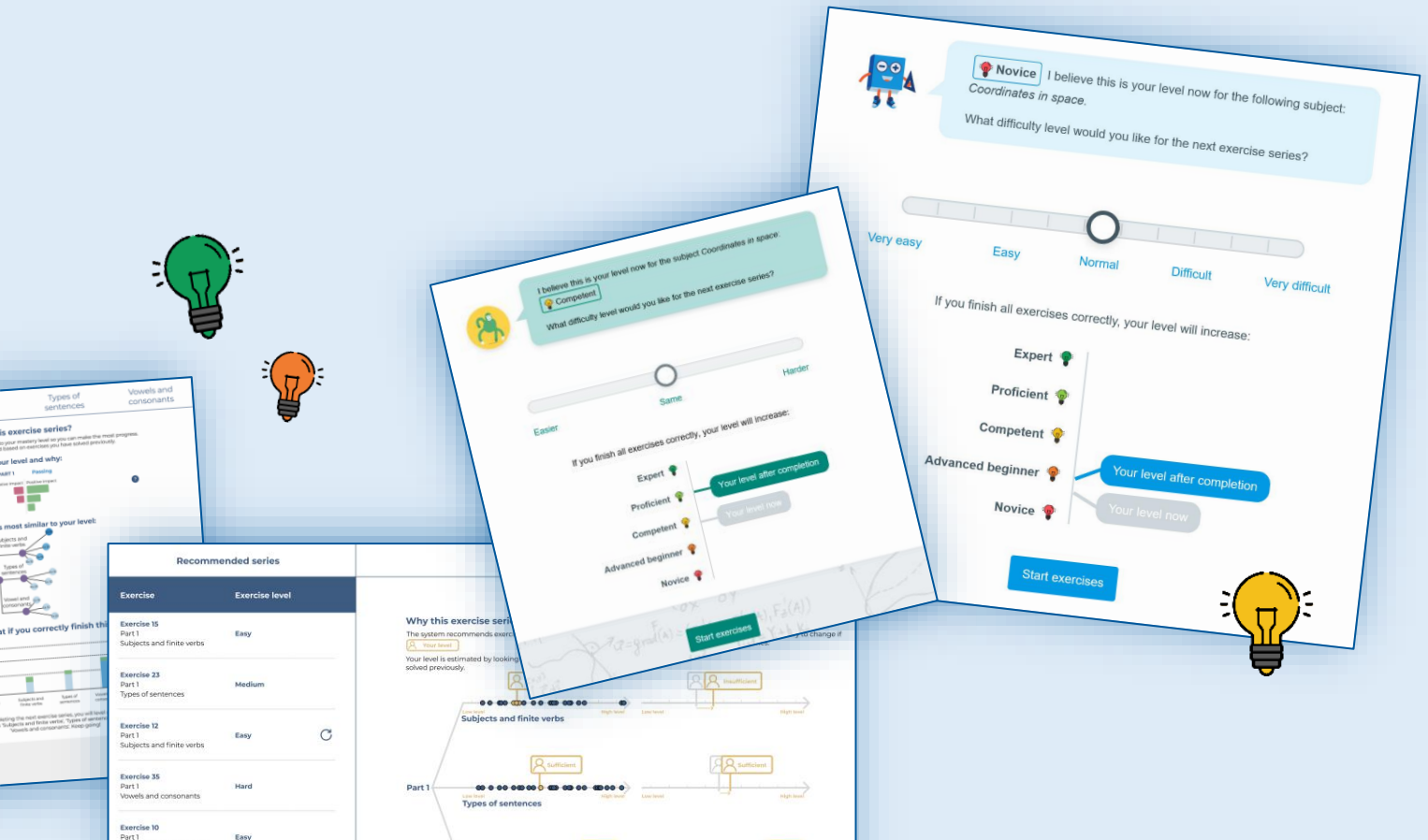
Designing Visual Explanations and Learner Controls to Engage Adolescents in AI-Supported Exercise Selection

LAK25

Universiteit Utrecht

KU LEUVEN





Jeroen Ooge
jeroenooge.com



Arno Vanneste



Maxwell Szymanski



Katrien Verbert



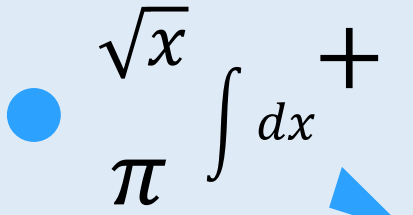
expert

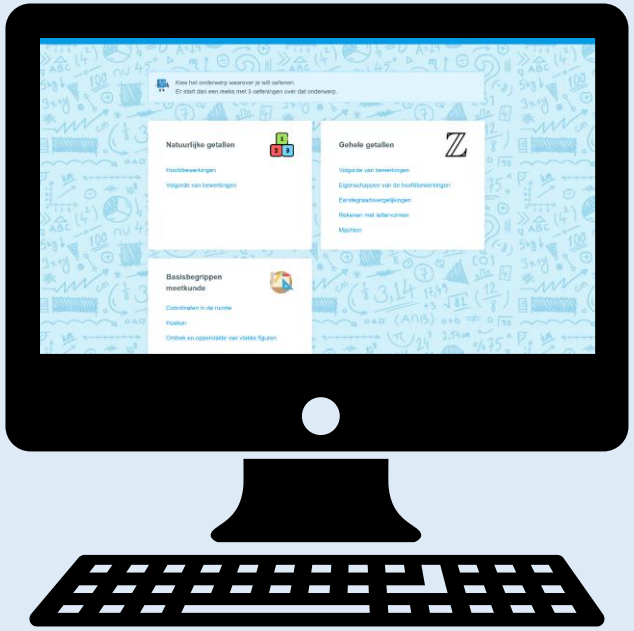


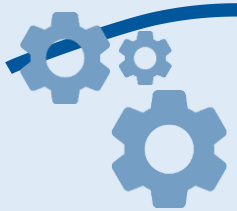
competent



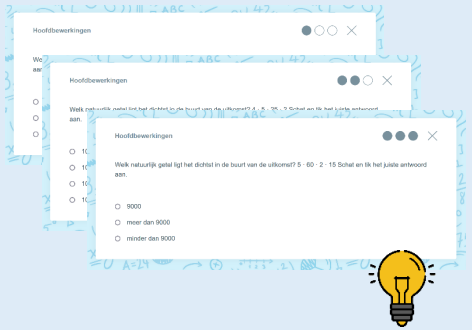
beginner

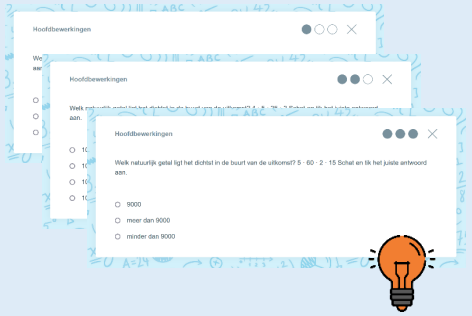












E-learning platform recommending exercises




Hoofdbewerkingen
Hoofdbewerkingen
aan.
Hoofdbewerkingen
Welk natuurlijk getal ligt het dichtst in de buurt van de uitkomst? 5 · 60 · 2 · 15 Schat en tik het juiste antwoord aan.
9000
meer dan 9000
minder dan 9000

?

