How Learner Control and Explainable Learning Analytics About Skill Mastery Shape Student Desires to Finish and Avoid Loss in Tutored Practice

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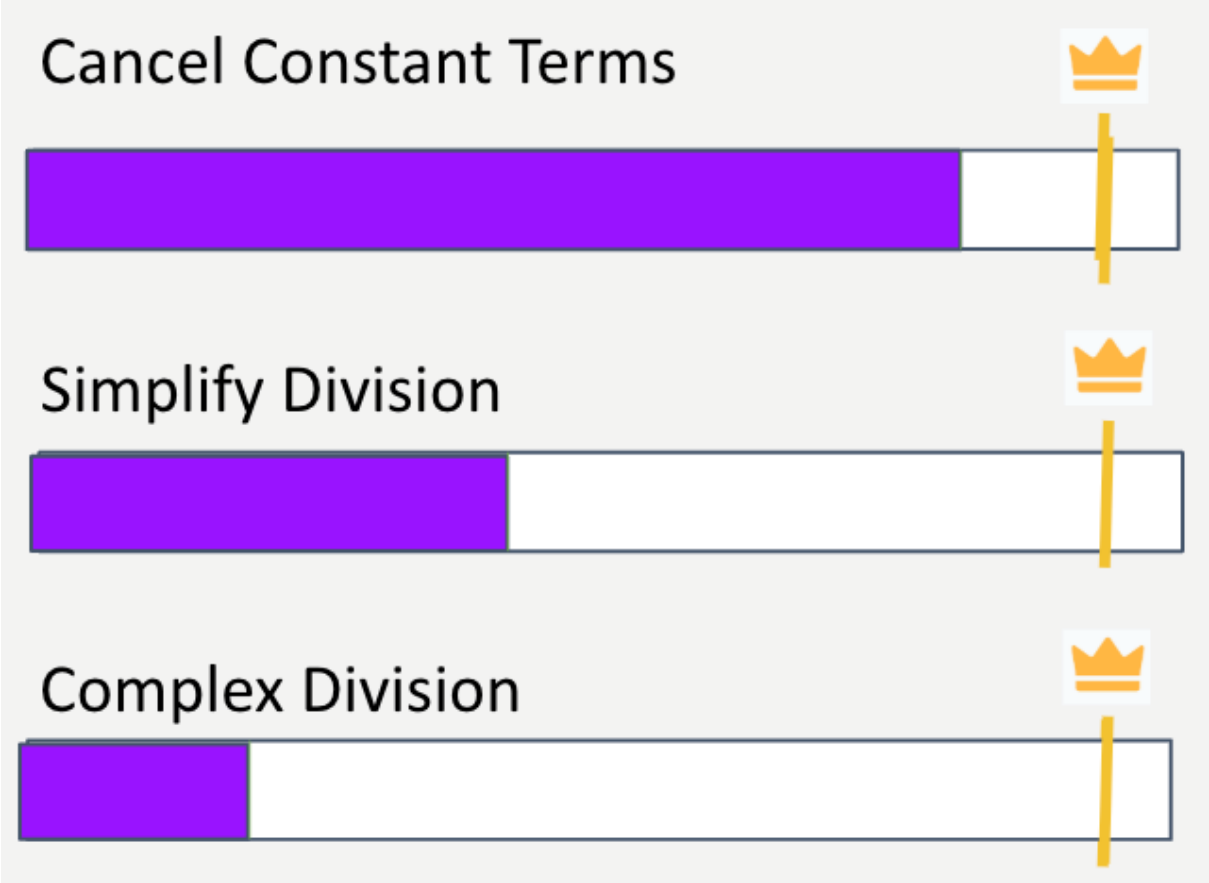
LAK25

