

# The Effect of Informing Agency in Self-Directed Online Learning Environments

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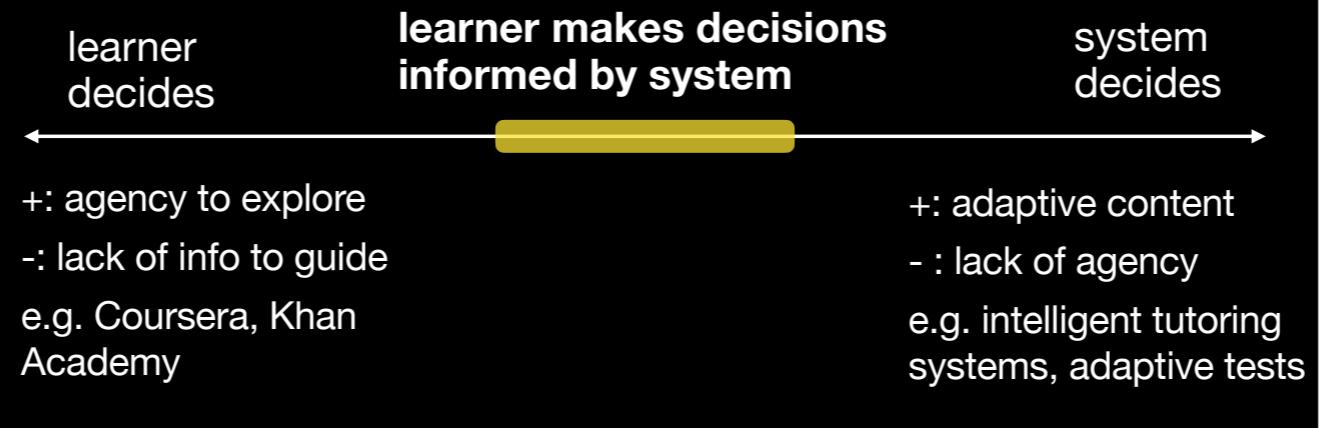
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Hi  
name + pronouns  
PhD candidate  
On behalf of my collaborators, presenting...  
Designing for agency in online learning



context of self-directed online learning  
often alone (without peers or instructors to support)  
navigate their own experiences  
Make decisions, take actions towards learning-related goals  
Experience defined by how we design tools impacts

## how do learners navigate online experience?



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paradigms

More informed agency

proximal and action-related info key to making decisions  
(Bettman, Luce, & Payne 1998; Lichtenstein & Slovic 2006)

## ↓ how does varying information & agency affect self-directed online learning?

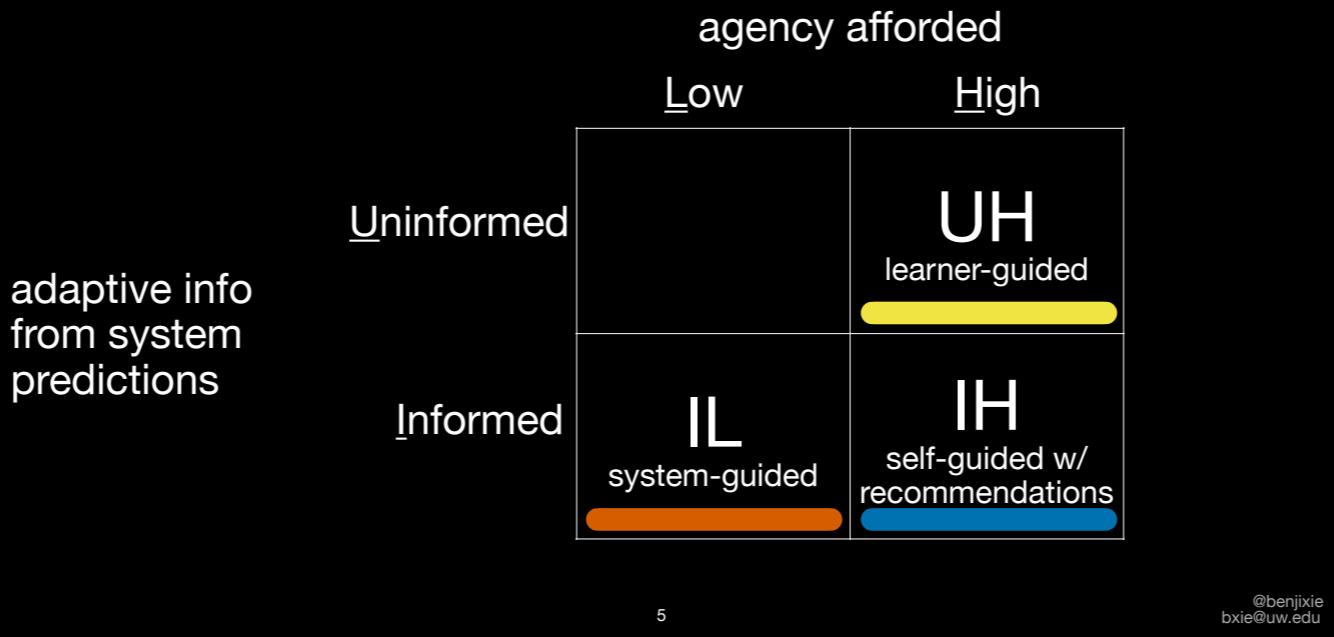
learner can take informed actions that align with their goals  
(Wardrip-Fruin et al. 2009)