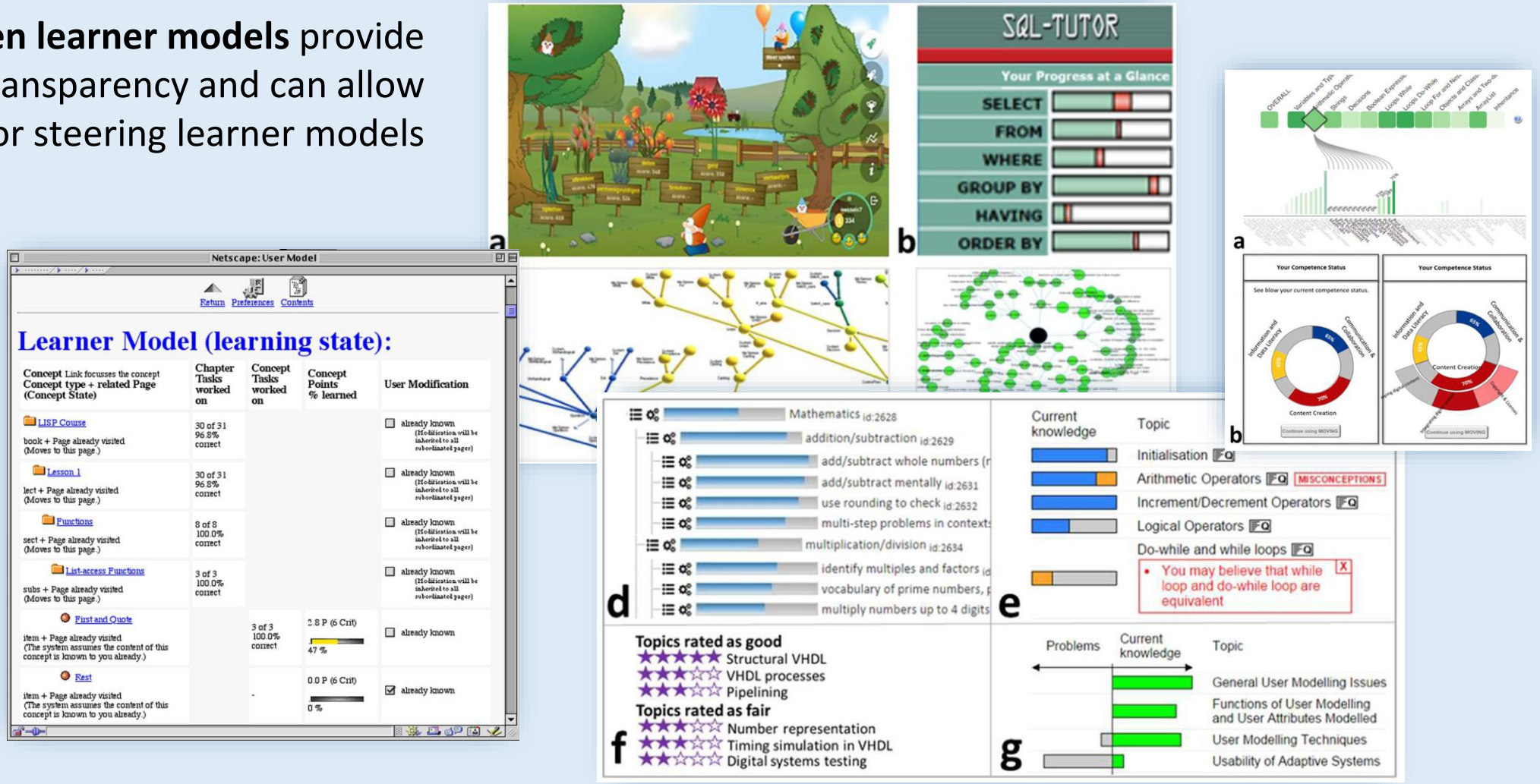


Why do I have to solve these exercises?

Can I change these recommendations?



Open learner models provide transparency and can allow for steering learner models



Susan Bull. 2020. There are Open Learner Models About! https://doi.org/10.1109/TLT.2020.2978473
Peter Brusilovsky. 2023. AI in Education, Learner Control, and Human-AI Collaboration. https://doi.org/10.1007/s40593-023-00356-z

Data

What kind of data was the system trained on?
What is the source of the training data?
How were the labels/ground-truth produced?
What is the sample size of the training data?
What dataset(s) is the system NOT using?
What are the potential limitations/biases of the data?
What is the size, proportion, or distribution of the training data with given feature(s)/feature-value(s)?

Output

What kind of output does the system give?
What does the system output mean?
What is the scope of the system's capability? Can it do...?
How is the output used for other system component(s)?
How should I best use the output of the system?
How should the output fit in my workflow?

Performance

How accurate/precise/reliable are the predictions?
How often does the system make mistakes?
In what situations is the system likely to be correct/ incorrect?
What are the limitations of the system?
What kind of mistakes is the system likely to make?
Is the system's performance good enough for...?

How

How does the system make predictions?
What features does the system consider?
Is [feature X] used or not used for the predictions?
What is the system's overall logic?
How does it weigh different features?
What kind of rules does it follow?
How does [feature X] impact its predictions?
What are the top rules/features that determine its predictions?
What kind of algorithm is used?
How were the parameters set?

Why

Why/how is this instance given this prediction?
What feature(s) of this instance determine the system's prediction of it?
Why are [instance A and B] given the same prediction?

Why not

Why is this instance NOT predicted to be [a different outcome]?
Why is this instance predicted [P instead of a different outcome Q]?
Why are [instance A and B] given different predictions?

How t

How sl differe
What is instanc
How sh instanc
What differen

How t

What instanc
What is feature
What value(s) predicti
What k tion?

What if

What instanc
What v feature
What w instanc

Other

How/w prove/c
Can I, a (improv
Why i algorith
What c mean?
What a system?

Why

Why/how is this instance giving this prediction?
What feature(s) of this instance determine the system's prediction of it?
Why are [instance A and B] given the same prediction?

What if

What would the system predict if this instance changes to...?
What would the system predict if a given feature changes to...?
What would the system predict for [a different instance]?



explainable AI
human-AI interaction

Q. Vera Liao et al. 2020. Questioning the AI: Informing Design Practices for Explainable AI User Experiences. https://doi.org/10.1145/3313831.3376590

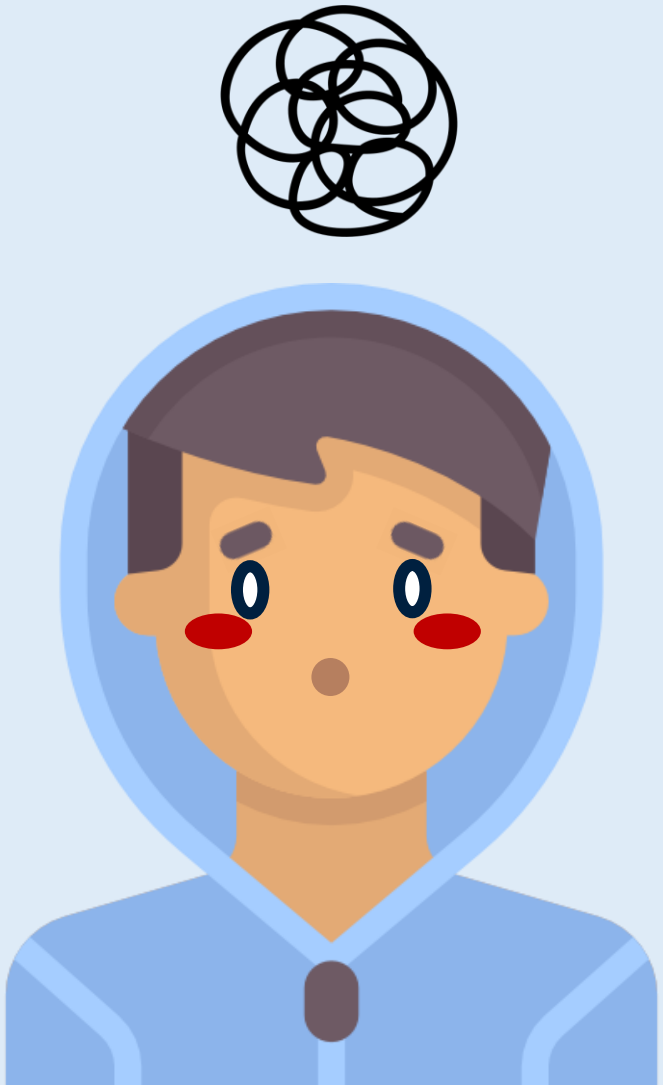
Open challenges ☂️

Unclear which explanation types are suitable for adolescents in education

Static explanations often fail to cognitively engage

Little research on learner control mechanisms for selecting learning materials with AI support