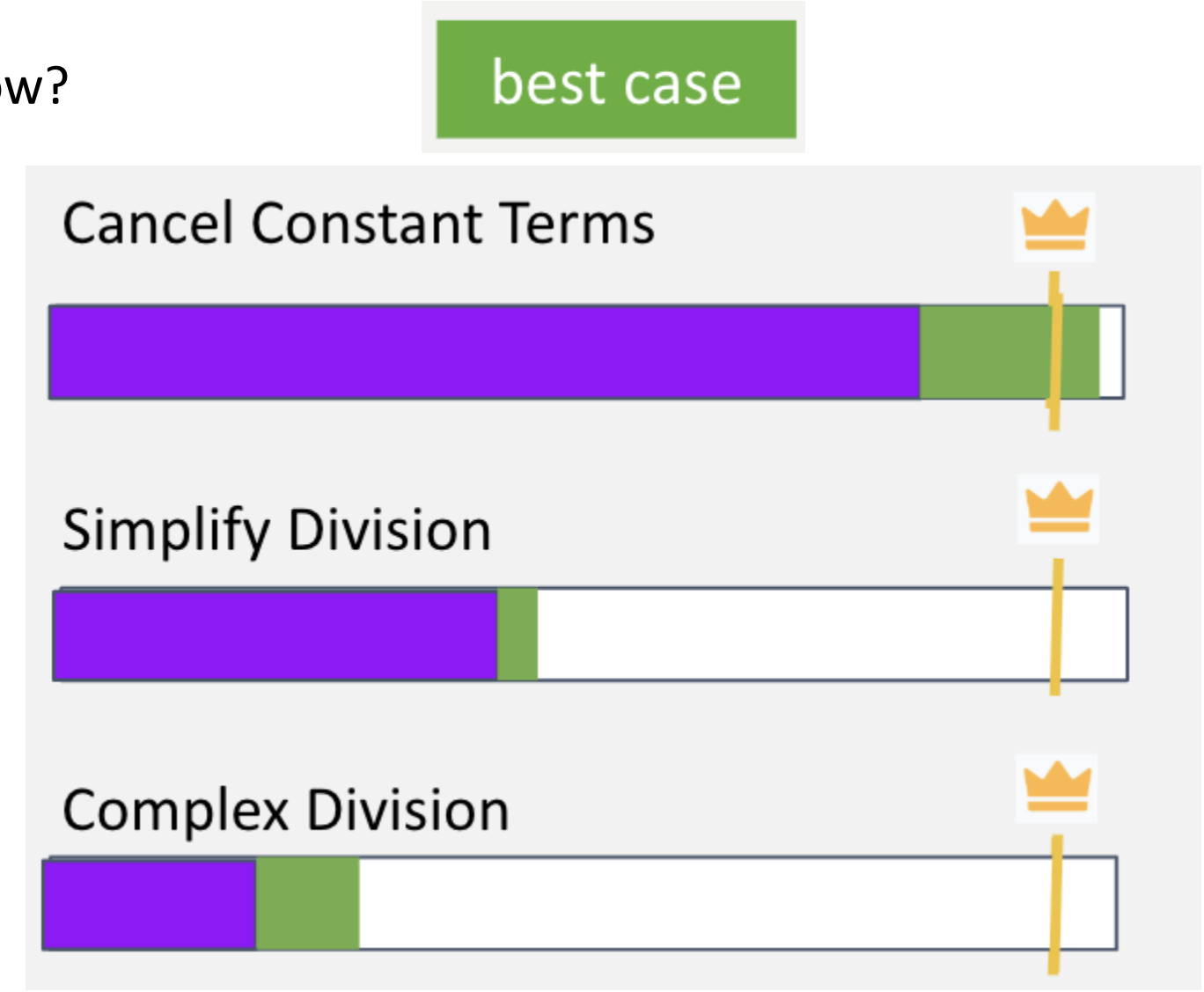
Introduction

Imagine you are using an app for linear equation practice and you could choose skills to practice next. Which skill would you choose?



Introduction

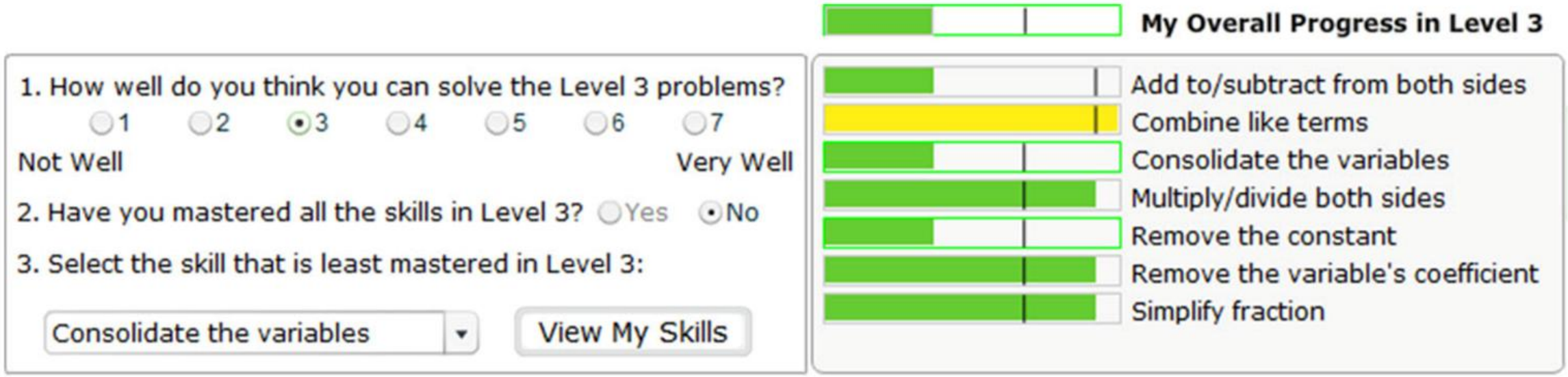
What about now?



Introduction

Learners often see open learner models in tutoring systems.

Sometimes, they can even interact with them, boosting self-regulated learning.



