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Office of the Vice Provost for Advances in Learning

Enabling Adaptive Assessments [and Learning] in HarvardX

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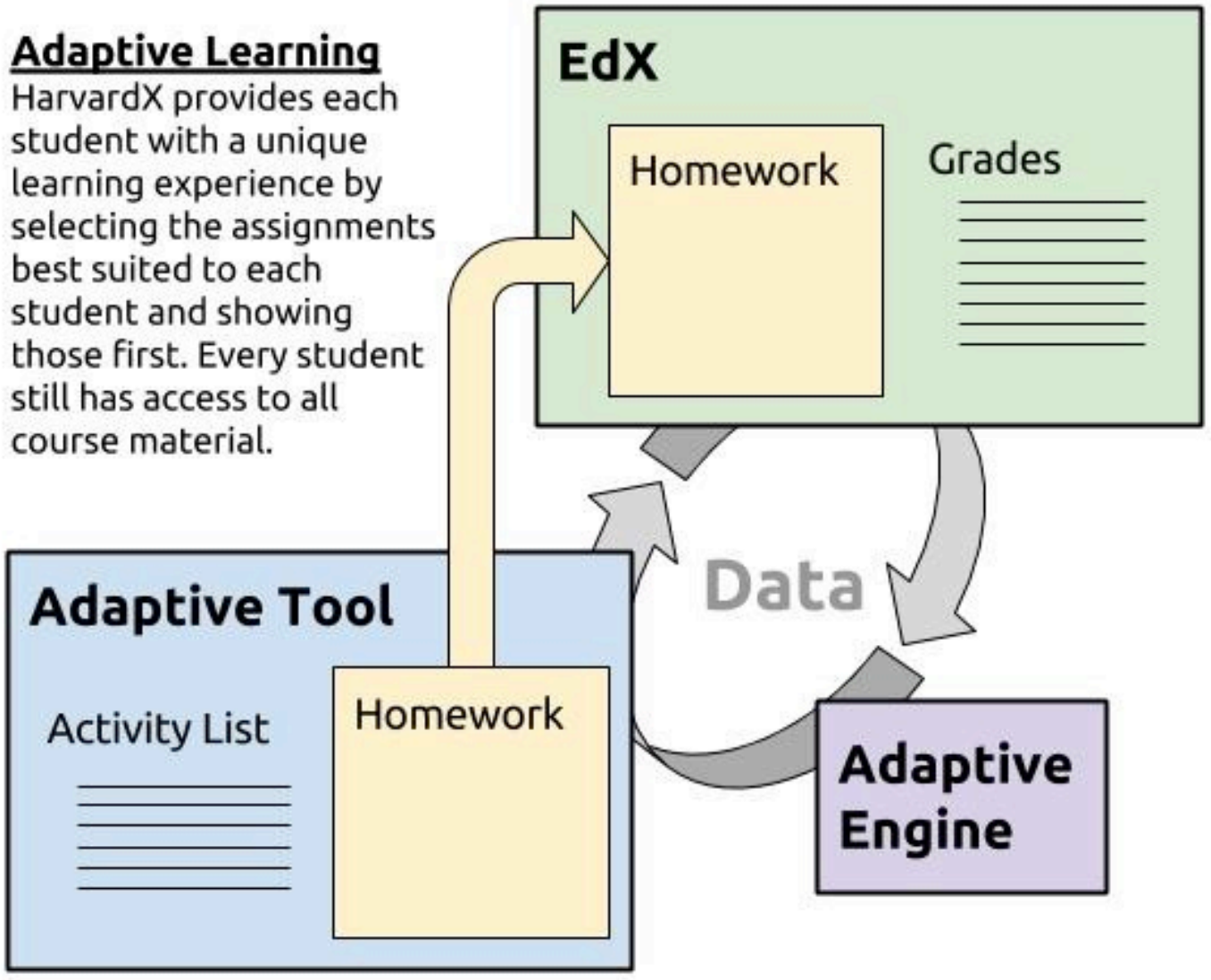
Adaptive Learning

HarvardX provides each student with a unique learning experience by selecting the assignments best suited to each student and showing those first. Every student still has access to all course material.