Few examples of elaborate design processes involving multiple stakeholders

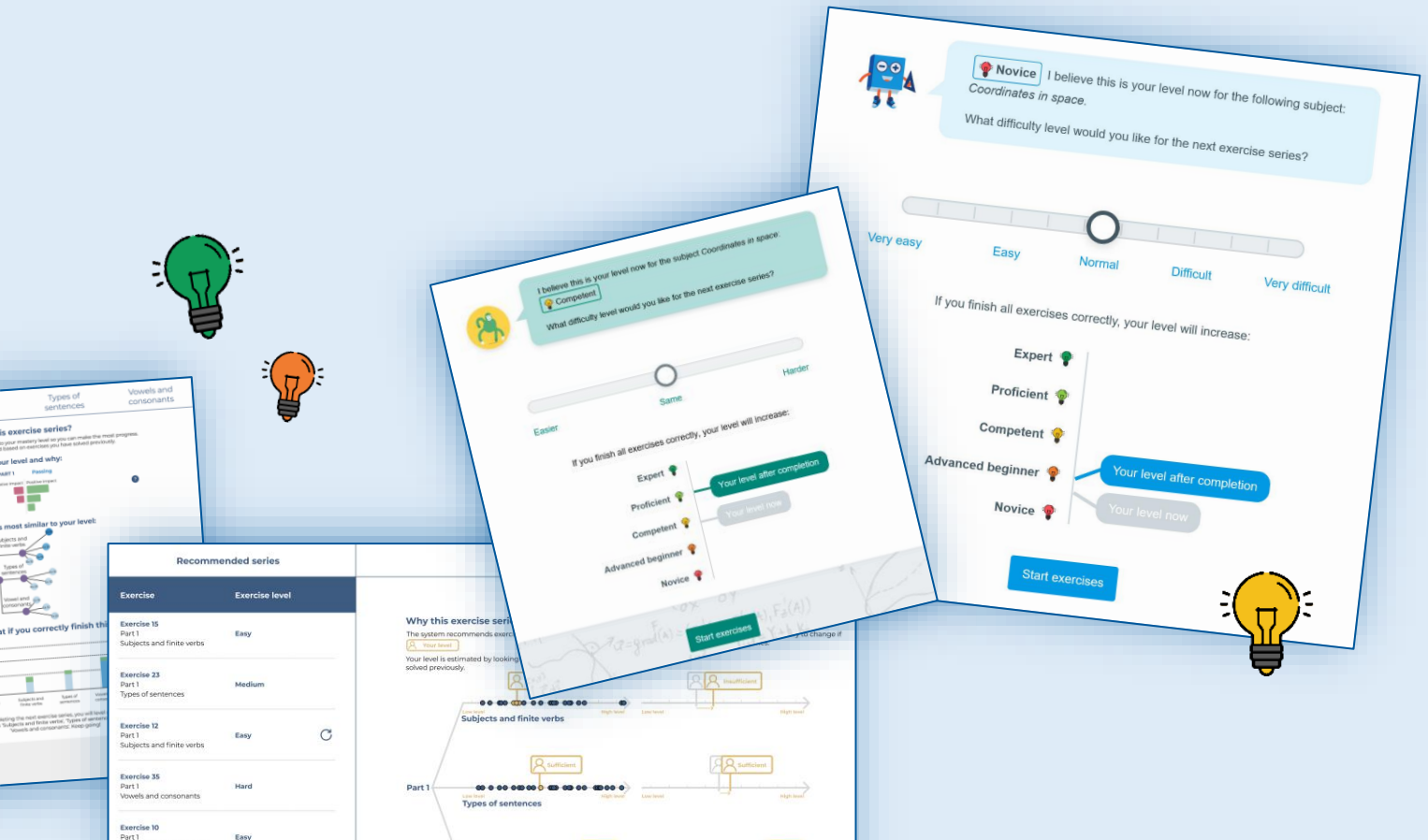


Designing Visual Explanations and Learner Controls to Engage Adolescents in AI-Supported Exercise Selection

LAK25

Universiteit Utrecht

KU LEUVEN





Jeroen Ooge
jeroenooge.com



Arno Vanneste



Maxwell Szymanski

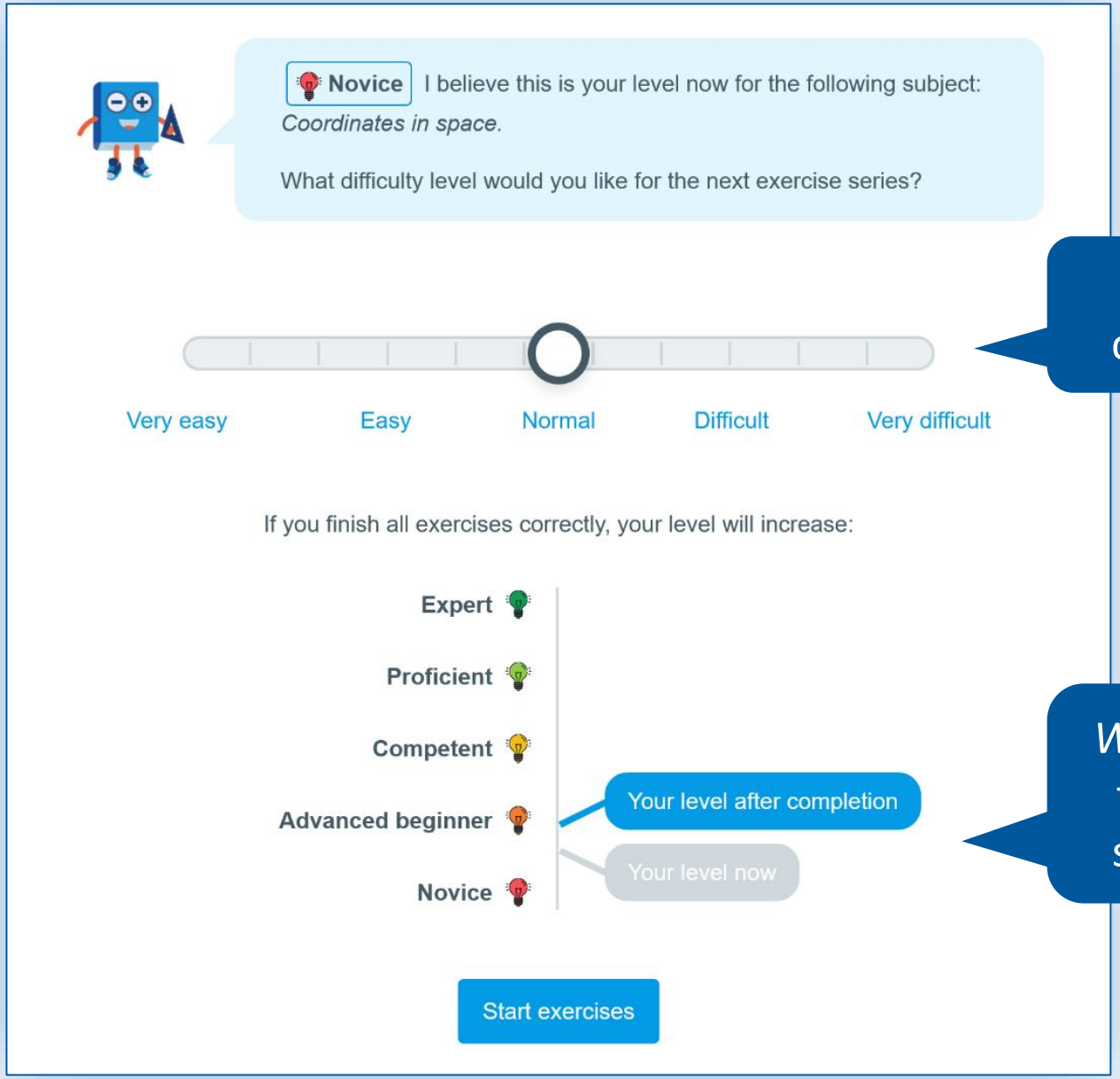


Katrien Verbert

RQ1. How can ***why*** **and** ***what-if*** **explanations** be operationalised on exercise-recommending e-learning platforms while meeting the explainability needs of adolescent learners and teachers?