interaction of information and agency

Critical to agency is decision-making

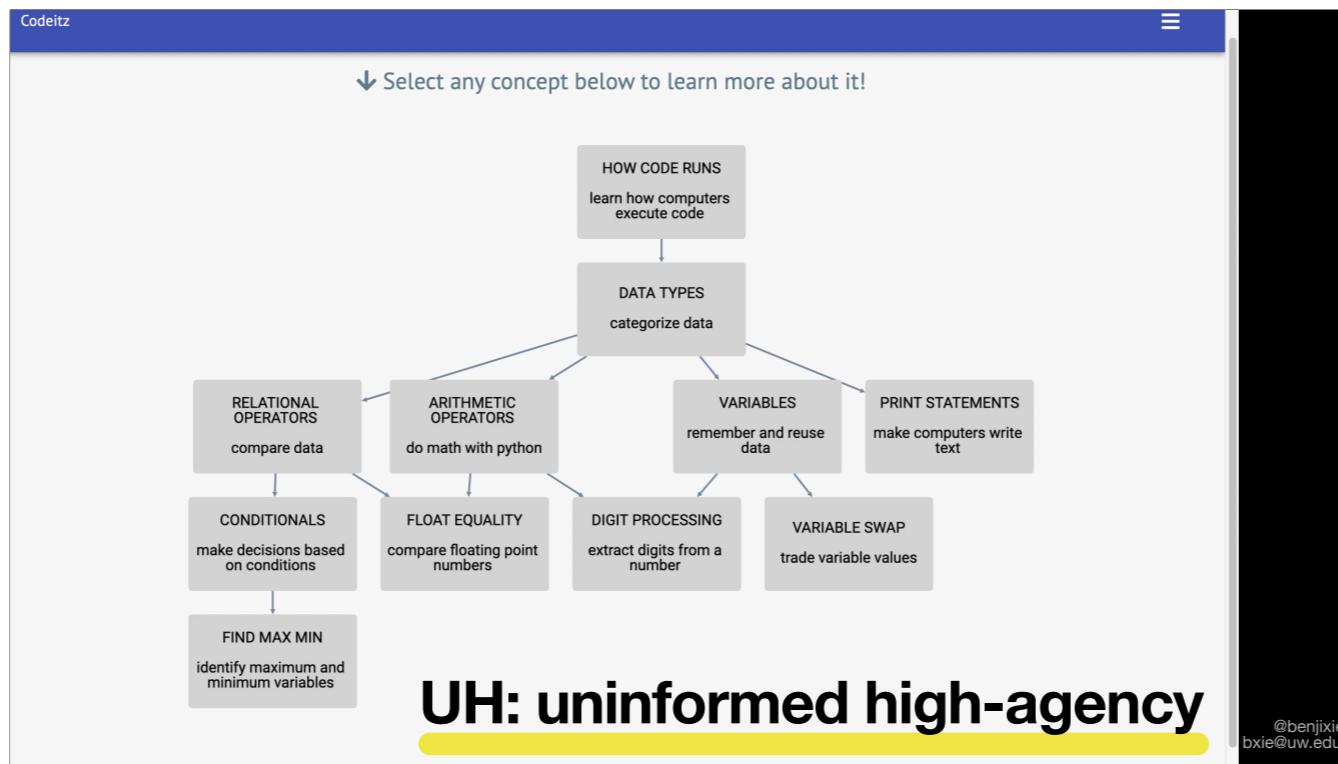
Design of interface > information > agency > learning outcomes

## variations of Codeitz by agency, information



Whereas prior work focused on low vs high agency,  
We explored interaction between agency and information  
Designed 3 variations of online learning tool (demo in next slides)  
agency: low and high  
information (adaptive info by system via BKT): uninformed, informed

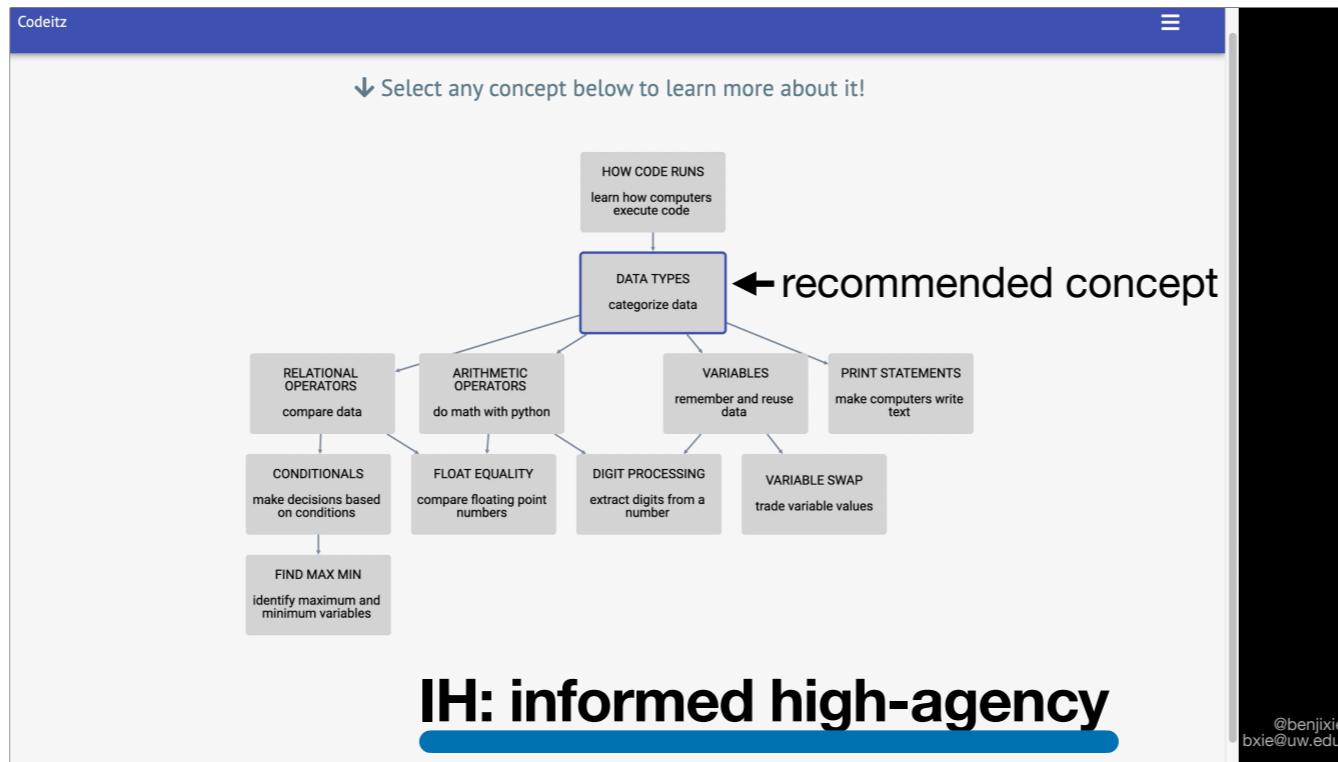
Let me demonstrate the experience of using each variation, starting with UH



world view

all content always available (similar to MOOC)

instruction to read, exercises to practice



similar to the previous UH version

but info based on system predictions (Bayesian Knowledge Tracing)