Adaptive learning framework

- Focus on assessment
- LTI tool: Research team
- Bayesian knowledge tracing: TutorGen SCALE
- Pilot course: SuperEarths and Life (25%)
- Content tagging
- 3-4 times more assessment items
- Pre-post assessment
- A/B testing

	A	B	C	D	E
1	category	index	Item name	LO (knowledge component)	LO (knowledge component) description
434	html	379	The Kepler Mission	Stars4	Recall the statistics for the types of stars and their associated planets
435	html	380	The Kepler Search Field	Exo-Detection2	Describe the number and types of exoplanets discovered thus far
436	html	381	Kepler's Discoveries	Exo-Detection2	Describe the number and types of exoplanets discovered thus far
437	html	382	Kepler's Changing Mission	(none)	This material has no learning objective that is relevant to astrobiology
438	html	383	Links	(none)	This material has no learning objective that is relevant to astrobiology
439	vertical	384	Extrapolating to the Whole Sky		#N/A
440	html	385	Kepler and the Whole Sky	Exo-Detection2	Describe the number and types of exoplanets discovered thus far
441	video	386	Kepler Orrery II	Exo-Detection2	Describe the number and types of exoplanets discovered thus far
442	html	387	The Occurrence Rate of Planets	Exo-Detection2	Describe the number and types of exoplanets discovered thus far
443	html	388	How Many of these Planets are Habitable?	Exo-Detection2	Describe the number and types of exoplanets discovered thus far
444	html	388	How Many of these Planets are Habitable?	Stars4	Recall the statistics for the types of stars and their associated planets
445	html	389	Extrapolating to the Whole Sky	Exo-Detection2	Describe the number and types of exoplanets discovered thus far
446	html	390	Links	(none)	This material has no learning objective that is relevant to astrobiology
447	vertical	391	How Far Away Are They?		#N/A
448	html	392	How Far Away Are They?	Exo-Transit3	Use current data from transits to extrapolate number and properties of planets around stars
449	problem	393	Probability of Detection	Exo-Transit3	Use current data from transits to extrapolate number and properties of planets around stars

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	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