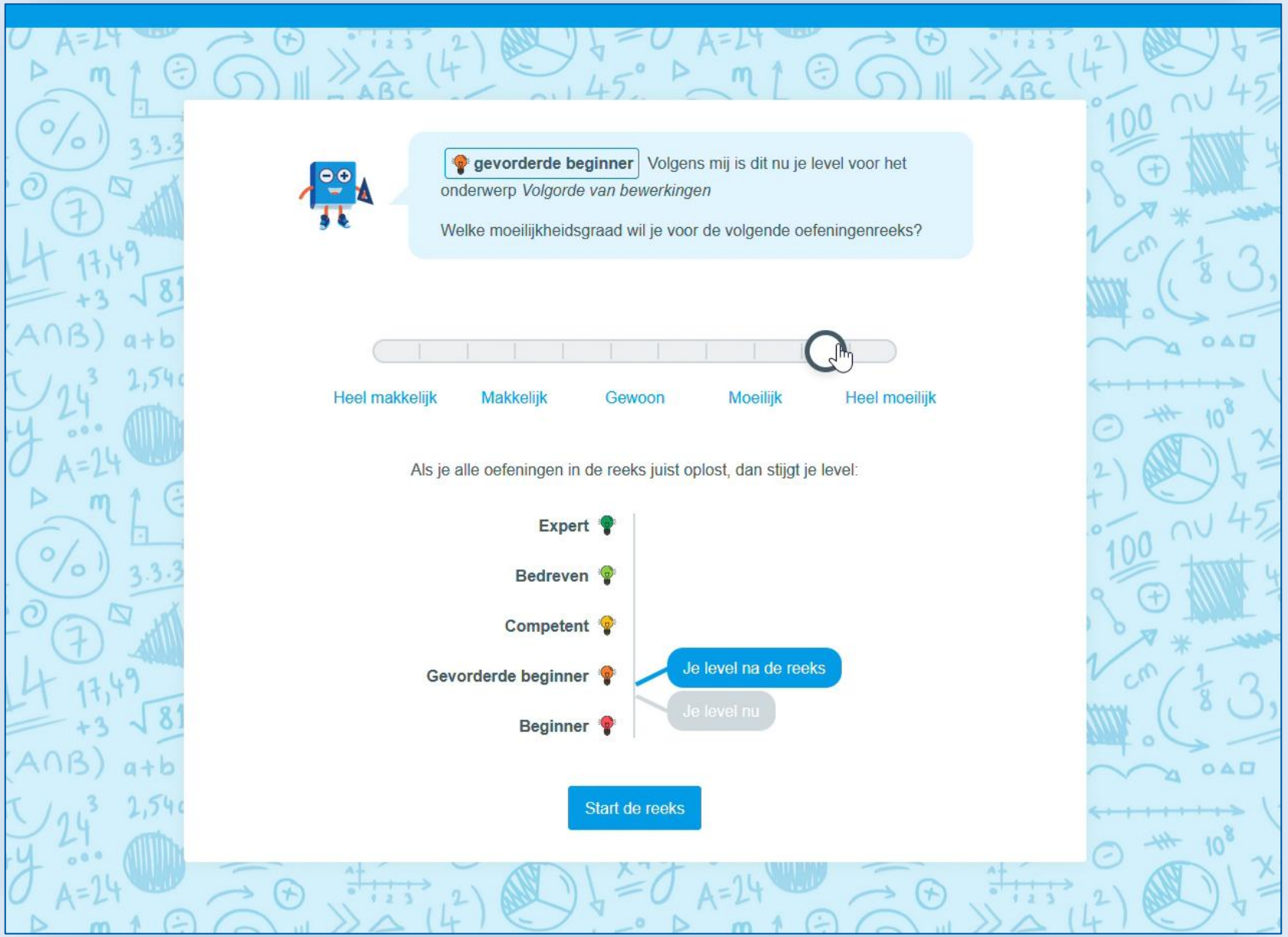
RQ2. How can adolescent learners steer the difficulty of recommended exercises on e-learning platforms in line with their needs for control and the appropriateness of such **control**?

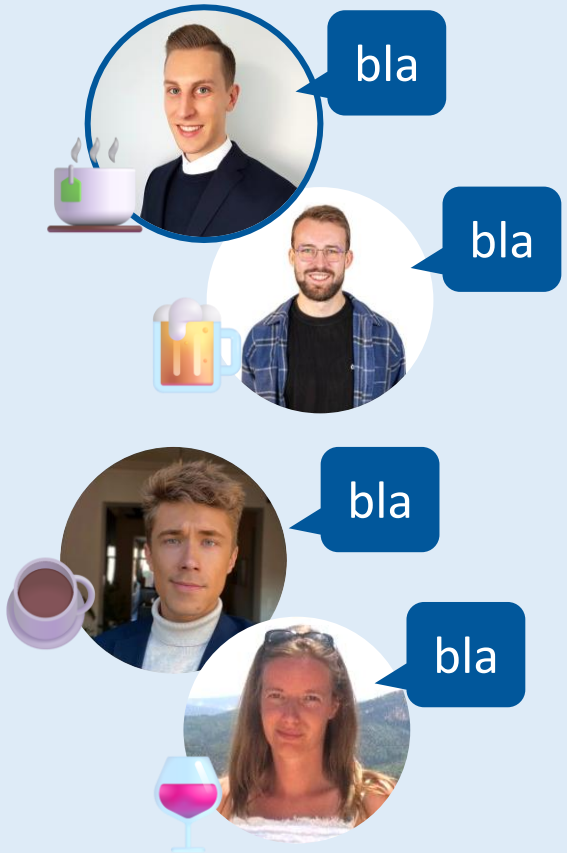


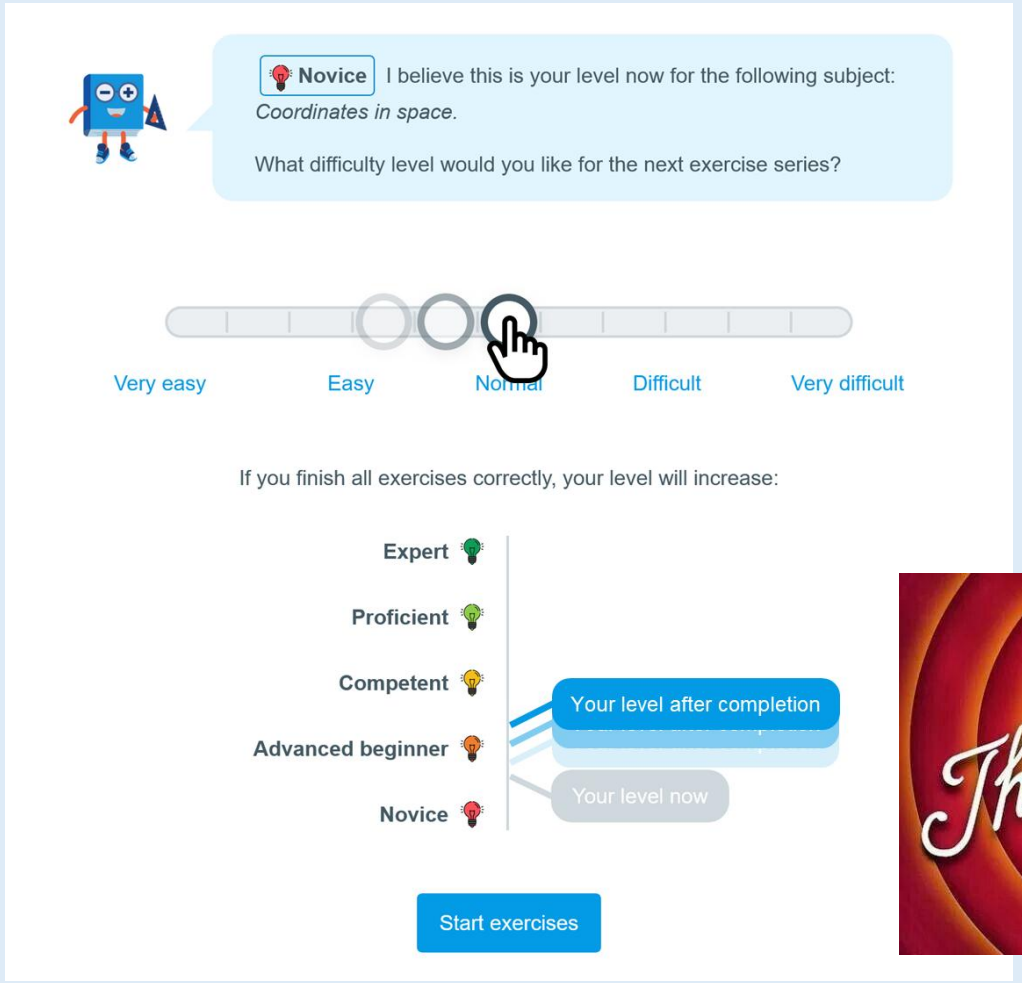


Learner control: choose difficulty of exercise series

What-if explanation: what is the impact on my level if I solve this series correctly?


gevorderde beginner Volgens mij is dit nu je level voor het onderwerp *Volgorde van bewerkingen*
Welke moeilijkheidsgraad wil je voor de volgende oefeningenreeks?
Heel makkelijk
Makkelijk
Gewoon
Moeilijk
Heel moeilijk
Als je alle oefeningen in de reeks juist oplost, dan stijgt je level:
Expert
Bedreven
Competent
Gevorderde beginner
Beginner
Je level na de reeks
Je level nu
Start de reeks


bla
bla
bla
bla


Novice I believe this is your level now for the following subject:
Coordinates in space.
What difficulty level would you like for the next exercise series?
Very easy
Easy
Normal
Difficult
Very difficult
If you finish all exercises correctly, your level will increase:
Expert
Proficient
Competent
Advanced beginner
Novice
Your level after completion
Your level now
Start exercises


That's all Folks!

