HARVARD

OFFICE OF THE VICE PROVOST FOR ADVANCES IN LEARNING

RESEARCH

Enabling Adaptive and Principled Assessment Design in MOOCs

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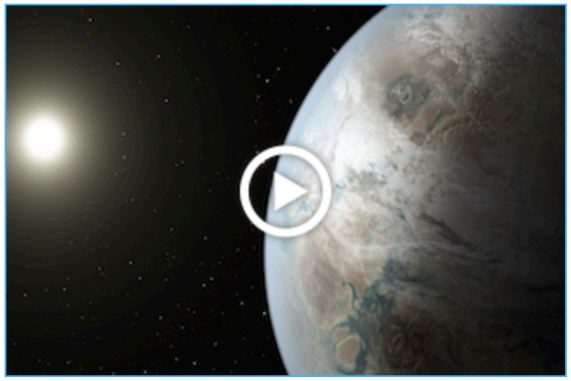
NCME

San Antonio, TX

April 30, 2017

Adaptive assessment in MOOCs

Home > All Subjects > Science > Super-Earths And Life



Super-Earths And Life

Learn about alien life, how we search for it, and what this teaches us about our place in the universe.

HARVARD UNIVERSITY

Self-Paced

Enroll Now

☑ I would like to receive email from Harvard University and learn about other offerings related to Super-Earths And Life.

Home > All Subjects > Computer Science > Data Science Essentials

Data Science Essentials

Explore data visualization and exploration concepts with experts from MIT and Microsoft, and get an introduction to machine learning.

Microsoft

Self-Paced

Enroll Now

☑ I would like to receive email from Microsoft and learn about other offerings related to Data Science Essentials.

1 | 2 | 3 | 4

Total points earned 8.55

Wobble Method

(2.15/5 points)

Imagine a star system with planets that orbit edge-on to us, as shown in the diagram below (not to scale).

Select all that apply.

While a planet orbits this star, we will see a greater Doppler shift in the star's spectrum if...

- [ ] The planet has greater mass, but the same size
- [x] The planet is larger, but has the same mass
- [ ] The planet orbits closer to its star
- [ ] The planet moves faster in its orbit
- [x] The star is less massive
- [ ] The star is not as bright
- [ ] The star is closer to us on Earth