The screenshot shows a web-based learning environment. At the top, a blue header bar displays the text "Codeitz". Below the header, a sidebar on the left contains a "Data Types" section with an "Overview" panel. The overview text explains that computers reason about different kinds of data to be precise when analyzing it, avoiding non-sensical errors like adding "2" and "yes". It notes that Python has three common data types: numbers, strings, and boolean. An "Example:" section shows a snippet of Python code:

```
1 | integer = 1
2 | float = 1.0
3 | string = "hello"
4 | boolean = True
```

Below the overview is a section titled "Choose any lesson or exercise." which includes a "Reading" section labeled "novice". Under "Reading", there are two items: "Why we have different data types" and "Data type examples".

## IL: informed low-agency

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no world view

similar to basic ITS

system decides next exercise

Codeitz

Data Types ▾

Overview ▾

↓ Choose any lesson or exercise.

Reading advanced ▾

- Why we have different data types ✓
- Data type examples ✓
- Floating vs Integers ✓
- Strings: The literal one ✓
- Booleans: True or False ✓
- Do you know the rules about data types? ★

Writing novice ▾

- Learn to write data types ✓

NEXT →

Determine whether the following statements are true or not.

Statement	Your response:
Strings ALWAYS have quotation marks ('single' or "double") around them.	<input checked="" type="radio"/> true <input type="radio"/> false
Numbers (integers, floats) may sometimes have quotation marks (" ") surrounding them.	<input checked="" type="radio"/> true <input type="radio"/> false
Boolean values in Python must ALWAYS start with an uppercase letter (e.g. <b>True</b> or <b>False</b> ).	<input checked="" type="radio"/> true <input type="radio"/> false

Get Hint Try Again

Feedback

Well done!

The correct answer is: **true, false, true**.

← Use the side navigation to decide what to learn next

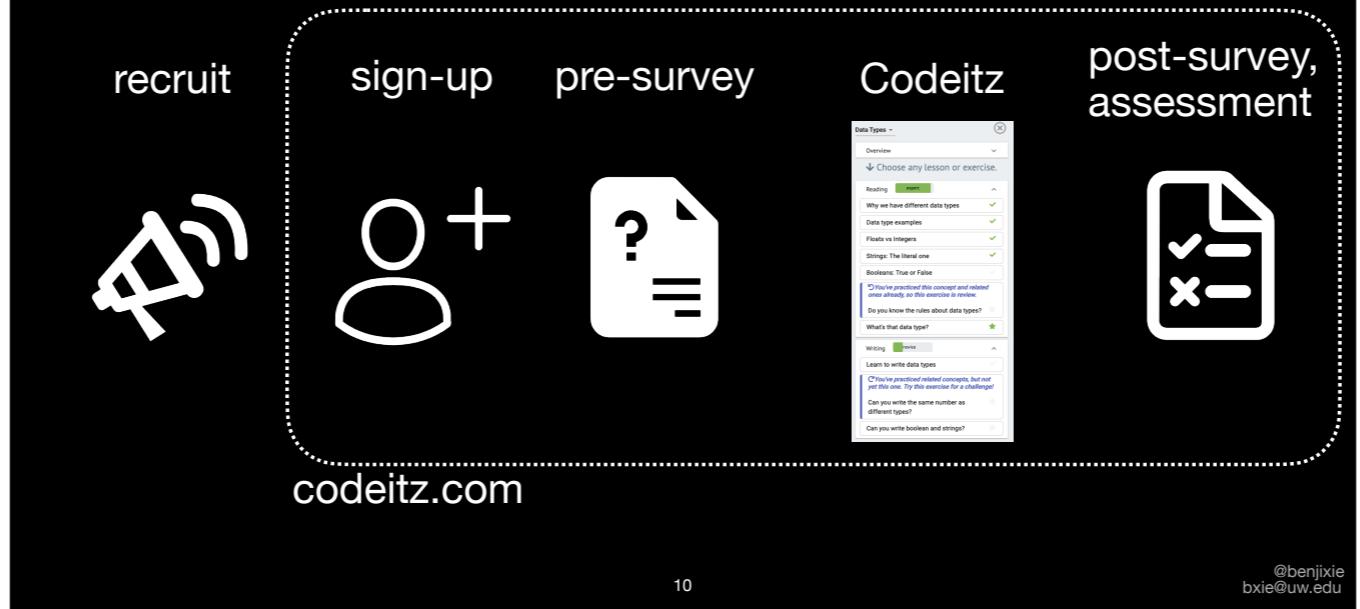
**IL: informed low-agency**

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<https://codeitz.com/instruction/printStatements/learn-to-read-code/page=0>

On submit, updates skill bars and click “next” to try next exercise

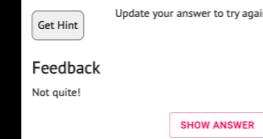
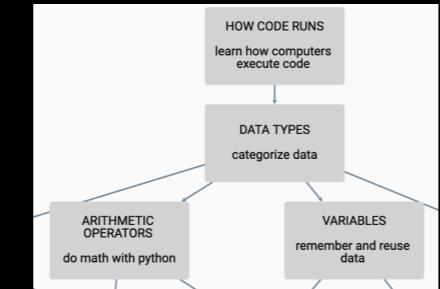
# study: one week to use Codeitz



adults, most of whom enrolled in post-secondary degree

# Codeitz: informing decision-making

world view  
(high-agency)



exercise  
feedback

skill bars  
(informed)

recommend-  
ations  
(informed)

The screenshot shows the 'Data Types' section of the Codeitz interface. It includes:

- Reading:** A skill bar labeled 'expert' with a green bar. Below it are sections: 'Why we have different data types' (green checkmark), 'Data type examples' (green checkmark), 'Floats vs Integers' (green checkmark), 'Strings: The literal one' (green checkmark), and 'Booleans: True or False' (gray).
- Writing:** A skill bar labeled 'novice' with a gray bar. Below it are sections: 'Learn to write data types' (blue box with text: 'You've practiced related concepts, but not yet this one. Try this exercise for a challenge!'), 'Can you write the same number as different types?' (gray), and 'Can you write boolean and strings?' (gray).

