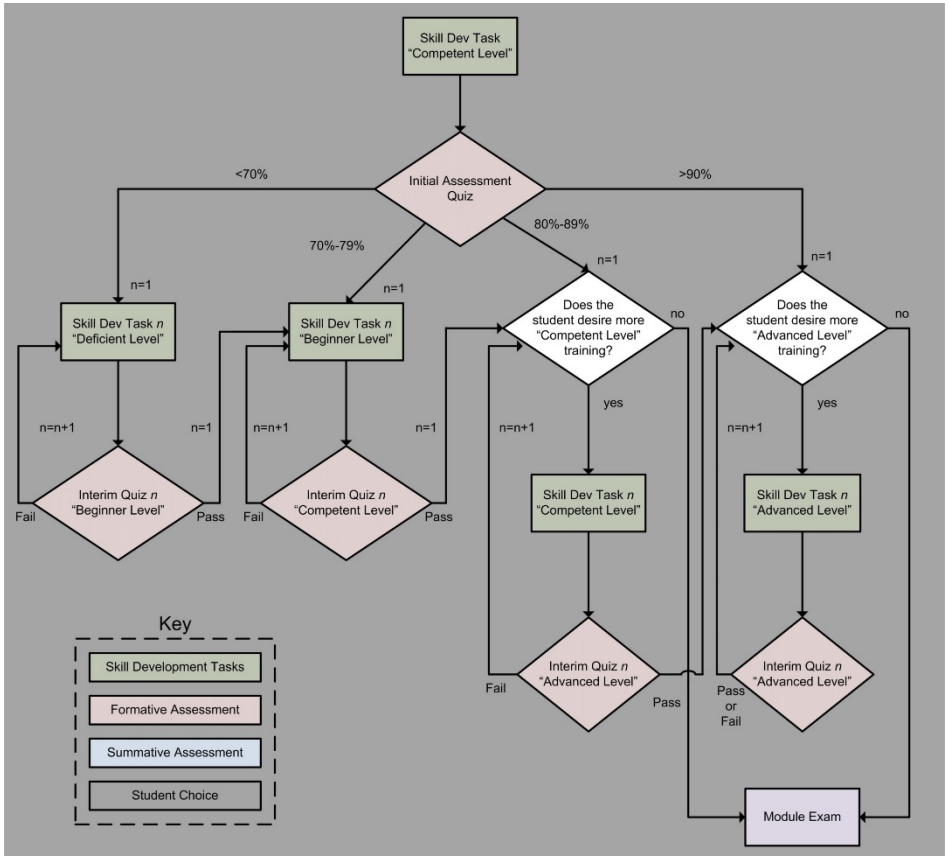
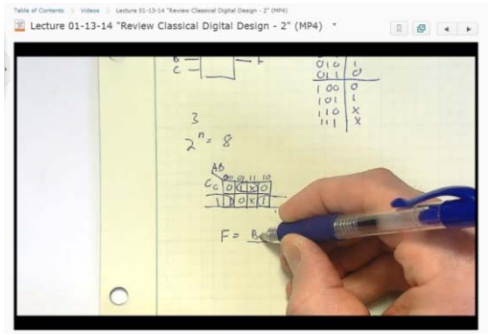


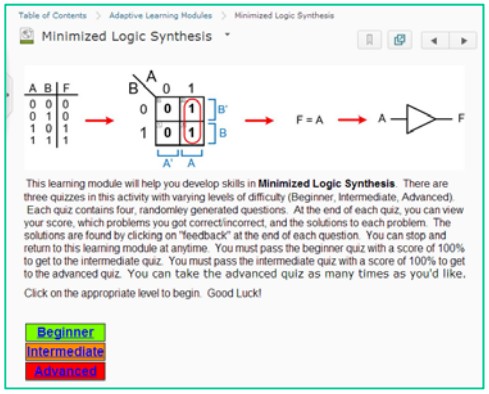
Simple intervensions can make a big difference.