*

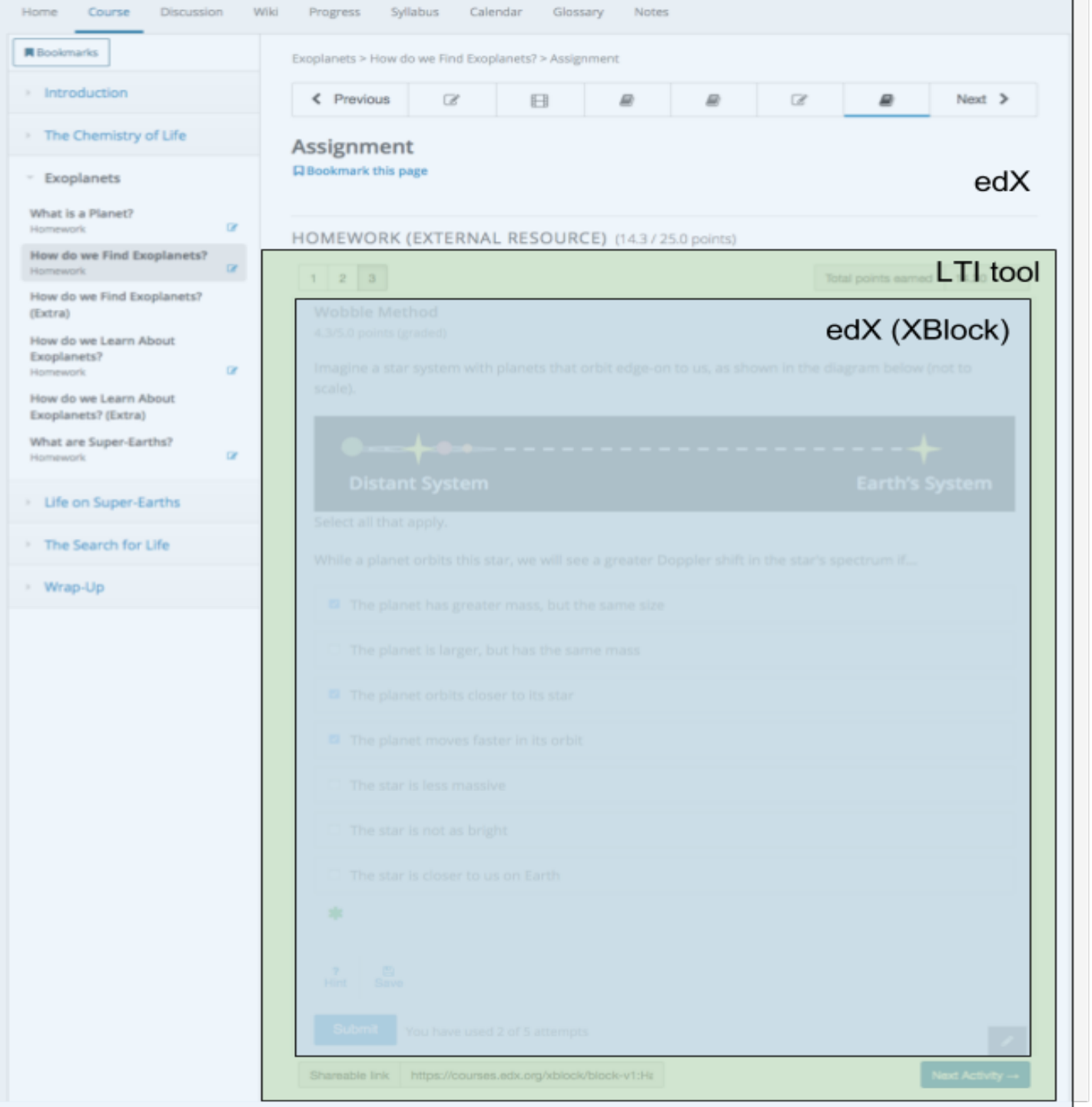
CHECK | HINT | SAVE | SHOW ANSWER

You have used 2 of 5 submissions

Shareable link https://courses.edx.org/xblock/block-v1:H

Next Question →

Engagement + Competency


Home
Course
Discussion
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Notes
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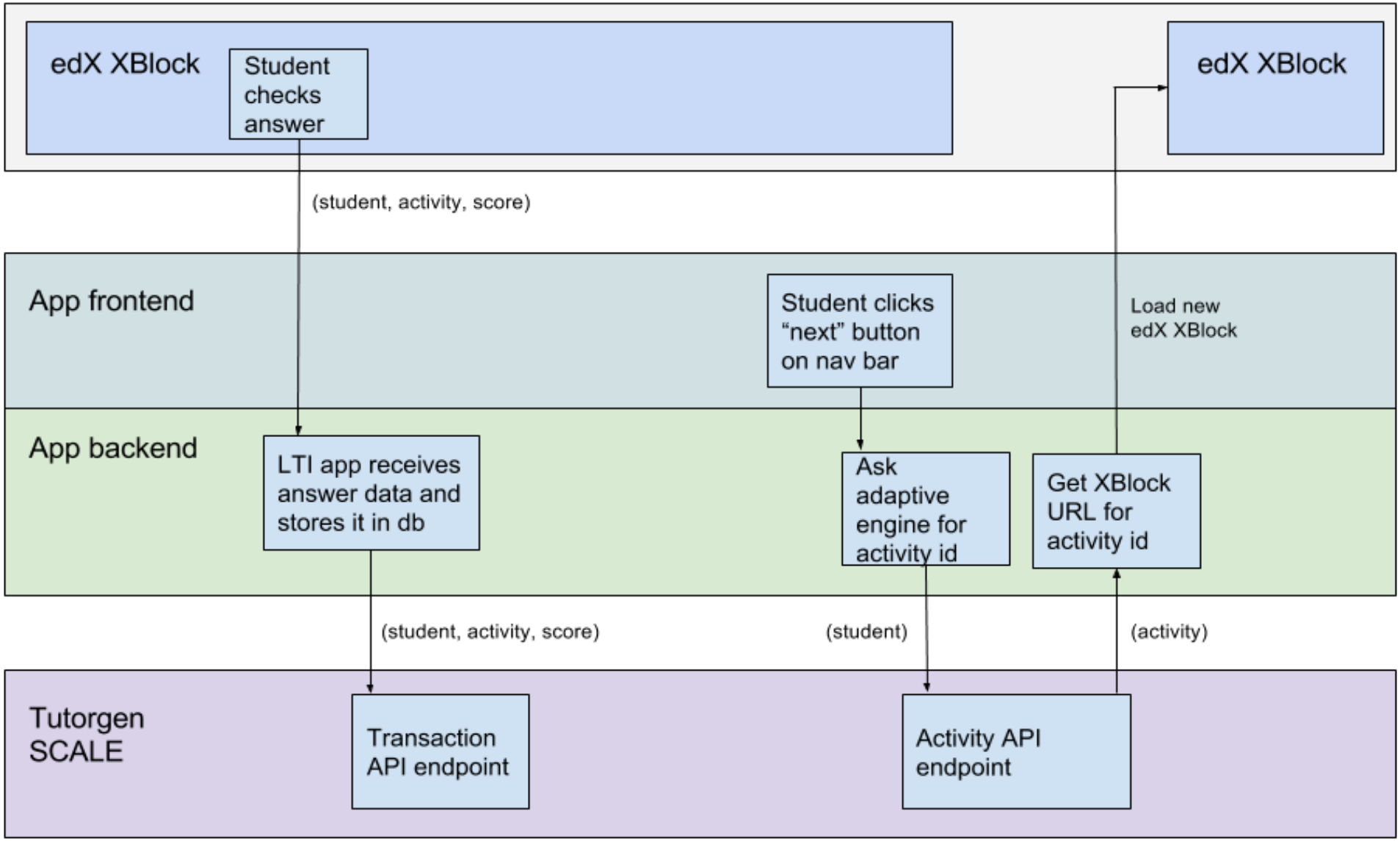
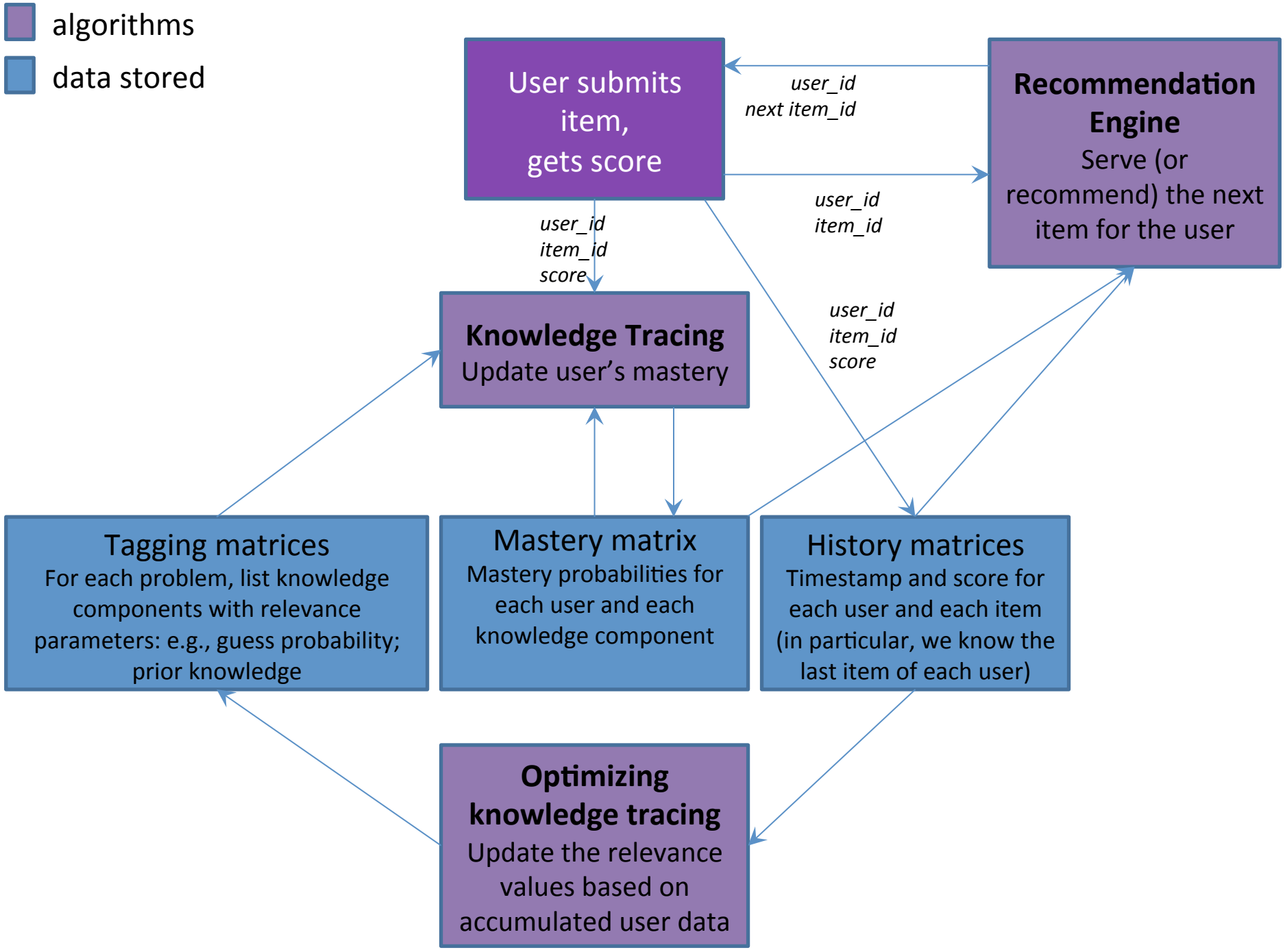
Introduction
The Chemistry of Life
Exoplanets
What is a Planet?
Homework
How do we Find Exoplanets?
Homework
How do we Find Exoplanets? (Extra)
How do we Learn About Exoplanets?
Homework
How do we Learn About Exoplanets? (Extra)
What are Super-Earths?
Homework
Life on Super-Earths
The Search for Life
Wrap-Up
Exoplanets > How do we Find Exoplanets? > Assignment
Previous
Next
Assignment
Bookmark this page
edX
HOMEWORK (EXTERNAL RESOURCE) (14.3 / 25.0 points)
LTI tool
edX (XBlock)
Wobble Method
4.3/5.0 points (graded)
Imagine a star system with planets that orbit edge-on to us, as shown in the diagram below (not to scale).
Distant System
Earth's System
Select all that apply.
While a planet orbits this star, we will see a greater Doppler shift in the star's spectrum if...
The planet has greater mass, but the same size
The planet is larger, but has the same mass
The planet orbits closer to its star
The planet moves faster in its orbit
The star is less massive
The star is not as bright
The star is closer to us on Earth
Hint
Save
Submit
You have used 2 of 5 attempts
Shareable link
Next Activity