Study 1: Group Discussion

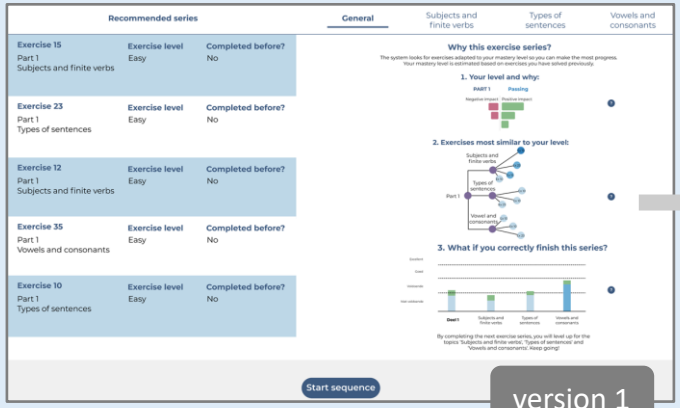
- 3 teachers and 6 EdTech professionals
- Collect learning and explainability needs; test understandability

Study 2: Think-Aloud Studies

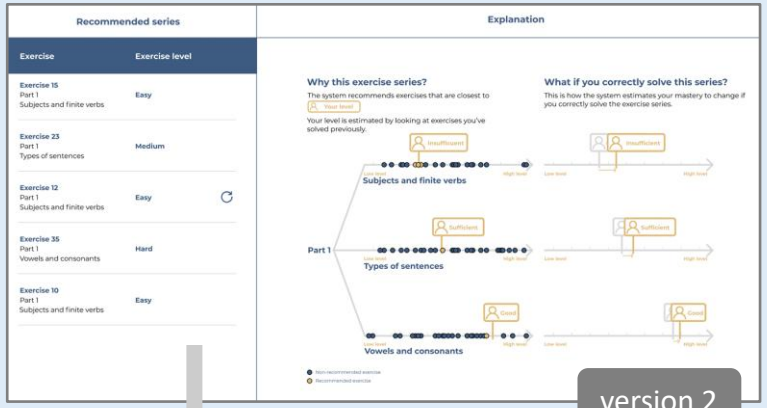
- 6 adolescents
- Collect explainability needs; test understandability and usability

Study 3: Focus Groups

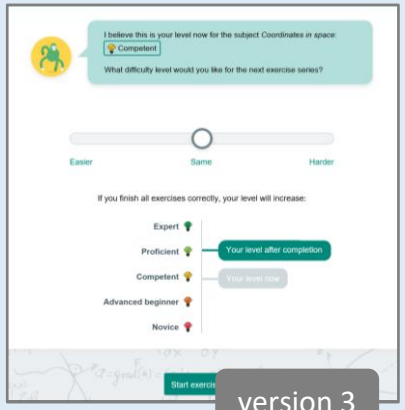
- 7 teachers and pedagogical experts
- Collect explainability and control needs; assess pedagogical value



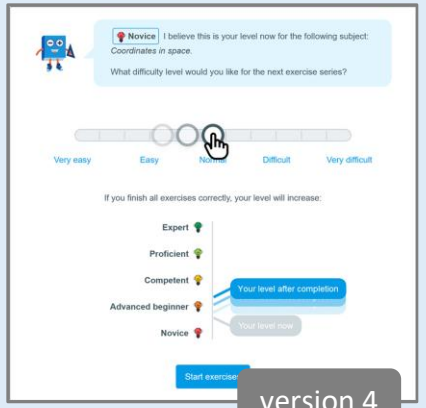
version 1



version 2



version 3



version 4

Study 4: Think-Aloud Studies

- 6 adolescents
- Collect explainability and control needs; test understandability and usability

Study 1: Group Discussion

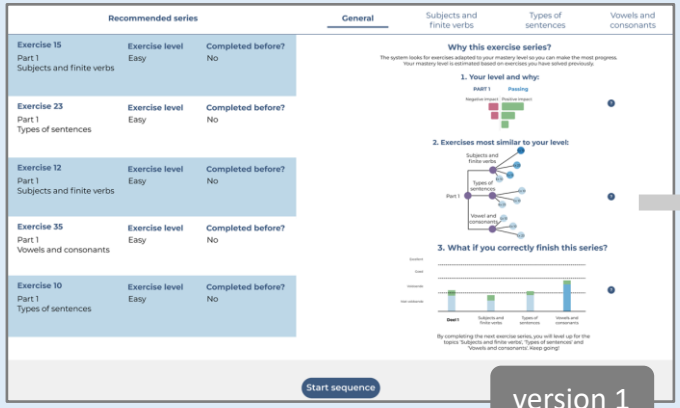
- 3 teachers and 6 EdTech professionals
- Collect learning and explainability needs; test understandability

Study 2: Think-Aloud Studies

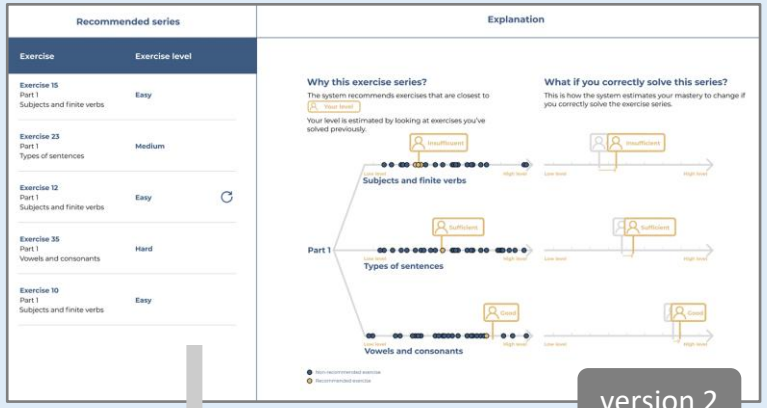
- 6 adolescents
- Collect explainability needs; test understandability and usability

Study 3: Focus Groups

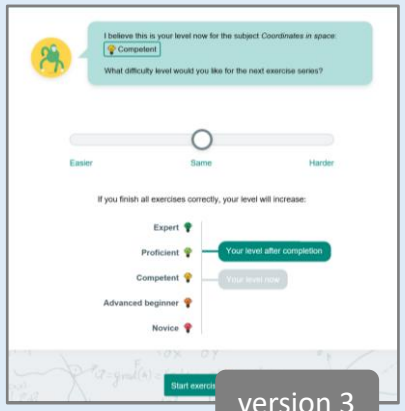
- 7 teachers and pedagogical experts
- Collect explainability and control needs; assess pedagogical value



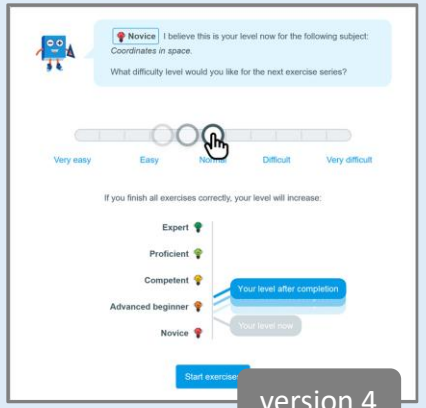
version 1



version 2



version 3



version 4

Study 4: Think-Aloud Studies

- 6 adolescents
- Collect explainability and control needs; test understandability and usability

Extensive **human-centred design process** with many educational stakeholders!