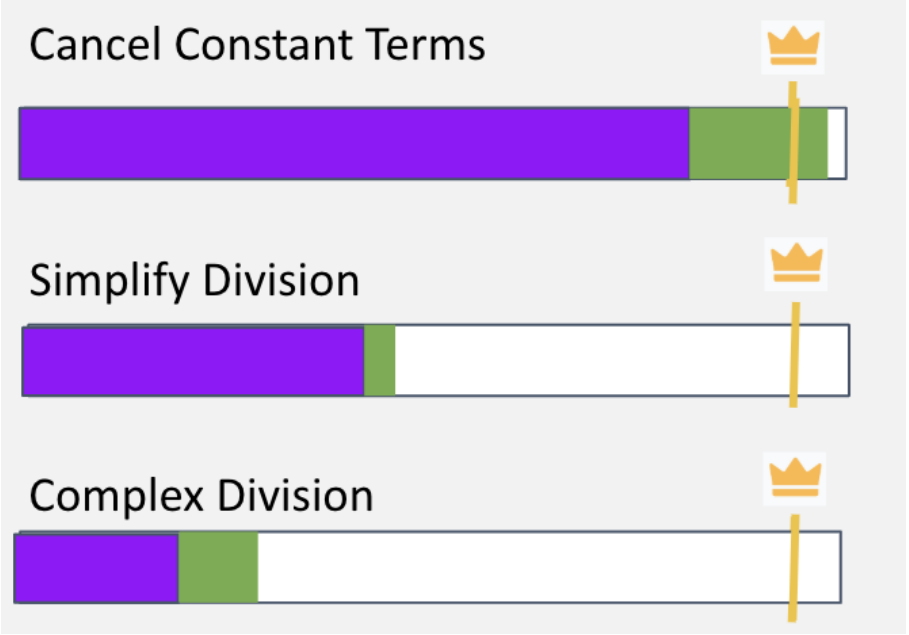
Long, Y., & Aleven, V. (2017). Enhancing learning outcomes through self-regulated learning support with an open learner model. User Modeling and User-Adapted Interaction, 27, 55-88.

Introduction

Learners struggle with understanding skill mastery goals (Peng et al., 2024).

Explainable AI may aid understanding, yet this design space is underexplored.

We conducted a prototyping interview study to develop and evaluate such explainable learning analytics.



Research Questions

RQ1: What are students' needs regarding learning analytics of skill mastery, *what-if* explanations, and control over practice materials in the context of ITS practice?

RQ2: How do learning analytics of skill mastery and *what-if* explanations shape students' selection strategies?

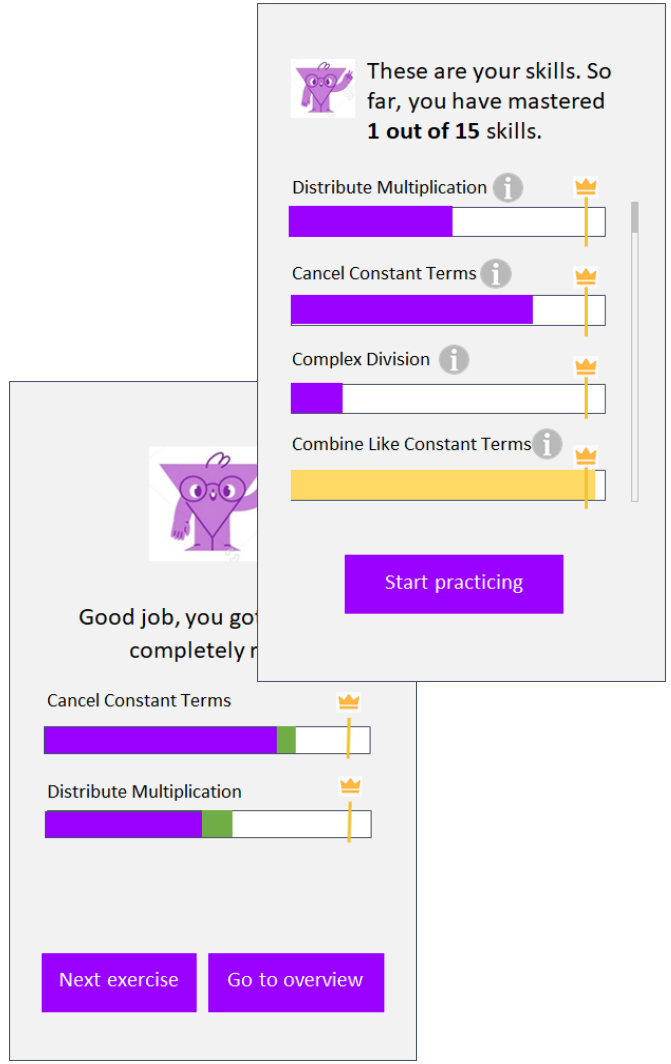
Methods Overview

Participants: 6 middle school students (ages 11-14, Northeastern USA), recruited via parent outreach centers