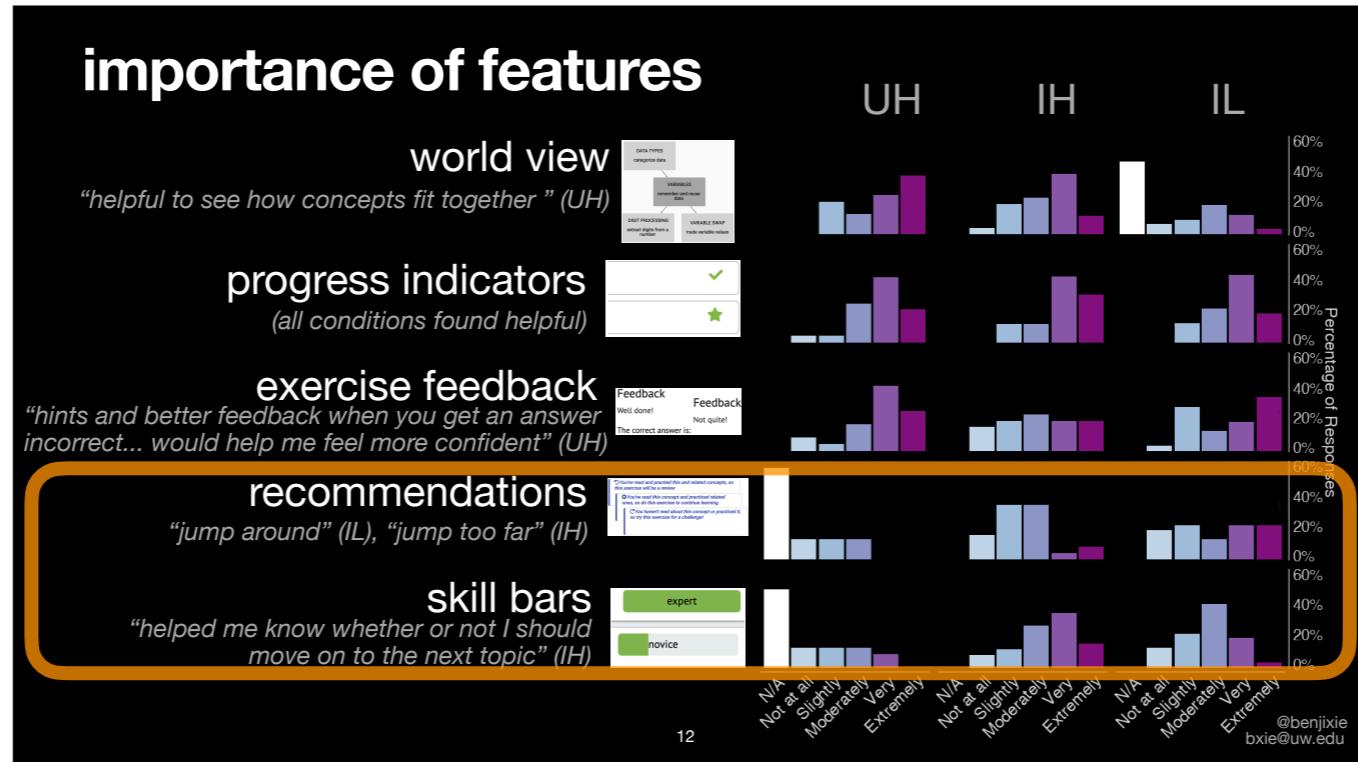
Yellow arrows point from the text labels 'skill bars (informed)', 'recommendations (informed)', and 'progress indicators' to the corresponding parts of the interface.

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designed features to inform decision making, agency  
world view: relationships between concepts (high-agency only)  
progress indicators: what you have done, have yet to do

info based on system predictions (only for informed conditions)  
skill bars: estimated mastery of concept  
recommendations: suggested exercises



[@7 min] participant feedback on importance, role of feature

- world view: high-agency only
- progress: useful across all conditions
- exercise: generally helpful, wanted more hints and feedback to fix mistakes

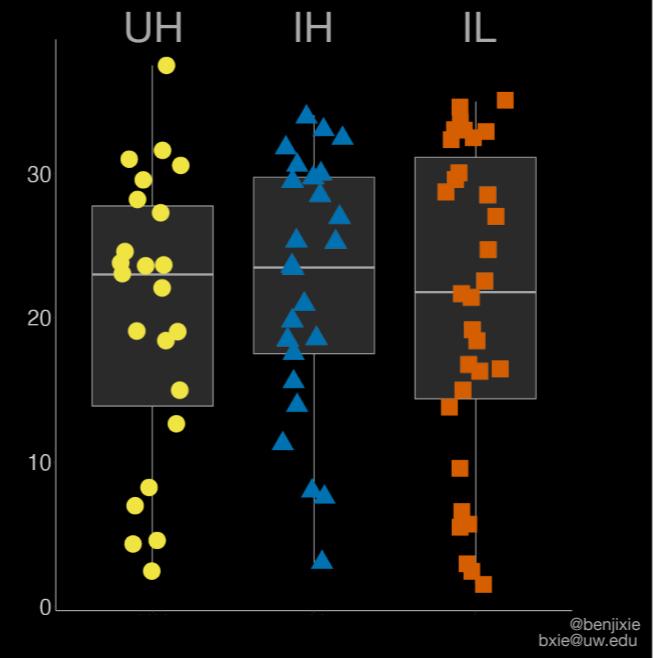
info based on system predictions (only for informed conditions)