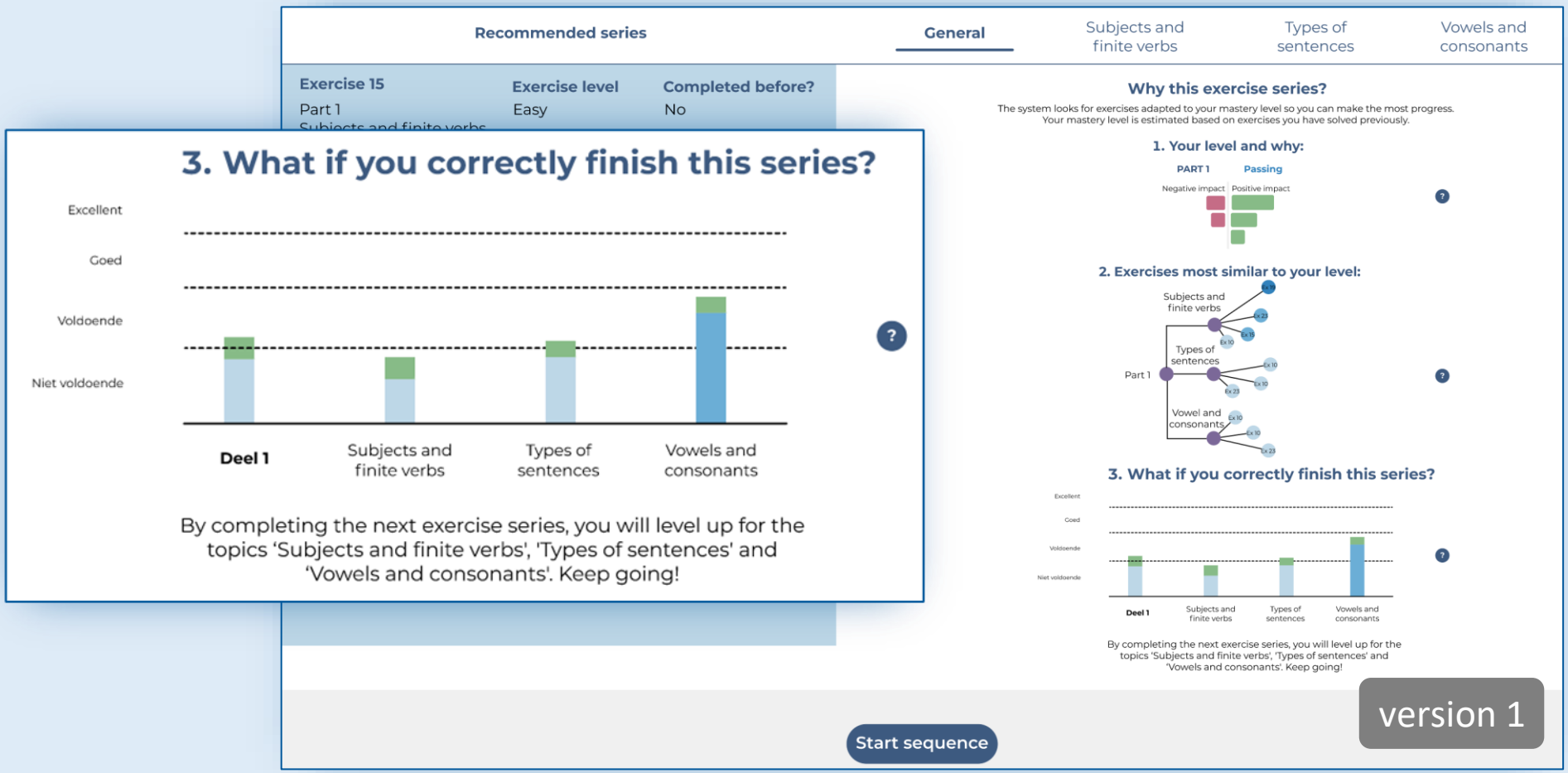
Study 1: Group Discussion

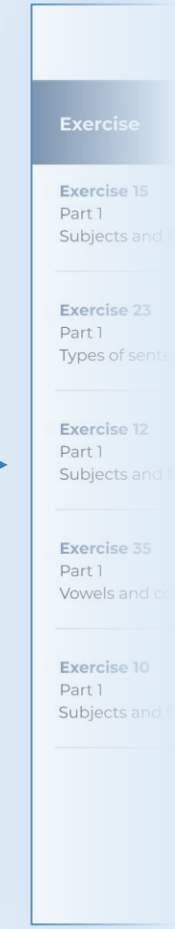
- 3 teachers and 6 EdTech professionals
- Collect learning and explainability needs; test understandability



Clarify visualisations and restrict information

What-if explanations might boost motivation





Study 2: Think-Aloud Studies

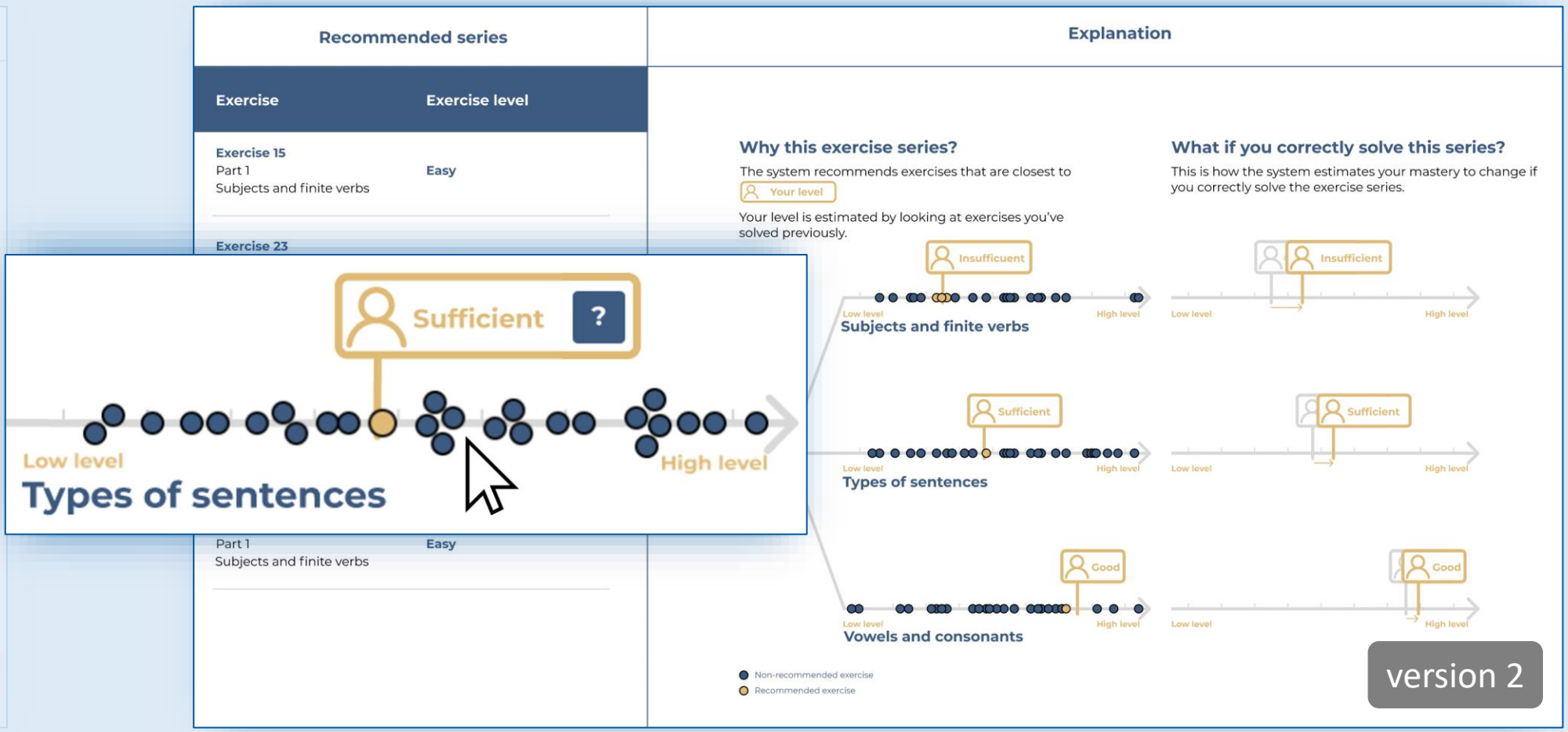
- 6 adolescents
- Collect explainability needs; test understandability and usability