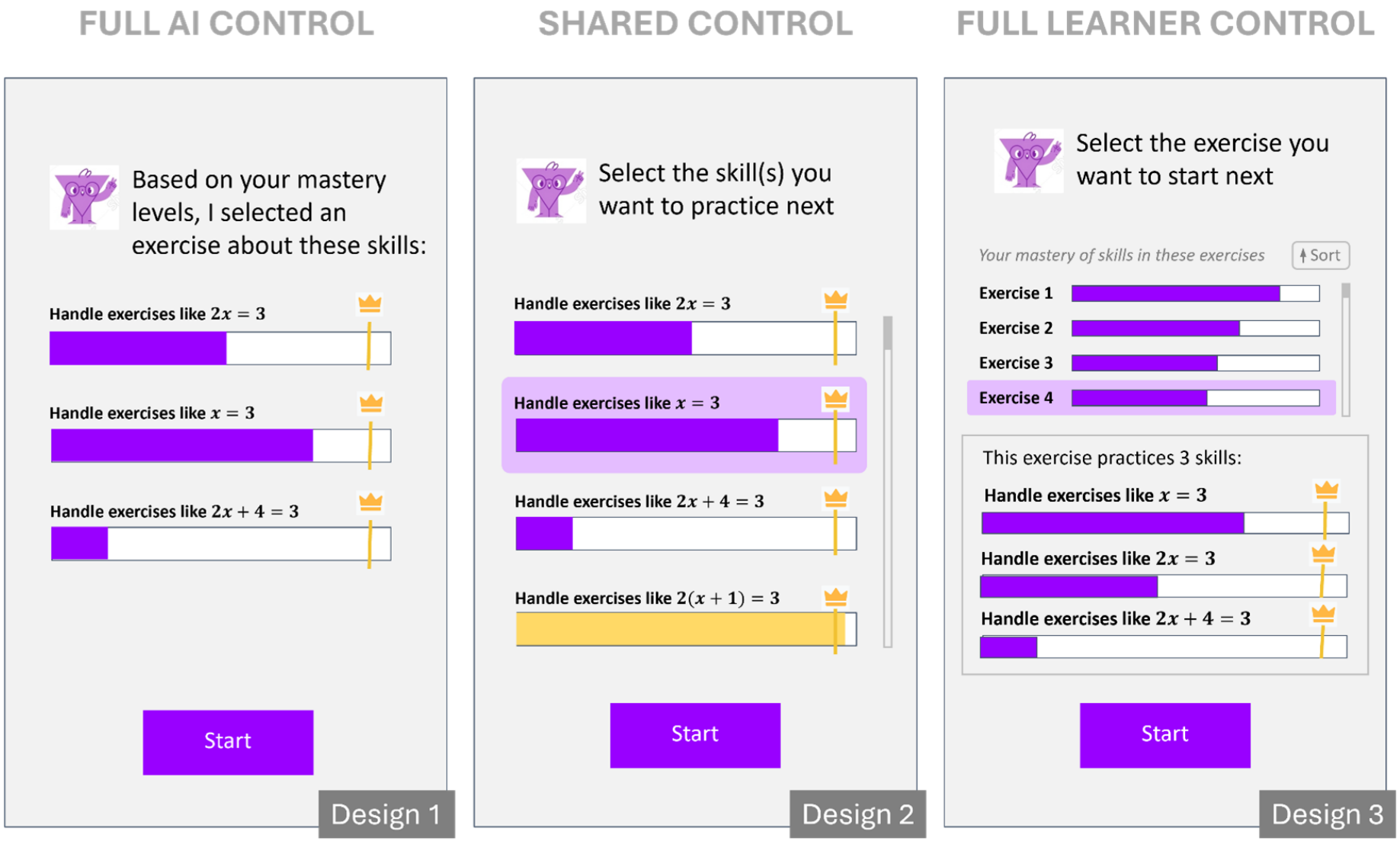
Online semi-structured interviews (July–Sept 2023)