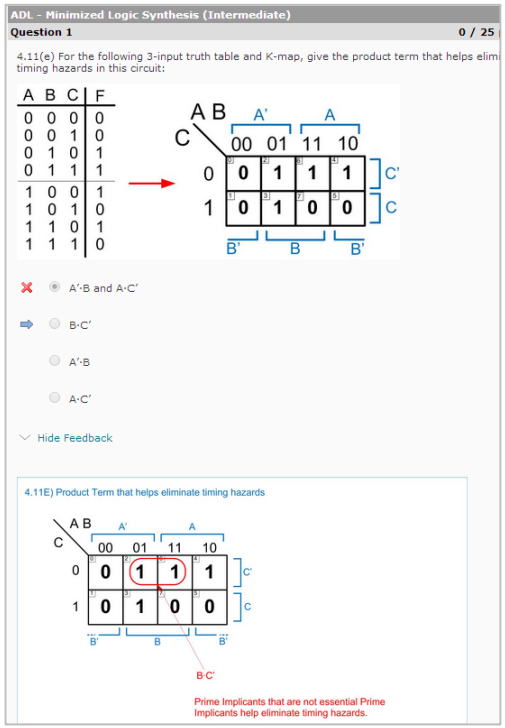
- **E-Learning Systems Have Big Potential**
  - Personalized instruction without instructor resources
  - Address background deficiencies
  - Challenge top students



- **They are becoming practical**
  - Course management systems support the creation.
  - Publishers are providing more sophisticated e-learning environments.







Our Contribution - Demographics

- **If we have the attention of the student, why not make the material "relevant".**
  - Wording of problems and choice of examples can make material "relevant".
- **"Relevance" varies between students**
  - Agentic vs. Communal value systems.
  - Values often track demographics.
- **But it's a lot of work to make material relavant to many different student groups!**
  - That's where the e-learning system has great potential.
  - The system automatically tailors the material based on the individual.

- **A simple example: The traditional question format**

Example 1. Calculating How Long a Battery Will Last	
Concept	• **DC Power Consumption**
Problem Statement	• **A 9v battery is has a capacity of 500 mAh. If you are driving a circuit that consumes 20mW of power, how long will the battery last?**

- **A simple example:** *More relevant to the millennials.*

Example 2. Calculating How Long a Battery Will Last	
Concept	• **DC Power Consumption**
Problem Statement	• **Your smart phone consumes 1W of power. Its rechargeable battery has a capacity of 1000 mAh. If you charge your phone overnight and then disconnect it at 8am when you go to class, at what time will you run out of power?**

- **A simple example:** *More relevant to communal value systems*.

Example 3. Calculating How Long a Battery Will Last	
Concept	• **DC Power Consumption**
Problem Statement	• **A pacemaker consumes 1nW of power. Its battery has a capacity of 100mAh. How long will the pacemaker operate before it needs to be replaced?**

Current Status of our Work

MONTANA STATE UNIVERSITY | College of ENGINEERING

- **Year 1 (now)**
  - Defined 13 broad learning objectives across two courses in digital logic.
  - Defined 60 specific learning outcomes to be measured.
  - Developed over 600 assessment tools (i.e., homework questions).
  - Implemented in course management system as auto-graded assignments.
  - Collected baseline data on student performance across 3 semesters (n=220).
- **Year 2 (next)**
  - Implement adaptive learning modules. Collect data.
- **Year 3 (final)**
  - Implement demographic-specific examples and implement in adaptive learning modules. Collect data.

- **Consent Forms**
  - Difficult to obtain demographic information.
  - We learned if coded sufficiently, we can pull data from university data base.
- **Auto-grading leads to poor students impacting results.**
  - Failing students are able to login and turn in assignments at the last minute.
- **Assessment measures need to match learning outcome category.**
  - If the learning outcome targets “synthesis”, the assessment tools can’t ask questions about “analysis”.
- **Labs are rich with assessment data, but hard to grade.**
  - Most learning in engineering occurs in the lab. But lab demonstrations are typically pass/fail.
  - Lab reports graded with rubrics give great assessment data, but scaling becomes impractical.

Questions

Thank you

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