- rec: least helpful of the features (paper)
- skill bars: move on or not

## test scores: no difference across conditions

Potential explanations:

- most learners finished all exercises
- learners did not exercise agency
- assessment did not measure well

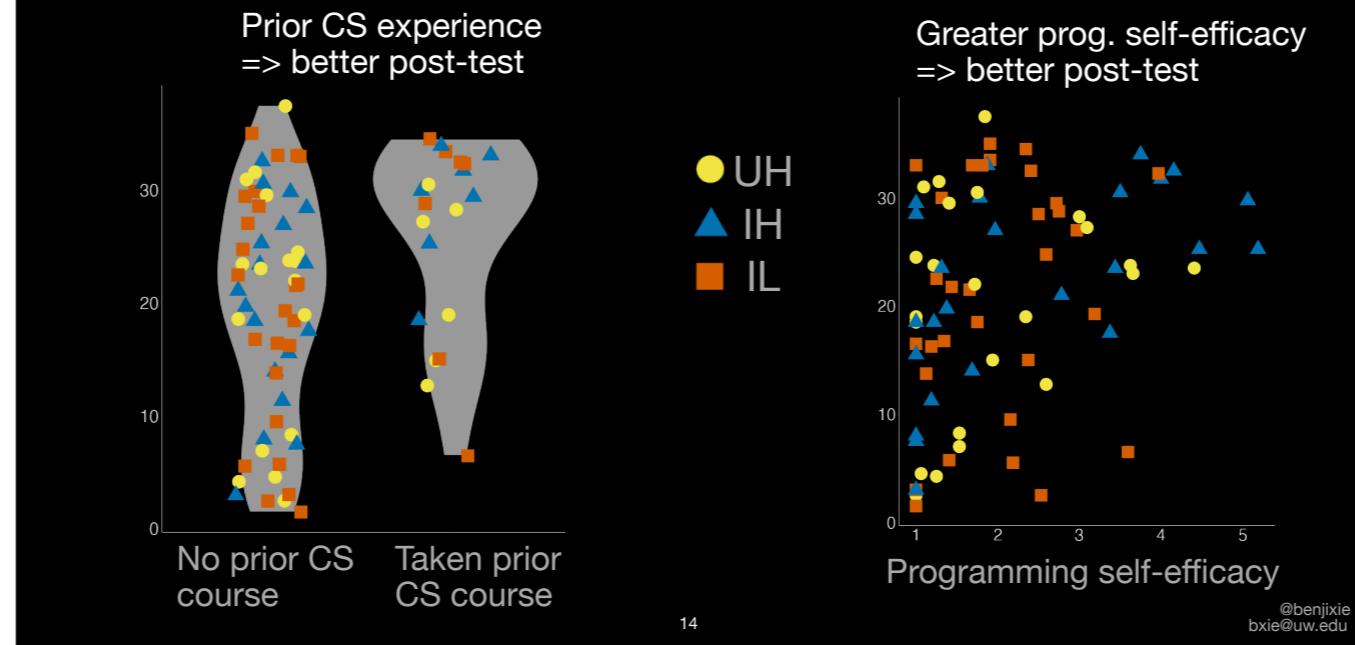


did not find diff in learning outcomes by condition

See paper for more explanations and qualitative data about this

- no agency: used to following instructions at undergrad studies

## prior knowledge, self-efficacy predictive of test score



prior programming experience, greater self-efficacy predictive of higher test scores

As expected

## results summary

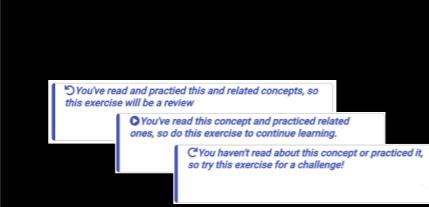
- conditions had no effect on learning
  - self-efficacy, prior knowledge had effects
  - high-agency (IH, UH) did more practice
  - skill bars, recommendations perceived as less important

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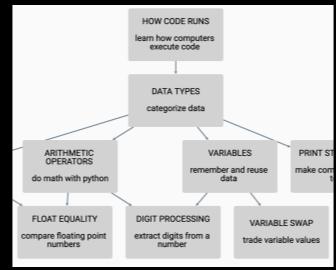
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- To summarize our results
- conditions w/ variations in information and agency afforded did not have detectable effect
- High agency did have more practice (may be indicator of motivation difference? More in paper)
- Skill bars, recommendations, info based on system predictions least helpful

# design implications: agency is nuanced



**perceptions**  
of adaptive  
indicators  
evolve



programming  
is unique  
**domain**

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*"the order [of  
concepts] did not  
seem intuitive"*

**expectations:**  
agency may  
be unusual

- recommendations:
  - Trust in recommendations is earned!
  - unintended interpretations, lack of trust or diminishing trust in adaptive feedback (cold start)
- domain: need to consider structure of domain. strict dependencies
  - ex: learning if/else before variables and relational operators may result in unproductive struggle
  - Think about what we want to design agency for
- expectations: may not be want to, comfortable, realize guiding own learning experience

## **agency is good bad nuanced**

- prior: agency for motivation & learning
- this study: agency & information interact
- how learners perceive information (UX design) affects decision-making, agency exhibited, learning outcomes

Prior work has told us that agency can be good for motivation & learning

Agency and information interact.

how learners perceive information (dictate through design of interface) affects decision-making, agency exhibit, learning outcomes

# How can supporting a plurality of interactions enable more equitable learning?

The screenshot shows a user interface for learning data types. On the left, there's a sidebar with categories like 'Reading' (expert level) and 'Writing' (novice level). The 'Reading' section has several items: 'Why we have different data types', 'Data type examples', 'Floats vs Integers', 'Strings: The literal one', and 'Booleans: True or False'. The 'Writing' section has: 'Learn to write data types', 'Can you write the same number as different types?', and 'Can you write boolean and strings?'. Two specific sections are highlighted with orange boxes:

- low self-efficacy:** follow recommendation
- high self-efficacy:** decide for themselves

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Challenge => support

More importantly, uncertainty => support

## The Effect of Informing Agency in Self-Directed Online Learning Environments

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- RQ: how can affording learners options between agency and guidance support diverse learners?
- takeaway: **must design information in interfaces to enable agency**

paper: [dx.doi.org/10.1145/3386527.3405928](https://doi.org/10.1145/3386527.3405928)  
archive: [github.com/codeandcognition/archive-2020las-xie](https://github.com/codeandcognition/archive-2020las-xie)

### design implications:

- perceptions of recommendations
- CS is unique domain
- agency may be unusual to users

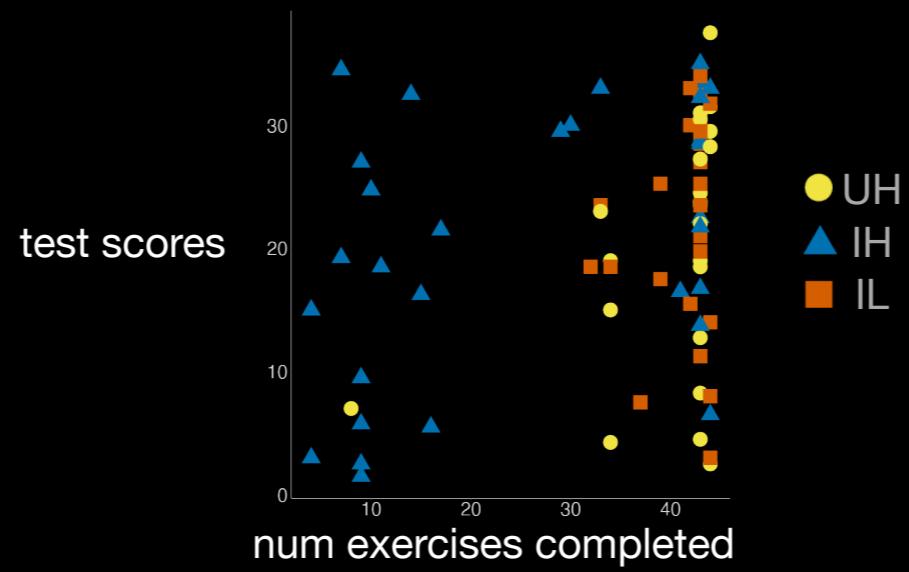
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main takeaway: enabling agency requires considering information that informs decision agency  
archive: surveys, protocols, code, assessment.

## agency: self-efficacy and information are critical

- **agency**: a learner can take actions that align with their learning-related goals (*Wardrip-Fruin et al. 2009*)
- **self-efficacy**: belief in ability to organize and execute course of action, process information (*Bandura 2001, 2006*)
- **information**: proximal action-related key to making decisions (preference construction, Bettman, Luce, & Payne 1998; Lichtenstein & Slovic 2006)

## high-agency conditions completed more practice



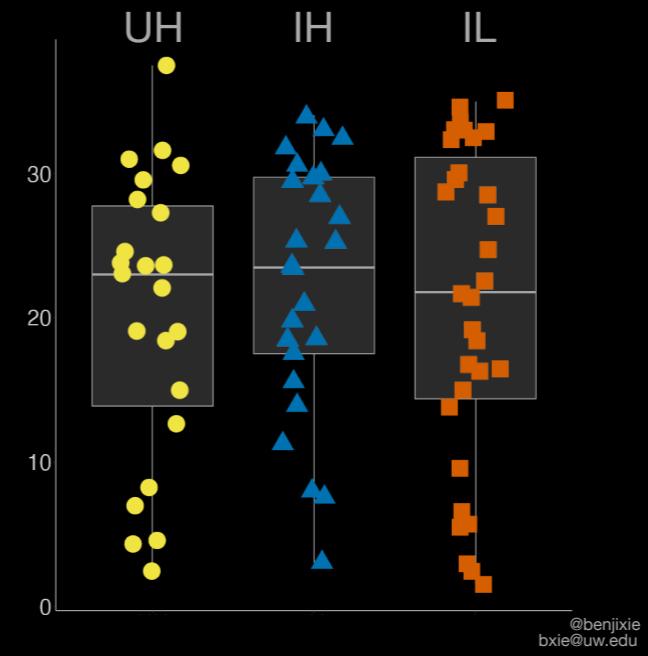
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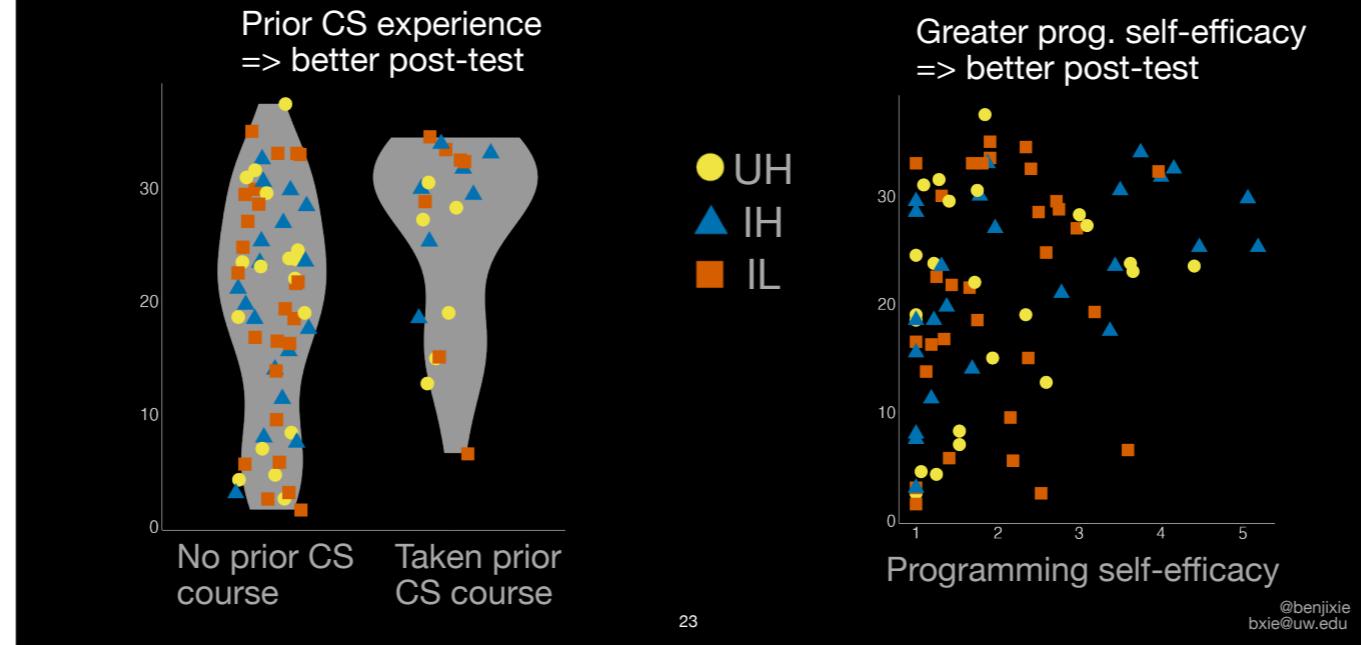
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did not find diff in learning outcomes by condition