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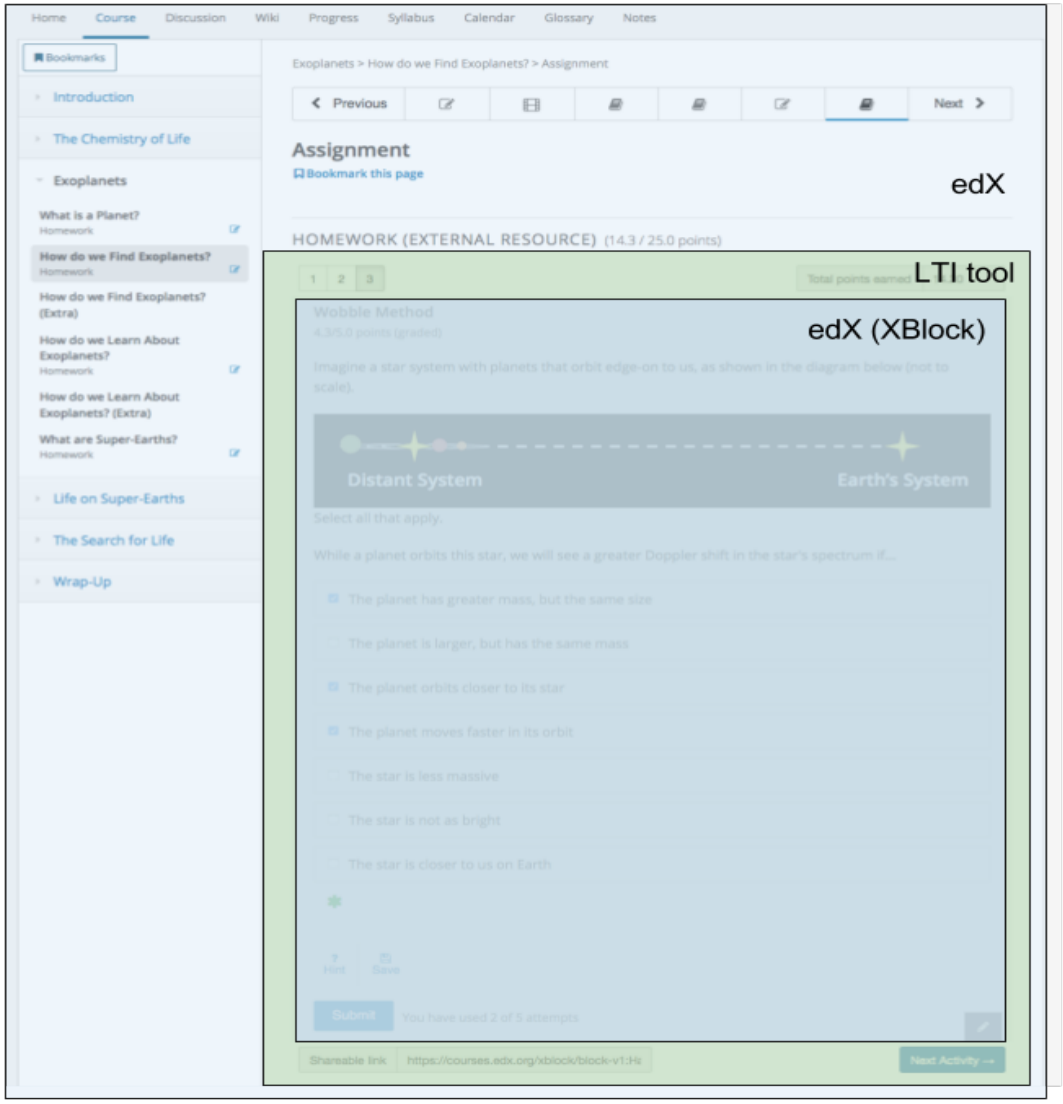
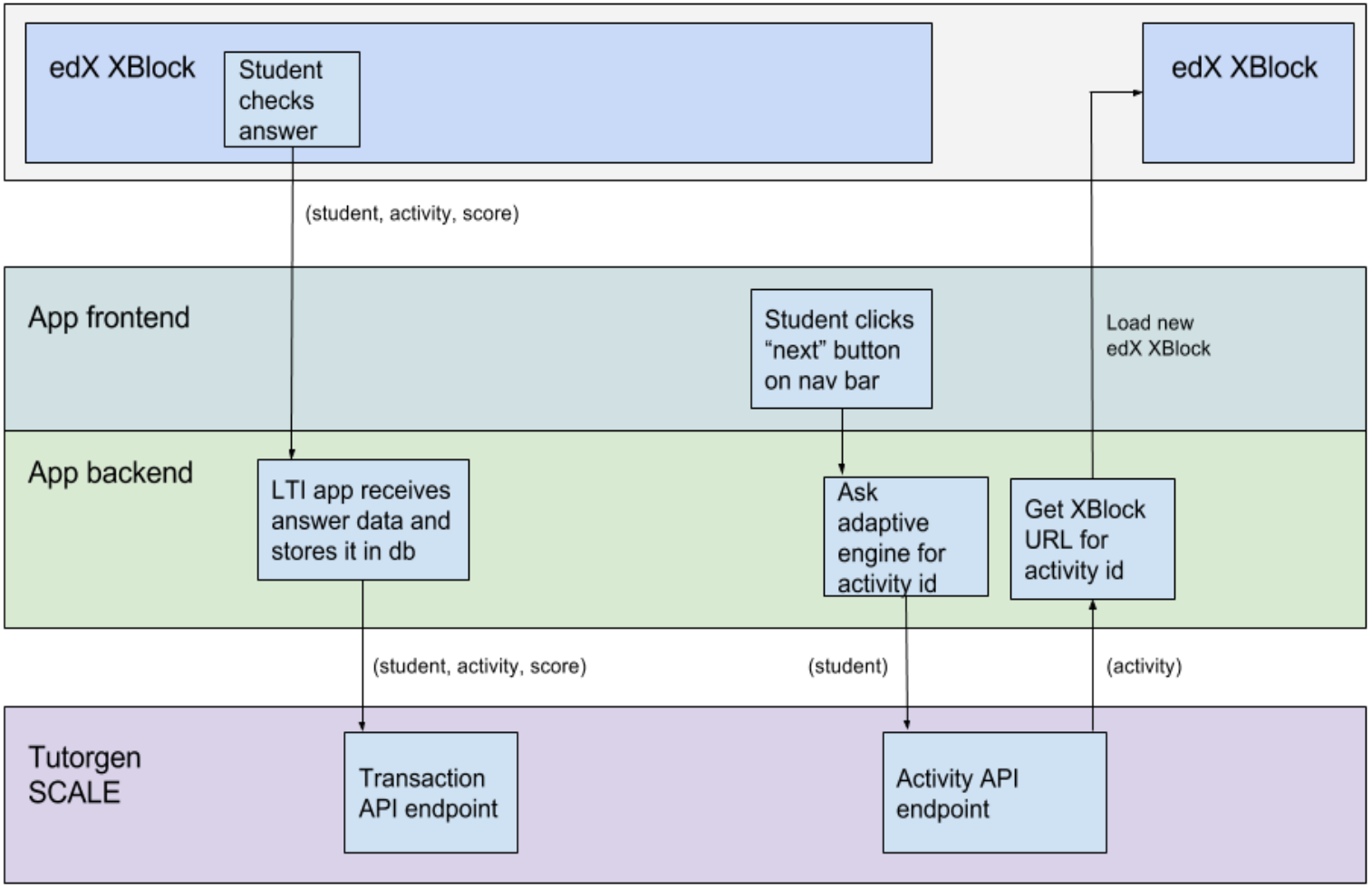
	A	B	C	D	E	F	G	
1	Post-req LO association	Post-req LO name	Post-req LO Description	Pre-req LO association	Pre-req LO name	Pre-req LO Description	Edge strength	Notes and justification
2	75	BigBang2	Recognize that the Big Bang spread the same elements everywhere (on average)	73	BigBang1	Describe the Big 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 how
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