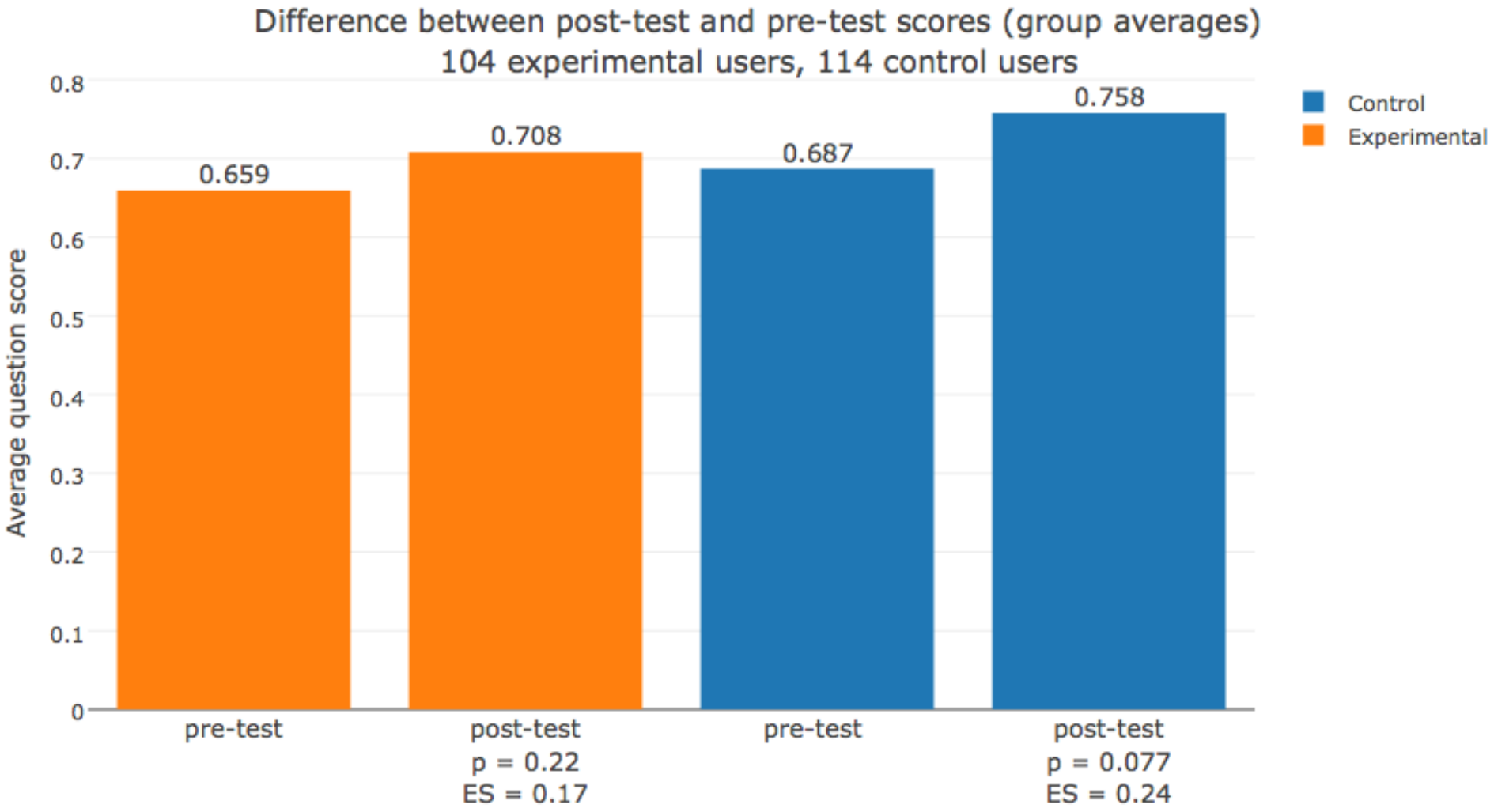


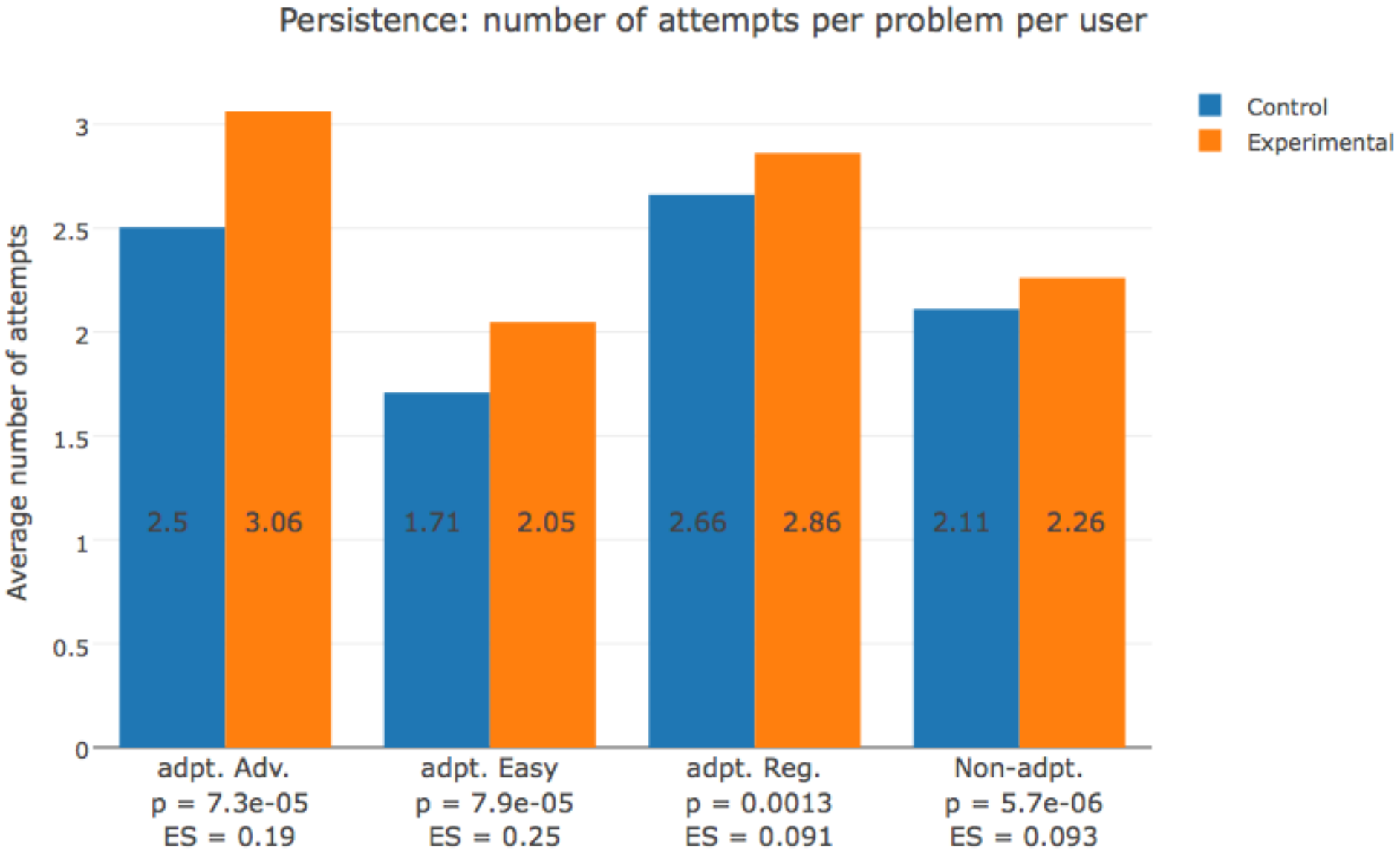
https://github.com/harvard-vpal/bridge-adaptivity


algorithms
data stored
User submits item, gets score
user_id
next item_id
Recommendation Engine
Serve (or recommend) the next item for the user
user_id
item_id
user_id
item_id
score
Knowledge Tracing
Update user's mastery
user_id
item_id
score
Tagging matrices
For each problem, list knowledge components with relevance parameters: e.g., guess probability; prior knowledge
Mastery matrix
Mastery probabilities for each user and each knowledge component
History matrices
Timestamp and score for each user and each item (in particular, we know the last item of each user)
Optimizing knowledge tracing
Update the relevance values based on accumulated user data