Mock-up app for linear equation practice, built on Lynnette

Evaluated skill mastery analytics, *what-if* explanations, and learner control

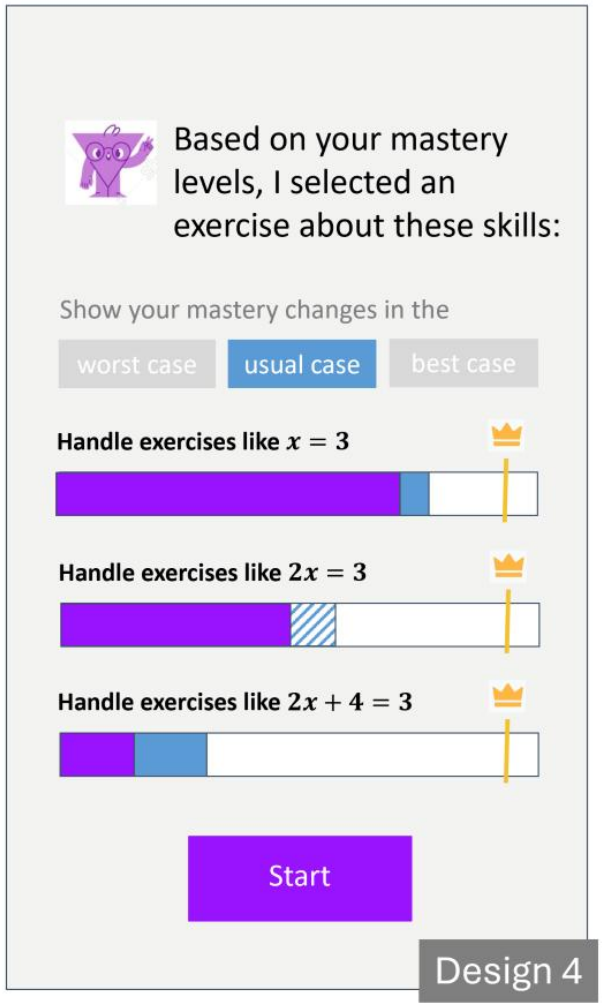


Learner Control

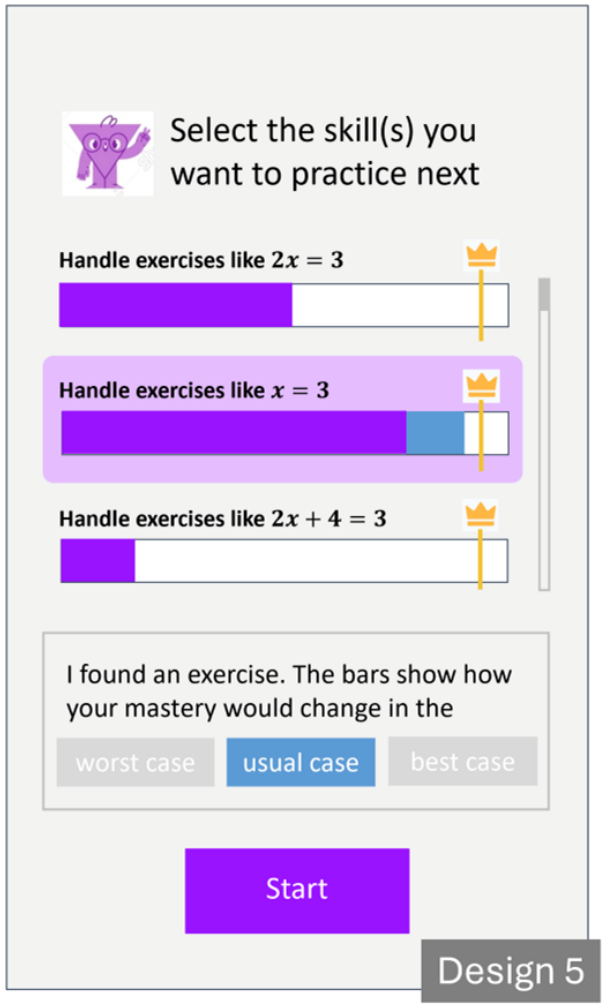


What-If Explanations