Home
Course
Discussion
Wiki
Progress
Syllabus
Calendar
Glossary
Notes
Bookmarks
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
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


edX XBlock
Student checks answer
edX XBlock
(student, activity, score)
App frontend
Student clicks "next" button on nav bar
Load new edX XBlock
App backend
LTI app receives answer data and stores it in db
Ask adaptive engine for activity id
Get XBlock URL for activity id
(student, activity, score)
(student)
(activity)
Tutorgen SCALE
Transaction API endpoint
Activity API endpoint

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*

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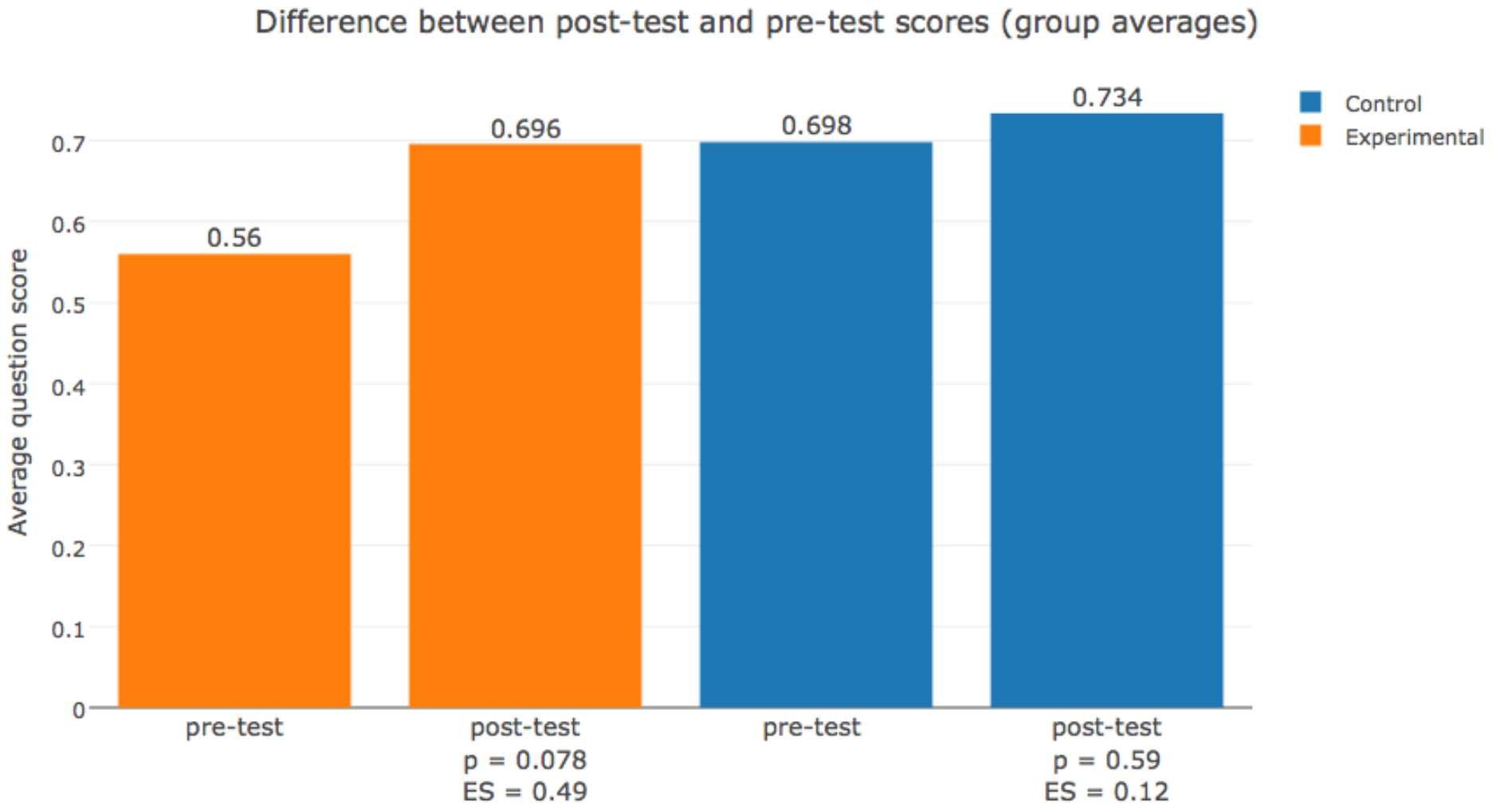