	A	B	C	D	E	F	G	H	I	J	K
1	**Section**	**Subsection**	**Unit**	**Title**	**Type**	**Level**	**LO1**	**LO2**	**LO3**	**LO4**	**XBlock URL**
2	Exoplanets	How do we find exoplanets?	Problems	Light Curves (answer)	Answer	Easy	Exo-Transit2				n/a
3	Exoplanets	How do we find exoplanets?	Problems	Transit Method (answer)	Answer	Easy	Exo-Transit1				n/a
4	Exoplanets	How do we find exoplanets?	Problems	Wobble Method (answer)	Answer	Easy	Exo-Wobble1				n/a
5	Exoplanets	How do we find exoplanets?	Problems	Direct Imaging (answer)	Answer	Easy	Exo-Direct1				n/a
6	Exoplanets	How do we find exoplanets?	Problems	Transit Method	Problem	Reg	Exo-Transit1				https://courses.edx.or
7	Exoplanets	How do we find exoplanets?	Problems	Wobble Method	Problem	Reg	Exo-Wobble1				https://courses.edx.or
8	Exoplanets	How do we find exoplanets?	Problems	Direct Imaging	Problem	Reg	Exo-Direct1				https://courses.edx.or
9	Exoplanets	How do we find exoplanets?	Problems	Light Curves	Problem	Reg	Exo-Transit2				https://courses.edx.or
10	Exoplanets	How do we find exoplanets? (Extra)	Light Deflection by Gravity	Light Deflection by Gravity (Advanc	HTML	Adv	Rel-Redshift1	Rel-Warp1			https://courses.edx.or
11	Exoplanets	How do we find exoplanets? (Extra)	Direct Imaging and Interfer	Direct Imaging and Interferometry (	HTML	Adv	Exo-Direct1	Light-ID1			https://courses.edx.or
12	Exoplanets	How do we find exoplanets? (Extra)	Extrasolar Planets and the	Extrasolar Planets and the Issue of	HTML	Adv	Distance3				https://courses.edx.or
13	Exoplanets	How do we find exoplanets? (Extra)	Interstellar Travel? (Advanc	Interstellar Travel? (Advanced)	HTML	Adv	Distance2	Velocity1			https://courses.edx.or
14	Exoplanets	How do we find exoplanets? (Extra)	Extra Material	Gravitational Redshift on the Sun	Problem	Adv	Rel-Redshift1				https://courses.edx.or
15	Exoplanets	How do we find exoplanets? (Extra)	Extra Material	The Deflection of Mercury	Problem	Adv	Rel-Warp1				https://courses.edx.or
16	Exoplanets	How do we find exoplanets? (Extra)	Extra Material	Parallax Angle	Problem	Adv	Distance3				https://courses.edx.or
17	Exoplanets	How do we find exoplanets? (Extra)	Extra Material	Telescope Size	Problem	Adv	Light-ID1	Distance3			https://courses.edx.or
18	Exoplanets	How do we find exoplanets? (Extra)	Extra Material	Hardest via Transit	Problem	Easy	Exo-Transit1				https://courses.edx.or
19	Exoplanets	How do we find exoplanets? (Extra)	Extra Material	Hardest via Wobble	Problem	Easy	Exo-Wobble1				https://courses.edx.or
20	Exoplanets	How do we find exoplanets? (Extra)	Extra Material	Ion Drive	Problem	Adv	Distance2	Velocity1			https://courses.edx.or
21	Exoplanets	How do we find exoplanets? (Extra)	Extra Material	Easiest via Direct Imaging	Problem	Easy	Exo-Direct1				https://courses.edx.or
22	Exoplanets	How do we learn about exoplanets?	Problems	Planet and Star Speeds (answer)	Answer	Easy	Exo-Wobble2				n/a
23	Exoplanets	How do we learn about exoplanets?	Problems	Using the Wobble Method (answer	Answer	Easy	Exo-Wobble2				n/a
24	Exoplanets	How do we learn about exoplanets?	Problems	Using the Light Curve (answer)	Answer	Easy	Exo-Transit2				n/a
25	Exoplanets	How do we learn about exoplanets?	Problems	Planet and Star Speeds	Problem	Reg	Exo-Wobble2				https://courses.edx.or
26	Exoplanets	How do we learn about exoplanets?	Problems	Using the Wobble Method	Problem	Reg	Exo-Wobble2				https://courses.edx.or
27	Exoplanets	How do we learn about exoplanets?	Problems	Using the Light Curve	Problem	Reg	Exo-Transit2				https://courses.edx.or
28	Exoplanets	How do we learn about exoplanets? (Extra)	Planetary Size (Advanced)	Planetary Size (Advanced)	HTML	Adv	Exo-Transit2				https://courses.edx.or
29	Exoplanets	How do we learn about exoplanets? (Extra)	Planetary Mass (Advanced	Planetary Mass (Advanced)	HTML	Adv	Exo-Wobble2				https://courses.edx.or
30	Exoplanets	How do we learn about exoplanets? (Extra)	Planetary Spectra (Advanc	Planetary Spectra (Advanced)	HTML	Adv	Spectro1	Exo-Direct3	Exo-Direct2		https://courses.edx.or
31	Exoplanets	How do we learn about exoplanets? (Extra)	Extra Material	Kepler Planet Distance	Problem	Adv	Distance3				https://courses.edx.or