Minimise text, tightly integrate explanations

Inattentiveness can harm mental models

Adolescents want control and motivation supports



Study 3: Focus Groups

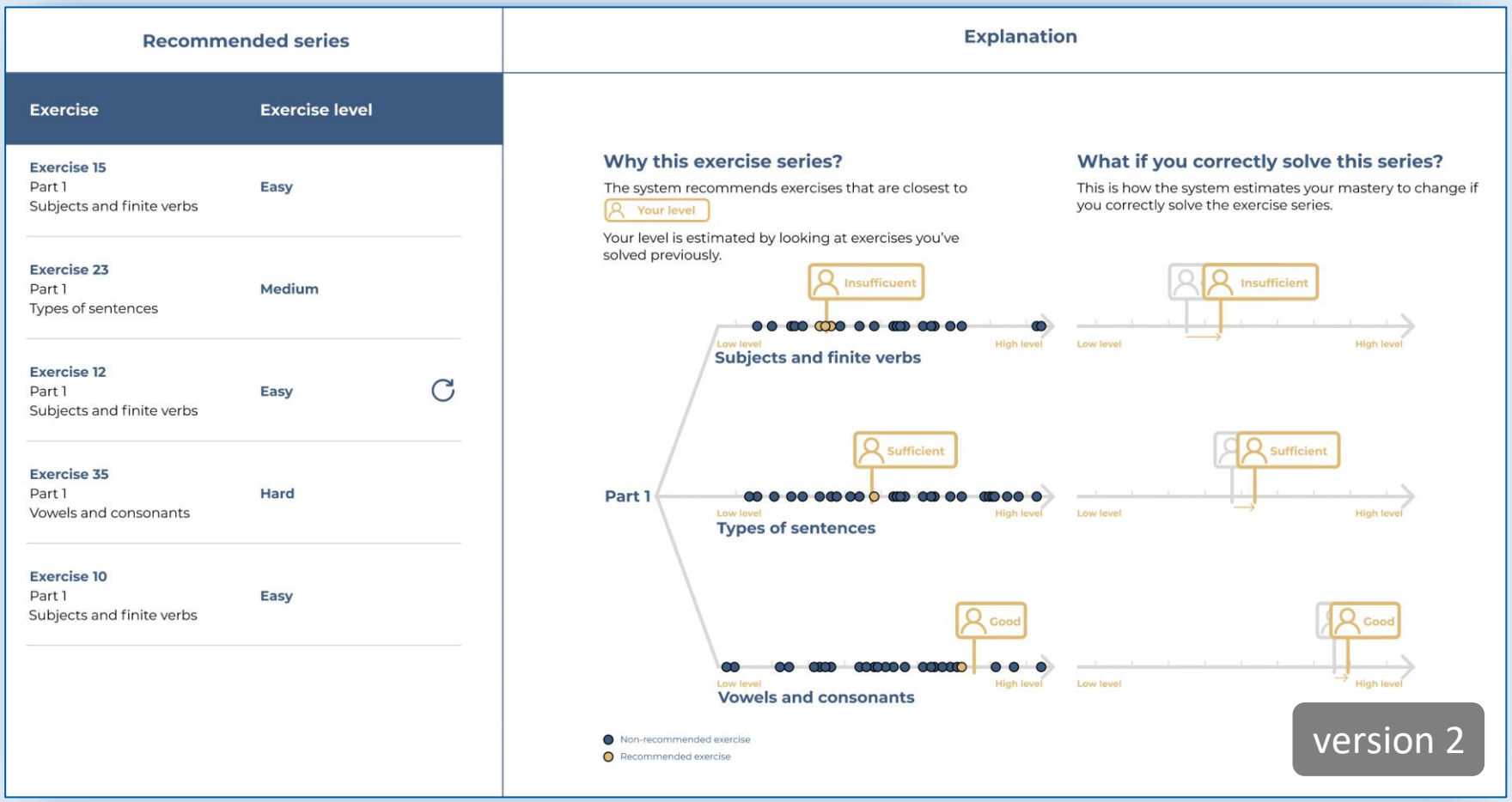
- 7 teachers and pedagogical experts
- Collect explainability and control needs; assess pedagogical value



Students need goal-oriented, motivating explanations

How appropriate is learner control?

Why explanations can empower teachers



Study 4: Think-Aloud Studies

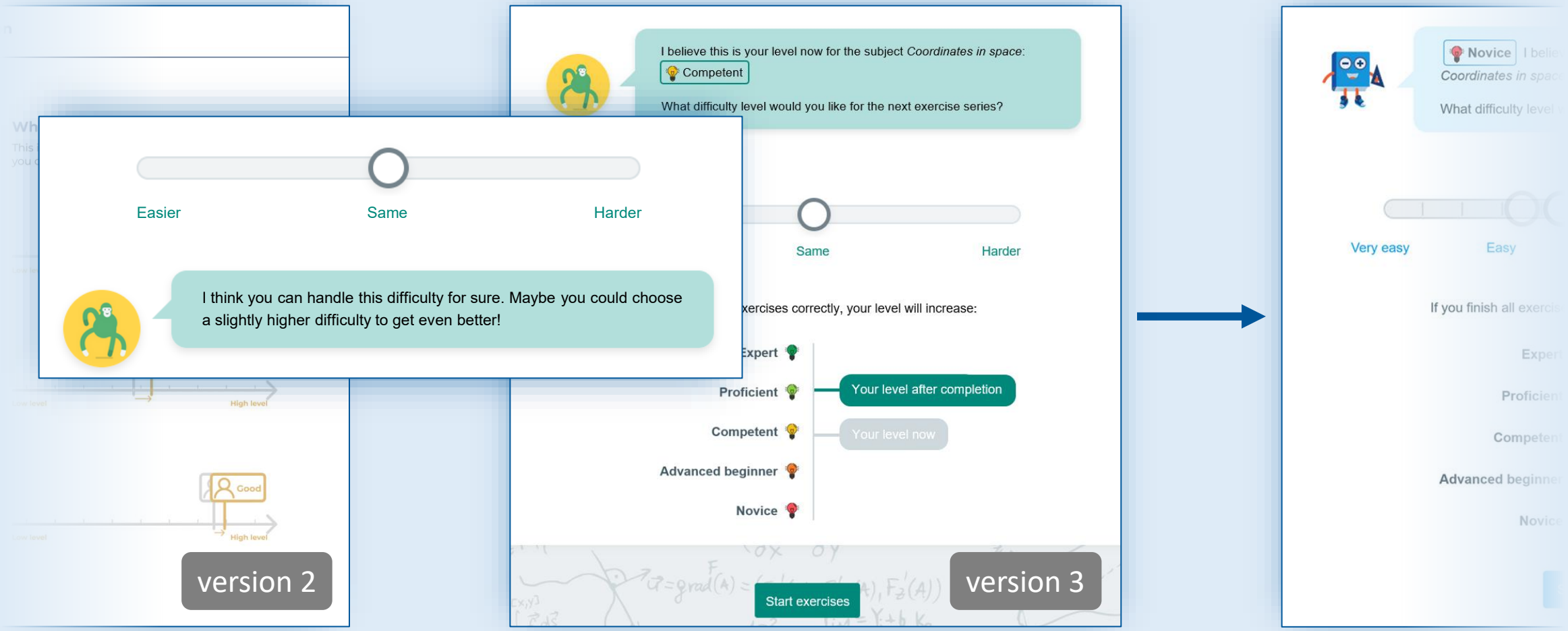
- 6 adolescents
- Collect explainability and control needs; test understandability and usability

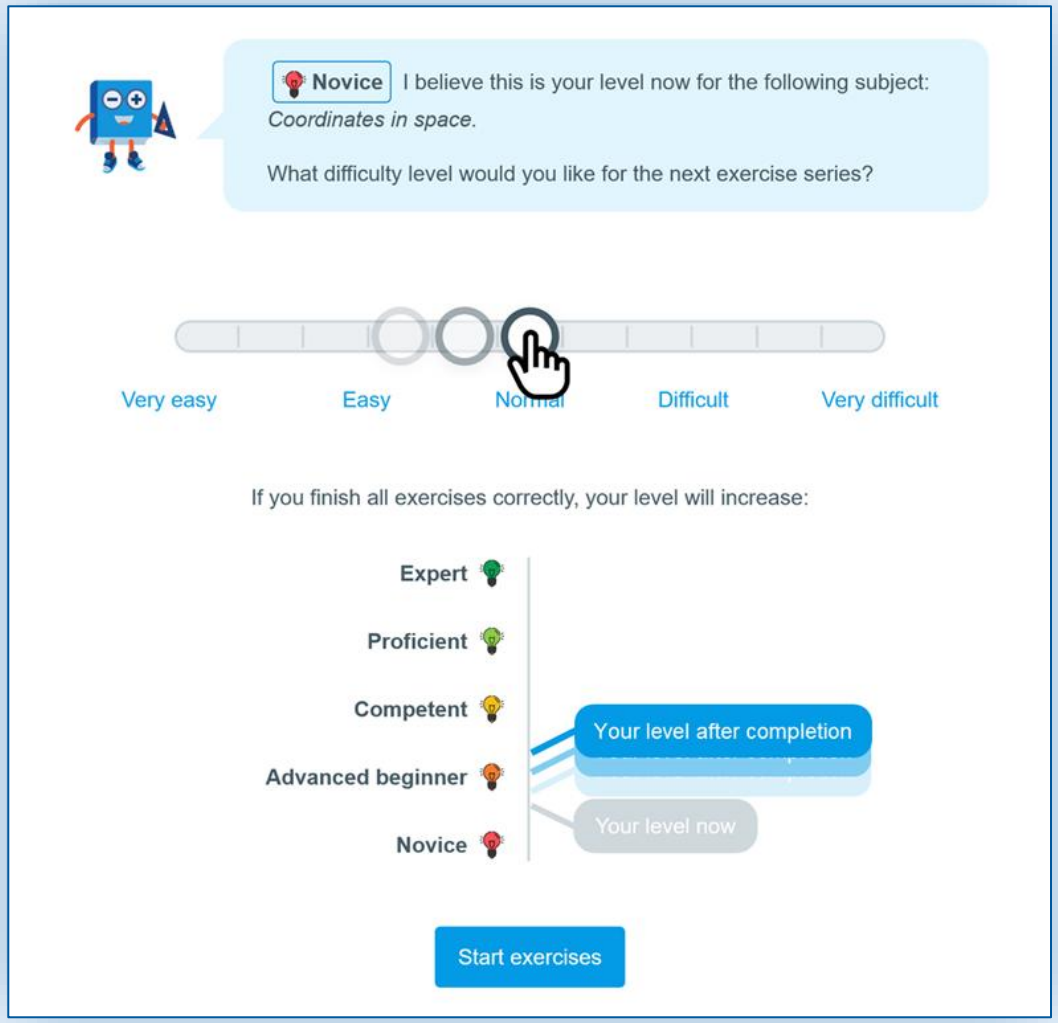


Control stimulates self-reflection

What-if explanations clarify progress

Motivational feedback can stimulate challenging oneself





RQ1. How can *why* and *what-if* explanations be operationalised?