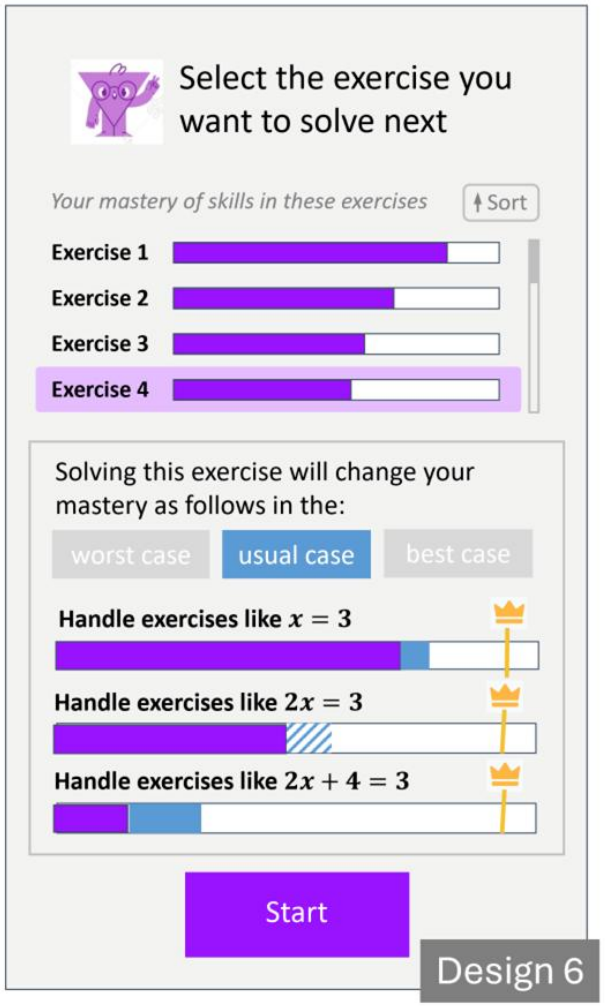
FULL AI CONTROL



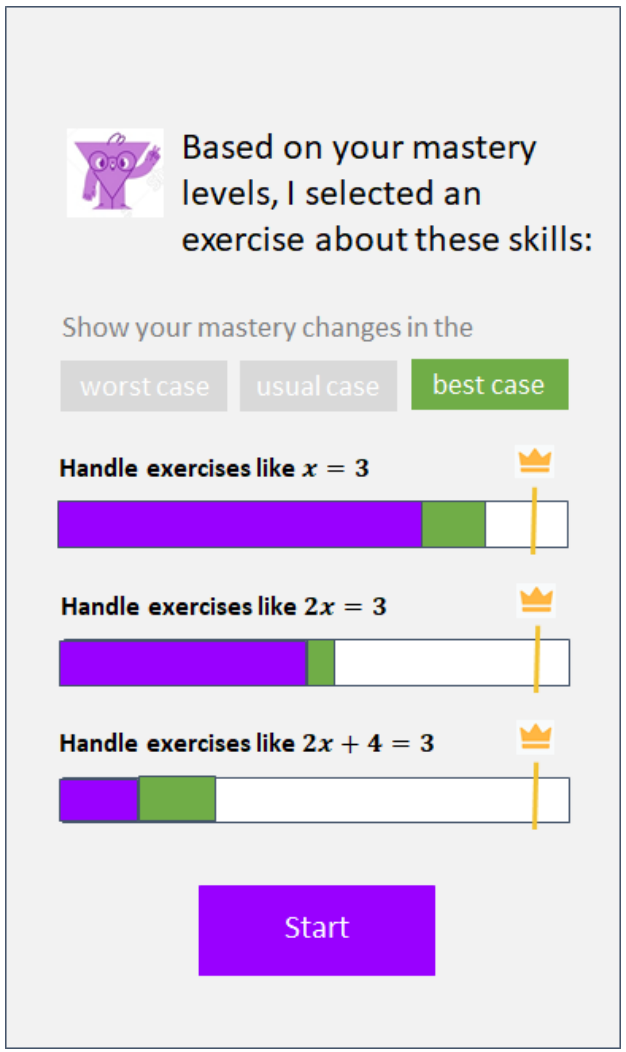
SHARED CONTROL

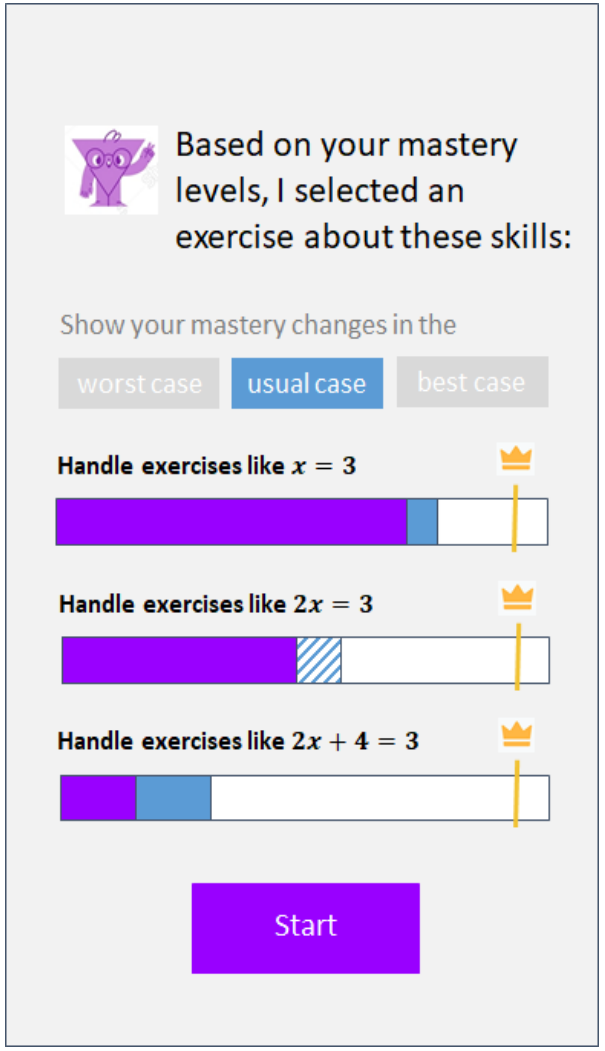


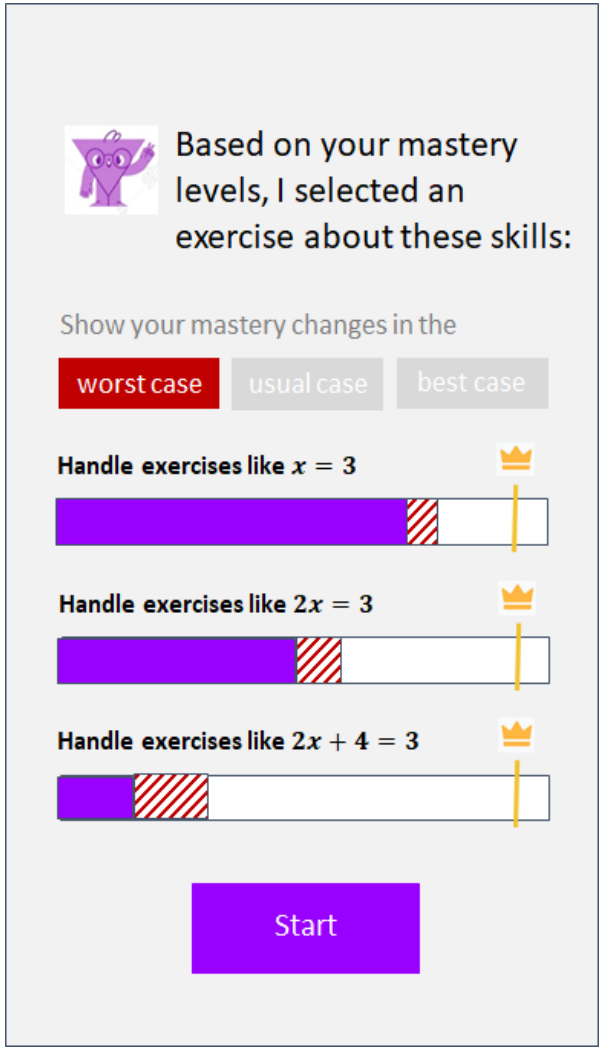
FULL LEARNER CONTROL



Best, Usual, and Worst Case