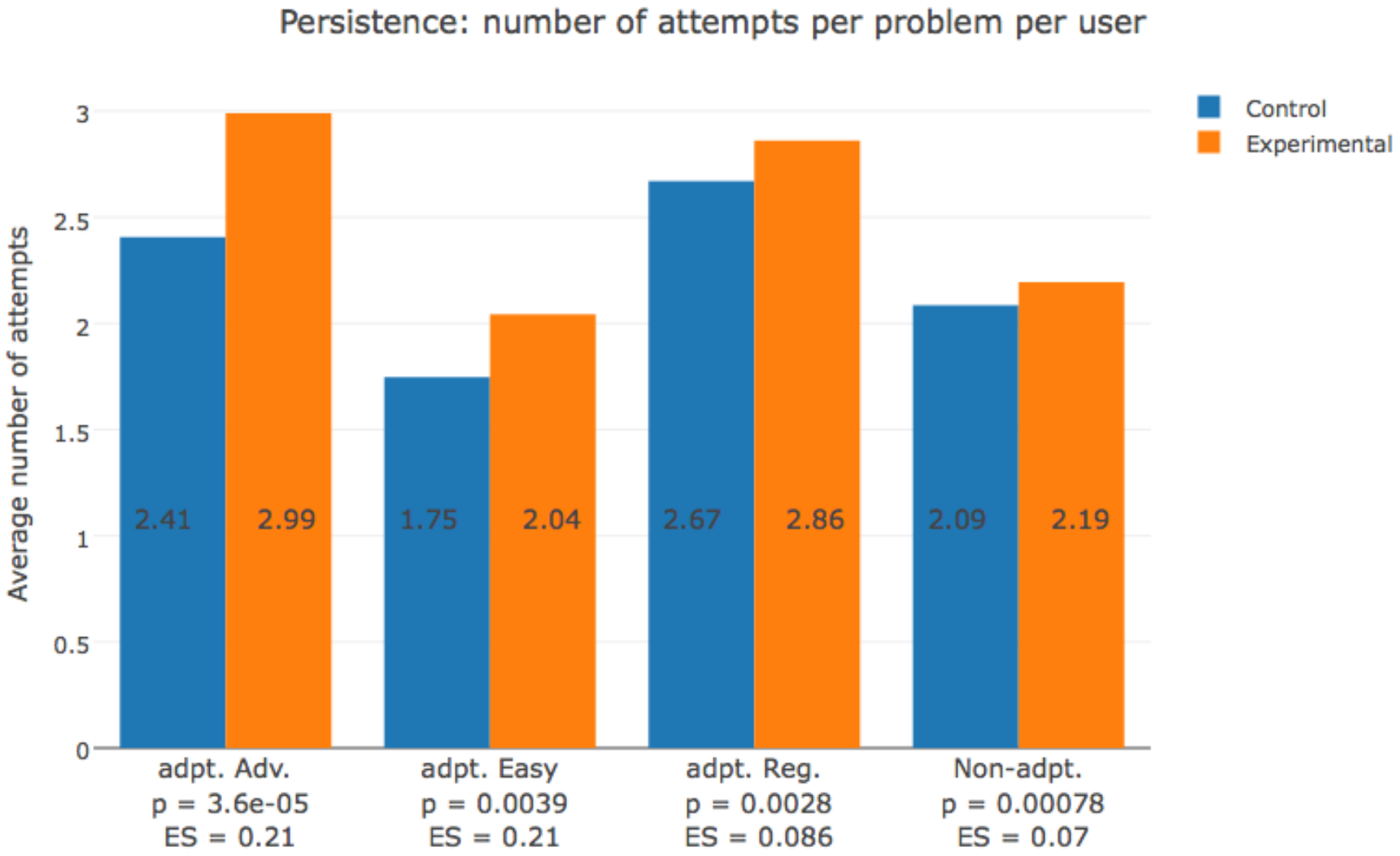
Persistence: number of attempts per problem per user
Control
Experimental
Average number of attempts
3
2.5
2
1.5
1
0.5
0
2.41
2.99
1.75
2.04
2.67
2.86
2.09
2.19
adpt. Adv.
p = 3.6e-05
ES = 0.21
adpt. Easy
p = 0.0039
ES = 0.21
adpt. Reg.
p = 0.0028
ES = 0.086
Non-adpt.
p = 0.00078
ES = 0.07