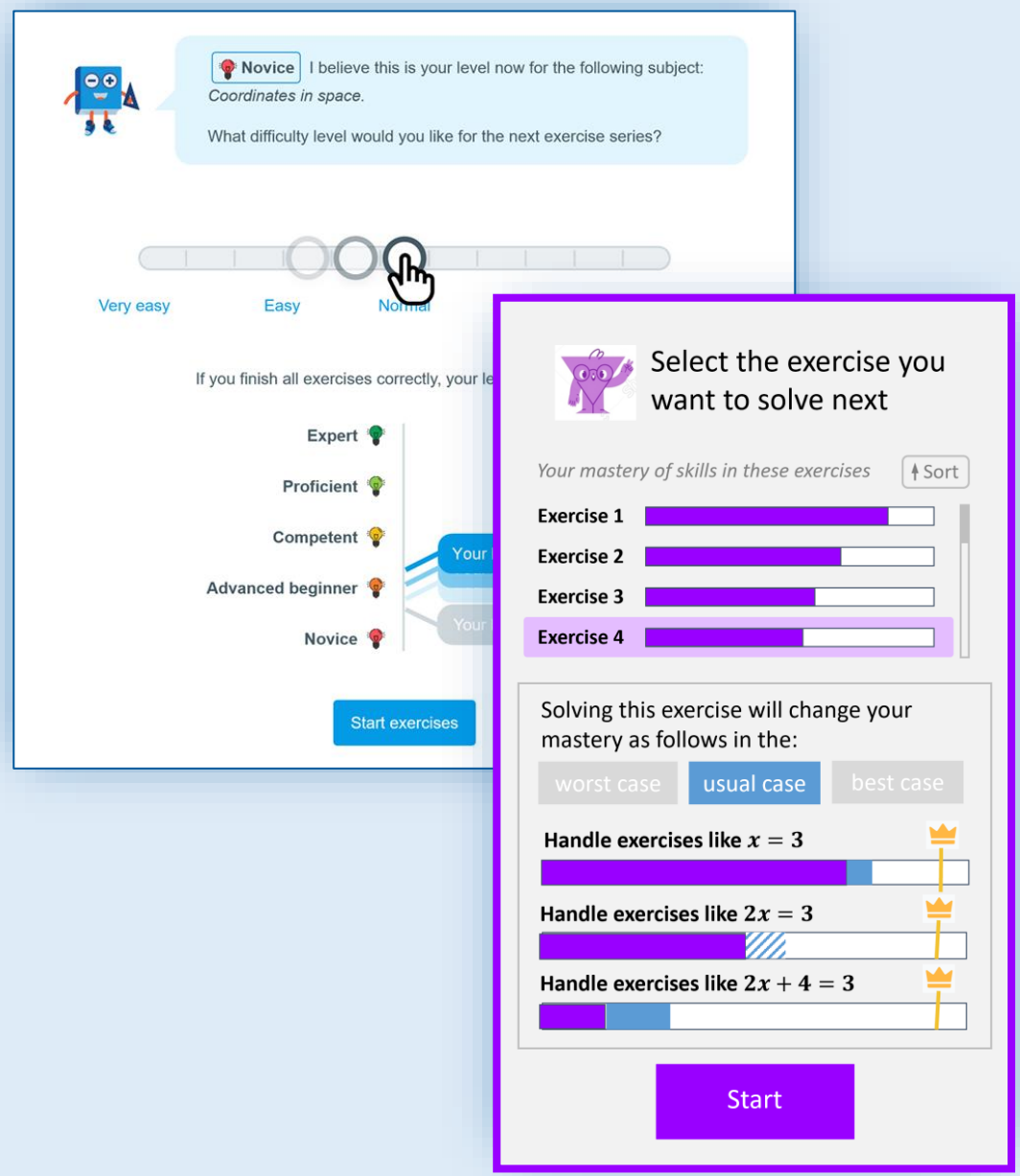
Why explanations for teachers, not adolescents

When relevant, introduce complex visual explanations incrementally

RQ2. How can adolescent learners steer the difficulty of recommended exercises?

What-if explanations and learner control to motivate and engage when appropriate

Further stimulate cognitive engagement by showing worst case and usual changes





Join our talk & read our paper!

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

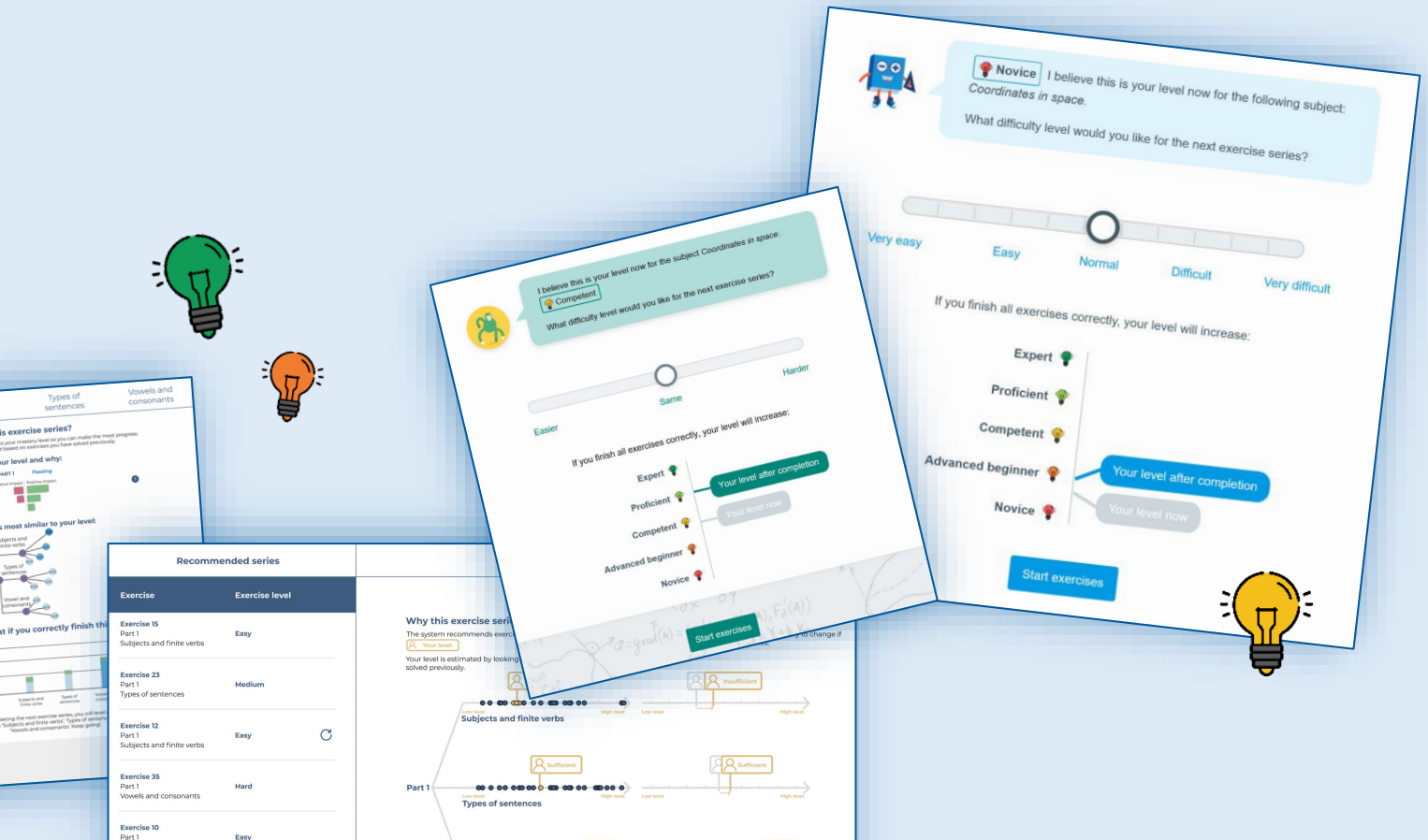
Further stimulate cognitive engagement by showing worst case and usual changes

Designing Visual Explanations and Learner Controls to Engage Adolescents in AI-Supported Exercise Selection

LAK25

Universiteit Utrecht

KU LEUVEN





Jeroen Ooge
jeroenooge.com



Arno Vanneste



Maxwell Szymanski



Katrien Verbert