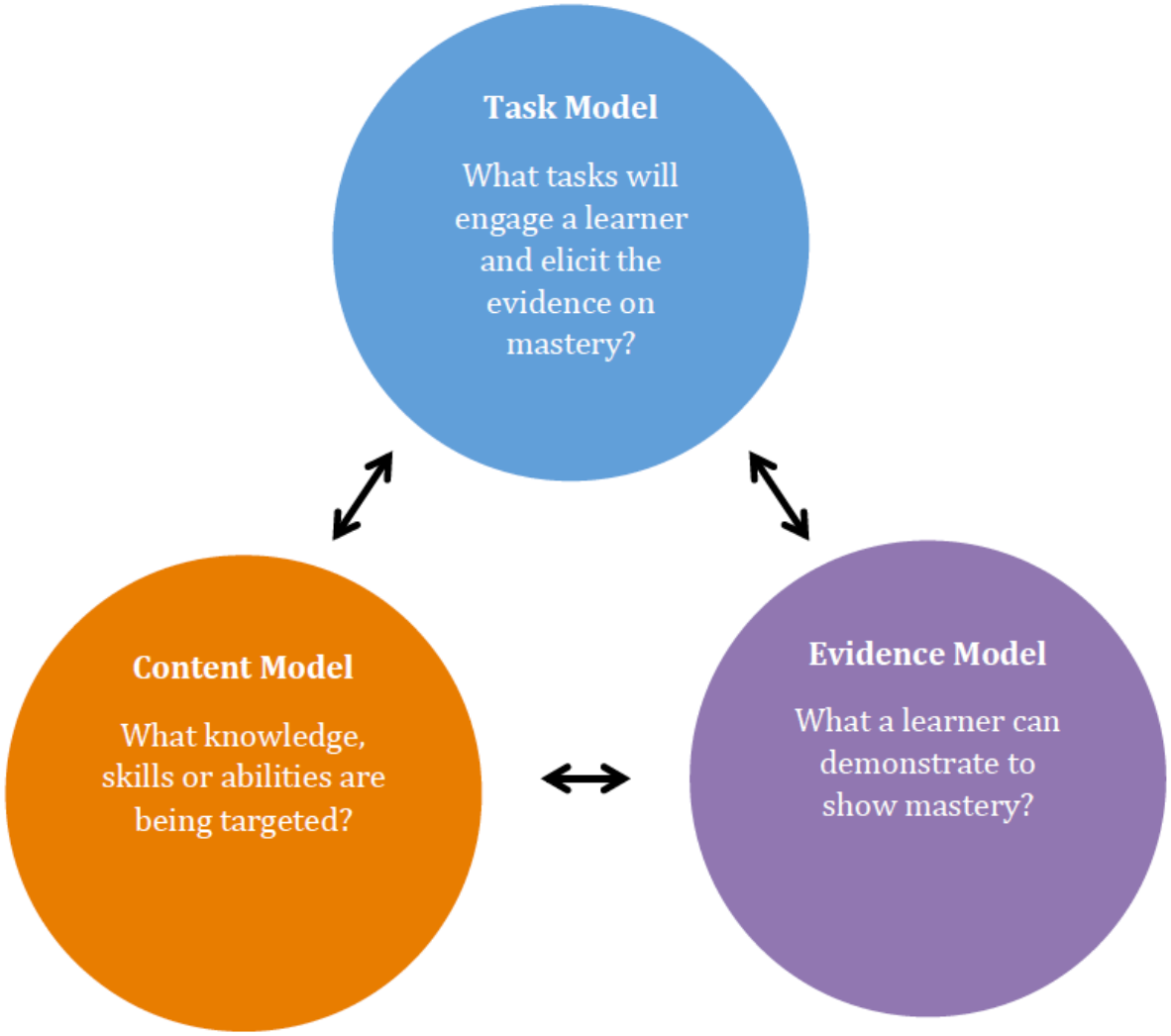
	A	B	C	D	E	F	G	
1	Post-req LO association	Post-req LO name	Post-req LO Description	Pre-req LO association	Pre-req LO name	Pre-req LO Description	Edge strength	Notes and justification
2	75	BigBang2	Recognize that the Big Bang spread the same elements everywhere (on average)	73	BigBang1	Describe the Big Bang theory of the beginning of our universe	S	Direct connection
3	75	SolarSystem2	Summarize how our solar system formed	73	BigBang1	Describe the Big Bang theory of the beginning of our universe	S	Straightforward connectio
4	137	Timeline-Life1	Rank life forms by how early they appear	73	BigBang1	Describe the Big Bang theory of the beginning of our universe	S	Problem 137 requires the
5	71	Timeline-Space 1	Rank astronomical items by how early they appear	73	BigBang1	Describe the Big Bang theory of the beginning of our universe	S	Straightforward connectio
6	122	Biochem-ATP2	Recall the structure of ATP	122	Biochem-ATP1	Explain the role of ATP in metabolism	S	Very important context for random molecule as far as
7	122	Chem-Catalyst1	Define catalysis	122	Biochem-ATP1	Explain the role of ATP in metabolism	S	Link to metabolism
8	167	Cells2	Explain the basic functions of different parts of the cell	198	Cells1	Recall that all life is made up of cells	S	Straightforward connectio
9	122	Biochem-ATP2	Recall the structure of ATP	113	Chem-Bonds1	Describe how positive and negative charges create bonds	S	Knowledge of chemistry (b
10	114	Chem-Life1	Explain why carbon is important to life	113	Chem-Bonds1	Describe how positive and negative charges create bonds	S	Discussion of properties o understanding chemical b
11	115	Life-Water1	Explain why water is important to life	113	Chem-Bonds1	Describe how positive and negative charges create bonds	S	Relies on understanding c
12	133	Biochem-Catalyst1	Recall that enzymes are catalysts	122	Chem-Catalyst1	Define catalysis	S	Direct reference.
13	166	Chem-Life2	Recall that life requires a high concentration of a variety of chemicals	114	Chem-Life1	Explain why carbon is important to life	S	Chem-Life1 explained hov
14	114	Chem-Polymer1	Describe what a polymer is	114	Chem-Life1	Explain why carbon is important to life	S	Carbon-based polymers (p Chem-Life1. It also subsu
15	120	DNA2	Describe the components of DNA (especially A/T/C/G)	114	Chem-Life1	Explain why carbon is important to life	S	Carbon-based polymers (p Chem-Life1. It also subsu
16	179	Chem-Life3	Recall that life arose from non-living compounds	166	Chem-Life2	Recall that life requires a high concentration of a variety of chemicals	S	Straightforward connectio
17	118	Chem-Protein1	Recall the definitions of proteins and amino acids	114	Chem-Polymer1	Describe what a polymer is	S	A straightforward connecti
18	118	Chem-Protein2	Recall that the structure of a protein is important to its function	118	Chem-Protein1	Recall the definitions of proteins and amino acids	S	Discussion of protein struc
19	122	Chem-Catalyst1	Define catalysis	118	Chem-Protein2	Recall that the structure of a protein is important to its function	W	Small reference to protein
20	76	Distance2	Recall the reach of human exploration, space probes, and telescopes	69	Distance1	Rank items by their distances from earth	S	Straightforward connectio
21	247	Exo-Direct1	Explain how direct imaging is used to detect exoplanets	69	Distance1	Rank items by their distances from earth	W	My be helpful for getting th imaging of exo-planets.
22	122	Chem-Catalyst1	Define catalysis	120	DNA2	Describe the components of DNA (especially A/T/C/G)	S	References to DNA replica