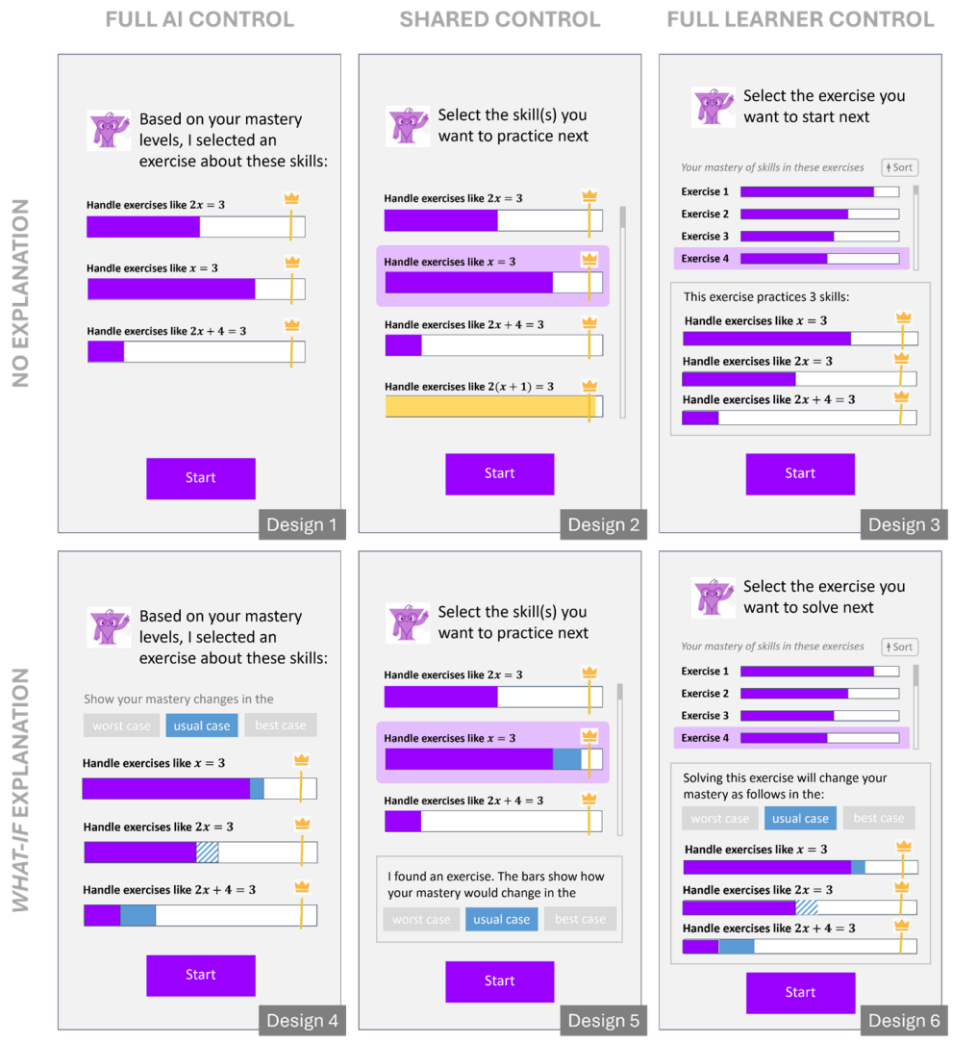


Procedure and Data Analysis

Participants interacted with all 6 designs

Questions about usefulness, their needs, and understanding of the components
e.g., "Why do you (not) like selecting exercises?"