- no agency: used to following instructions at undergrad studies

See paper for more explanations and qualitative data about this

## prior knowledge, self-efficacy predictive of test score



prior programming experience, greater self-efficacy predictive of higher test scores

# Codeitz: navigation enables flexibility

The screenshot shows a navigation interface for 'Data Types'. At the top, it says 'Choose any lesson or exercise.' Below that, there are two sections: 'Reading' (expert level) and 'Writing' (novice level). The 'Reading' section contains several lessons with green checkmarks: 'Why we have different data types', 'Data type examples', 'Floats vs Integers', 'Strings: The literal one', and 'Booleans: True or False'. The 'Writing' section contains two lessons: 'Learn to write data types' (with a note: 'You've practiced related concepts, but not yet this one. Try this exercise for a challenge!') and 'Can you write the same number as different types?' (with a note: 'You've practiced this concept and related ones already, so this exercise is review.') A yellow box highlights the 'Can you write boolean and strings?' lesson under 'Writing'.

**low self-efficacy:**  
follow recommendation

**high self-efficacy:**  
decide for themselves

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# importance of features

## world view

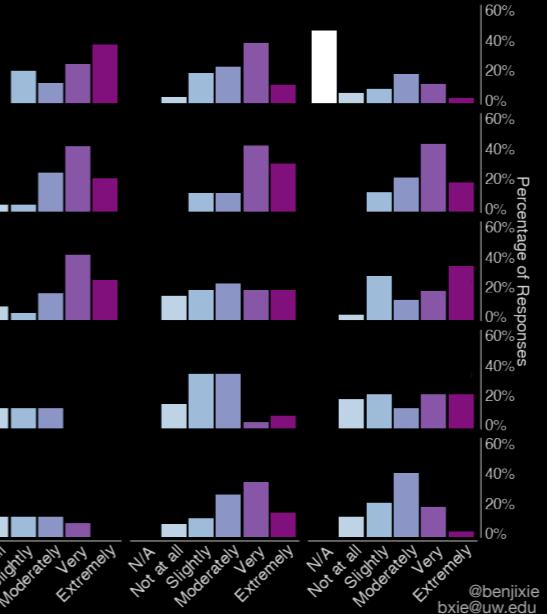
"helpful to see how concepts fit together" (UH)



UH

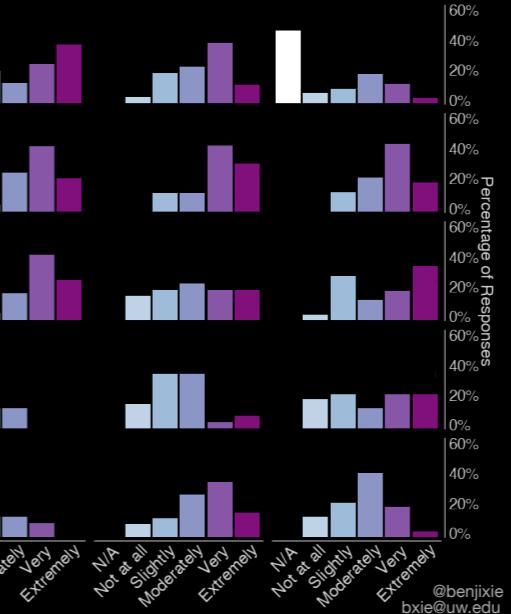
IH

IL



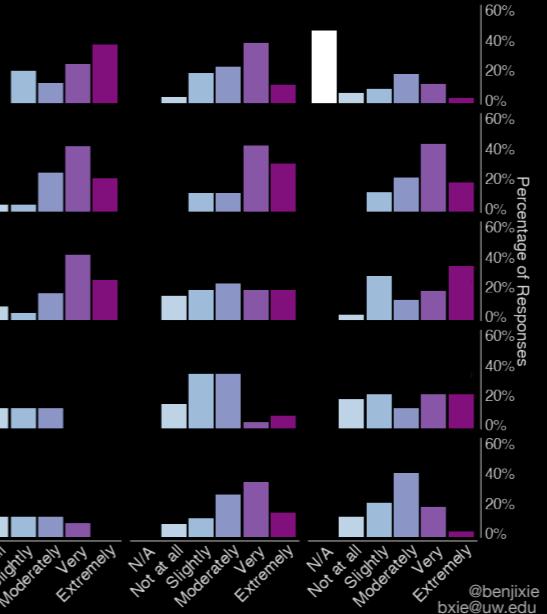
## progress indicators

(all conditions found helpful)