Difference between post-test and pre-test scores (group averages)
104 experimental users, 114 control users
Average question score
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.659
0.708
0.687
0.758
pre-test
post-test
p = 0.22
ES = 0.17
pre-test
post-test
p = 0.077
ES = 0.24
Control
Experimental



Net time-on-task: Control: 5.85 hours vs. Experimental: 5.47 hours

Principled assessment design



q1: I get a lot of satisfaction out of solving a mathematics problem	q2:I am confident that I could learn advanced mathematics
1: Stronly disagree: 729	1: Stronly disagree:1120
2: Disagree :1063	2: Disagree : 604
3: Neutral : 10	3: Neutral : 71
4: Agree : 1	4: Agree : 8
5: Stronly agree : 4	5: Stronly agree : 2
	NA's : 2

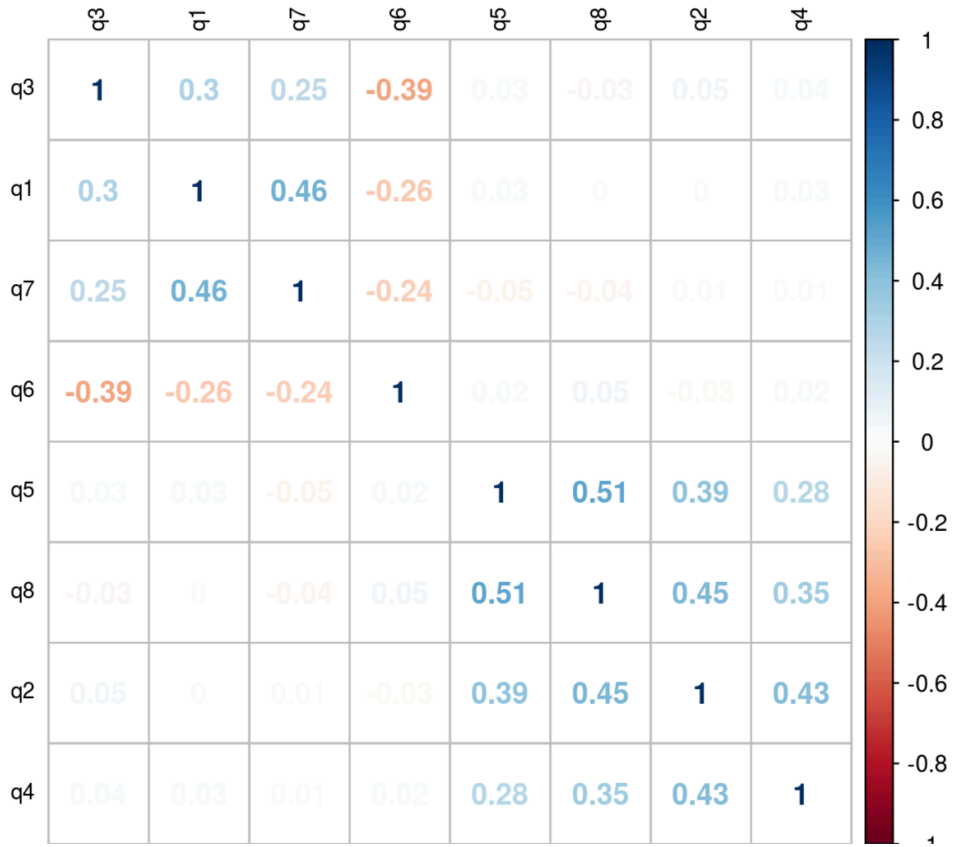
q3: I have usually enjoyed studying mathematics in school	q4: I would like to avoid using mathematics in university
1: Stronly disagree: 752	1: Stronly disagree:967
2: Disagree :1031	2: Disagree :668
3: Neutral : 14	3: Neutral :146
4: Agree : 3	4: Agree : 20
5: Stronly agree : 7	
	NA's : 6

Measuring student math

The Massachusetts Department of Education wants to examine whether students' attitudes and beliefs about math are correlated with their **MCAS** scores. To help answer this question, your research team has adminstered a survey of 8 questions to 1807 randomly-selected high school students throughout the state.