Thematic analysis of interview transcripts: mixing inductive & deductive approaches, and iterative affinity diagramming



Results

Desire to control the learning process

Desire to improve mastery

Desire to finish

Desire to avoid mastery losses

Students Needs and Preferences (RQ1)

Shaping Selection Strategies (RQ2)

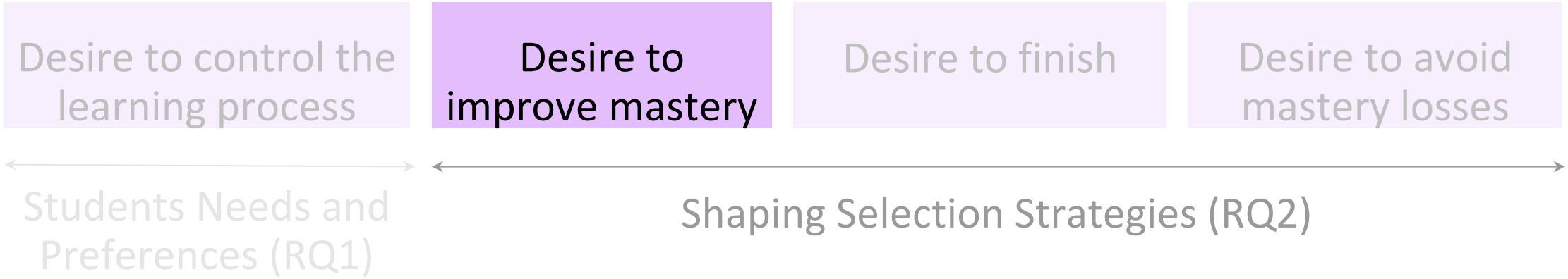
Students valued sharing control with AI:

> *"Understanding and choosing skills [...] helps me learn more and study better versus everything being chosen for me"*

Students adjusted difficulty based on mood and priorities:

> *"[On my best math days] I would just let them pick a skill for me, and then on my bad math days, I would pick a skill that would be easier for me to solve."*

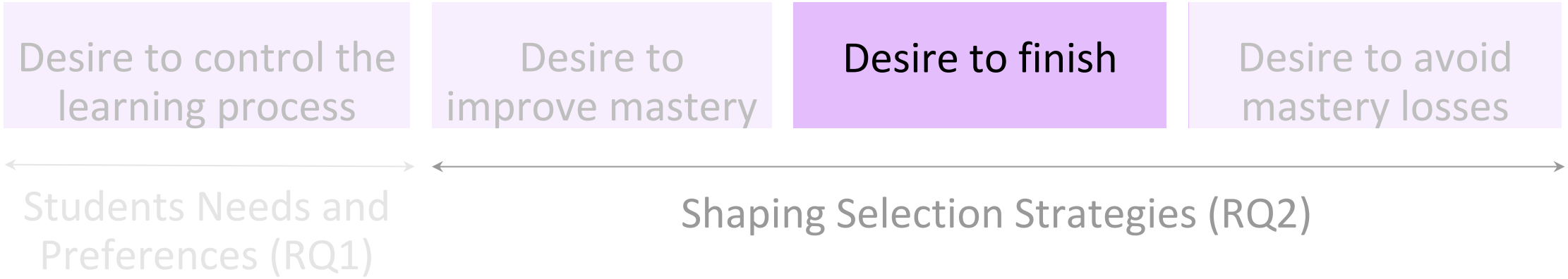
Results



Students diagnosed their weaknesses and made selections to compensate for them:

> *"I'll just work on that to get that better because that's not best. But I wouldn't work on [a skill…] if I already mastered all of that stuff."*

Results



Students wanted to practice almost mastered skills to quickly achieve mastery or because they anticipated low effort:

> *"I'm immediately drawn to the one [skill] I'm doing the best at [...] because you can choose the best-case scenario, and you end up just short of mastering it."*

Results

Desire to control the learning process

Desire to improve mastery

Desire to finish

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Students Needs and Preferences (RQ1)

Shaping Selection Strategies (RQ2)

Students wanted to keep mastery increasing and used *what-if* explanations extensively for decision-making:

> *"I would try to avoid losing a lot of the percentage, so I think it would be helpful to show [...] the worst-case scenario for the ones that have the lower score already. I feel if I would try that one, [...] it could go down a lot, which I would not want to happen."*

Discussion

Explainable analytics support self-regulation by guiding goal-oriented practice that aligns with mastery learning principles

- Focusing on close-to-mastered skills
- Avoiding mastery loss

What-if explanations may reinforce a growth mindset, helping students stay motivated and able to celebrate learning success

- A recent meta-analysis suggests growth mindset is associated with higher academic achievement (Burnette et al., 2023)

Students were satisfied with control over skills as opposed to problems, aligning with past research on choice overload (Corbalan et al., 2009)

Contributions

Learner control influences motivation and engagement

- What-if explanations shift focus from weaknesses to strengths
- Avoiding mastery loss is a strong motivator in practice selection

Explainable analytics shape selection strategies

- Skill mastery estimates sometimes lead students to select weak areas
- What-if explanations help students aim for achievable progress

Explainable open learner models could enhance known self-regulated **learning benefits** of involving students in **mastery learning decisions**

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Open materials: ***https://github.com/conradborchers/mastery-xai-lak25***

Paper link: ***https://tinyurl.com/lak25-xai***

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