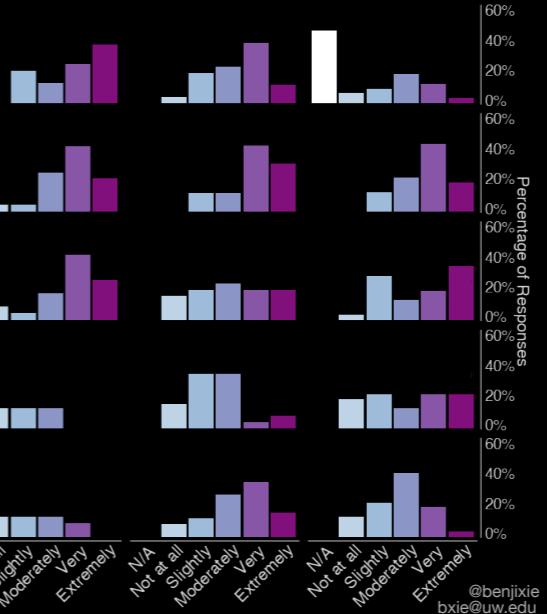
## exercise feedback

"hints and better feedback when you get an answer incorrect... would help me feel more confident" (UH)



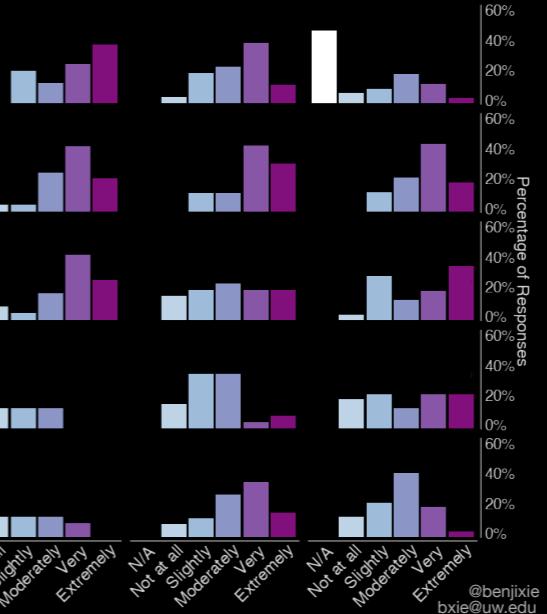
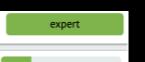
## recommendations

"jump around" (IL), "jump too far" (IH)



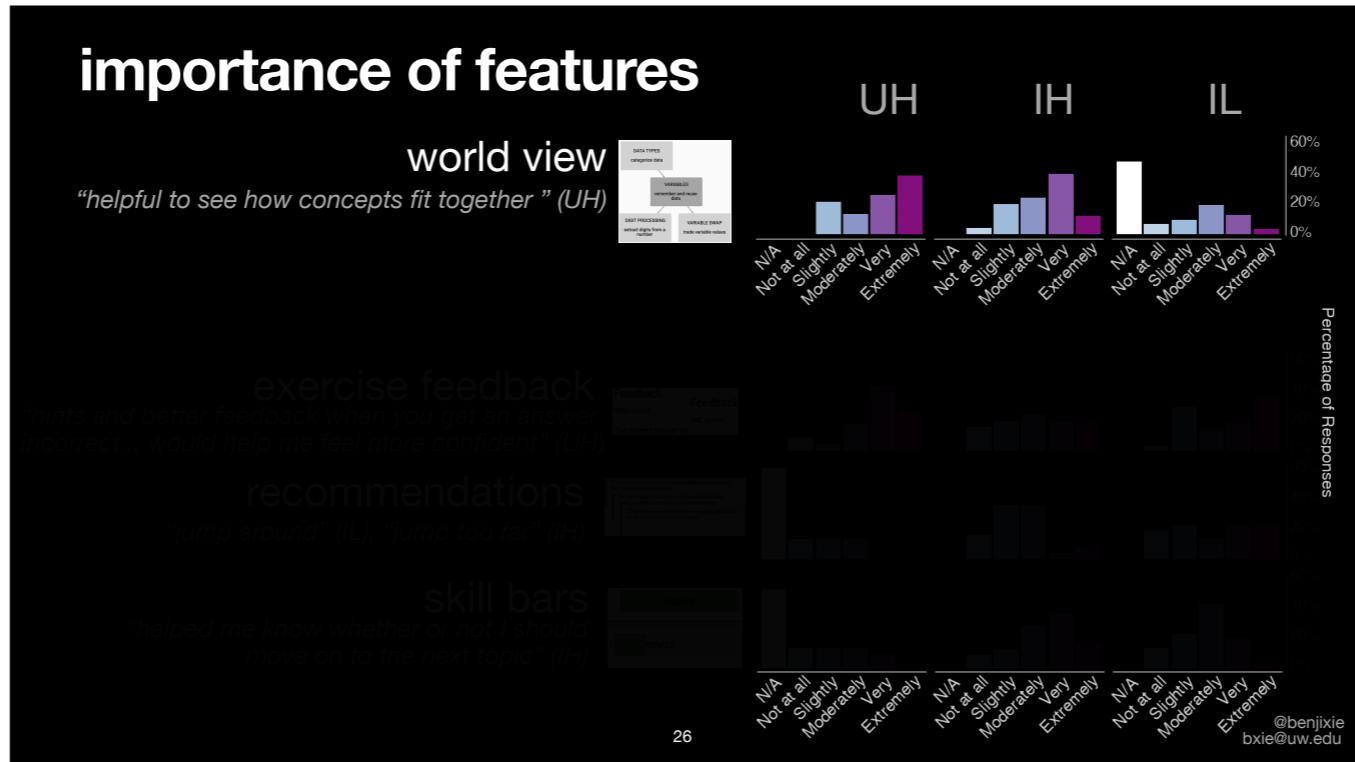
## skill bars

"helped me know whether or not I should move on to the next topic" (IH)



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participant feedback on importance, role of feature

- world view: high-agency only
- progress: useful across all conditions
- exercise: generally helpful, wanted more hints and feedback to fix mistakes

info based on system predictions (only for informed conditions)

- rec: least helpful of the features (paper)
- skill bars: move on or not
-