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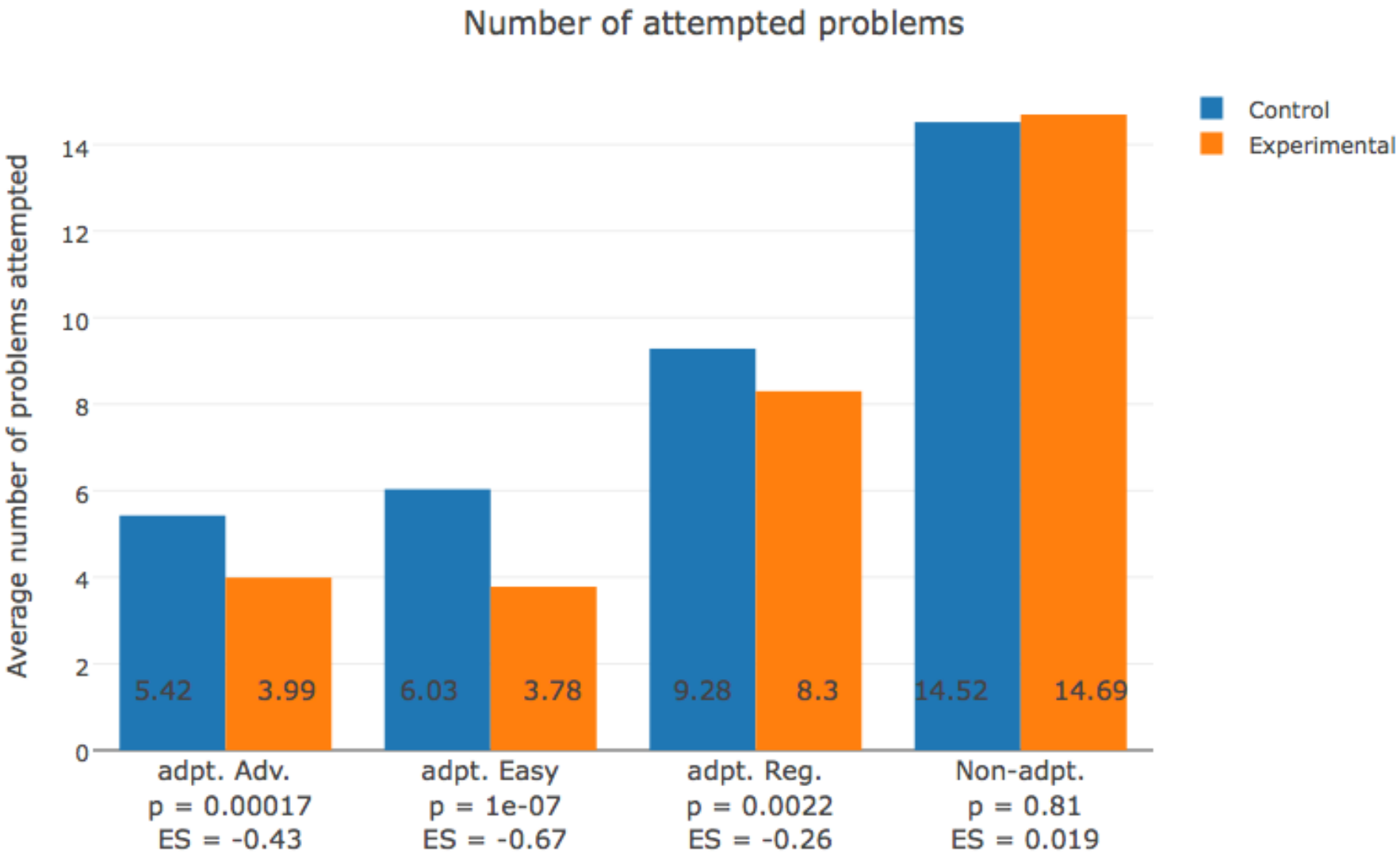
Net time-on-task
Control: 4.8 hours
Experimental: 4.37 hours



Next steps

- Developing two fully adaptive HarvardX MOOCs
- Adding adaptive learning
- Automated item generation
- Full scale study

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Thank you!

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