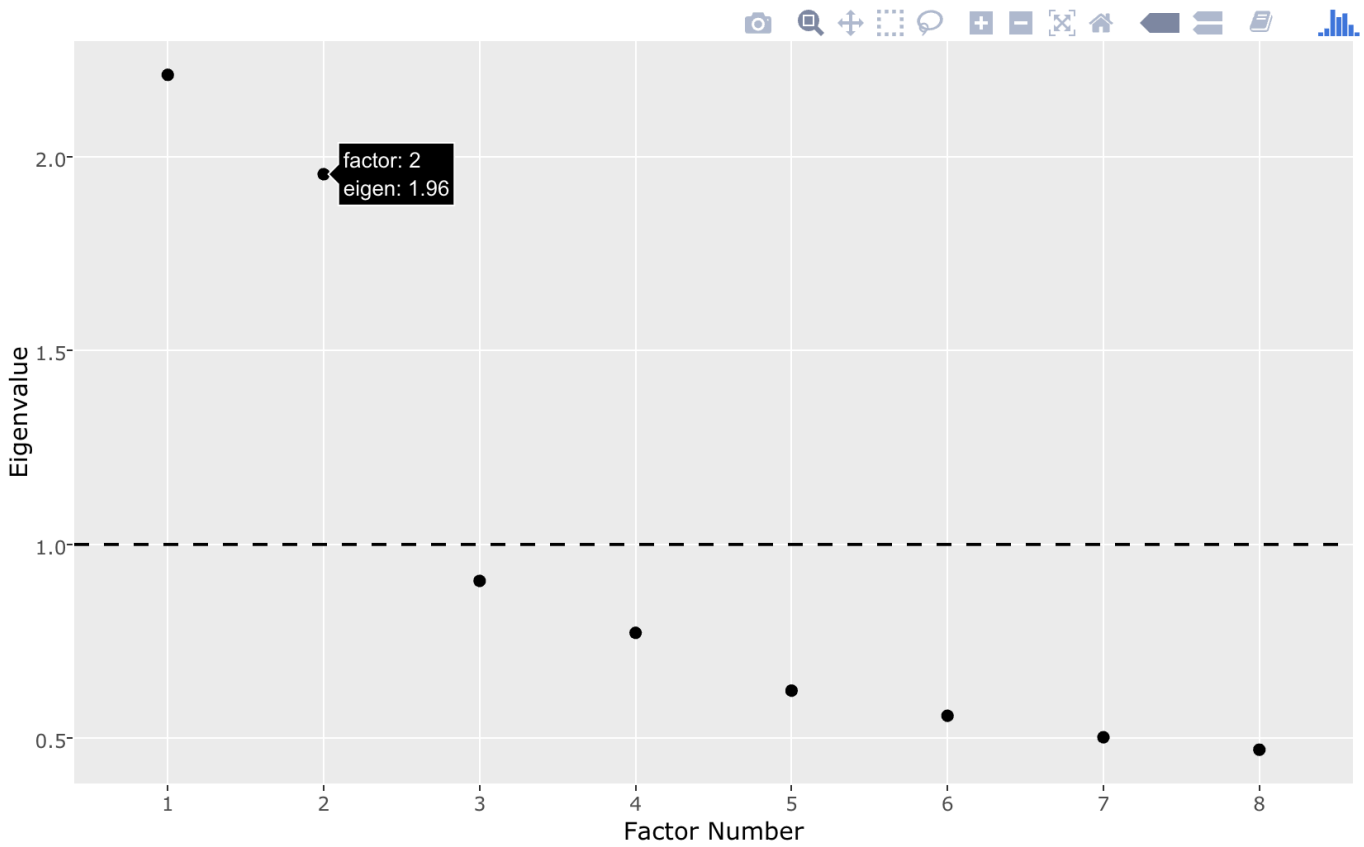
On the left are summaries of the responses.

Originally, your team planned on creating a single composite measure of students' attitudes and beliefs about math by averaging the 8 survey questions. You've been asked to conduct **factor analysis** to assess whether this is a "good" idea. The purpose of this analysis is to identify the number of "factors," i.e., constructs, that describe our data. The idea is that some survey items might be more related to each other than others. Factor analysis can help us determine this.



Preliminary analysis: are there any interesting correlations among the variables?

Note: lighter colors indicate weak correlations, while darker shades indicate strong correlations.



Scree plot

A scree plot allows you to assesses how many factors explain most of the variability in the data. The rule of thumb is to choose factors with eigenvalues above 1.

Based on the scree plot, how many factors do you think we should retain?

Variable	Factor1	Factor2
q1: I get a great deal of satisfaction out of solving a mathematics problem.		0.66
q2: I am confident that I could learn advanced mathematics.	0.64	
q3: I have usually enjoyed studying mathematics in school.		0.51
q4: I would like to avoid using mathematics in university.	0.52	
q5: I am willing to take more than the required amount of mathematics.	0.65	
q6: Mathematics is dull and boring.		-0.47
q7: I like to solve new problems in mathematics.		0.61
q8: The challenge of mathematics appeals to me.	0.73	

Showing 1 to 8 of 8 entries

Number of factors:

2

0
1
2
3

survey question. Like correlations, factor loadings can range from -1 to 1. For ease of interpreation, factor loadings between -3 and 3 have been removed.

Use the drop down menu to test out the different factor models.

How many factors, would you recommend?

Next steps

- Developing fully adaptive HarvardX MOOCs
- Research collaboration with other MOOC providers
- Experimentation with different adaptive methods
- Automated item generation
- Principled design for performance assessments in MOOCs

Thank you!

Adaptive assessment team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John Stamper

HGSE & T521 students