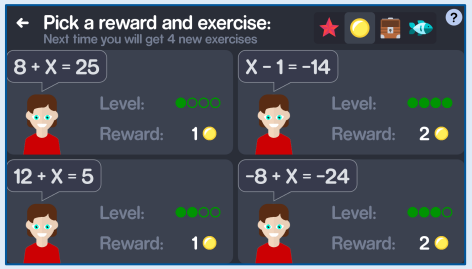
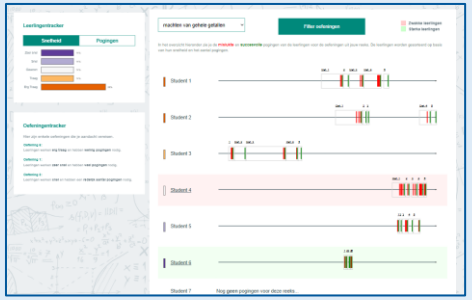
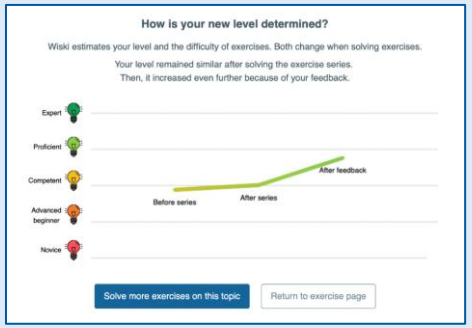
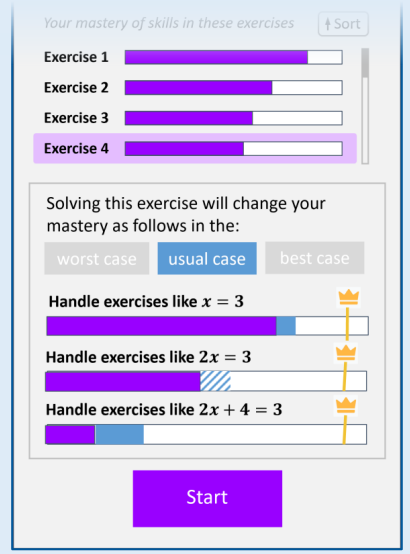
How can AI systems help with differentiation in education?

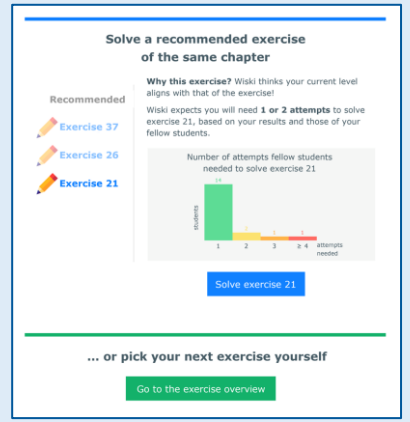
Jeroen Ooge
jeroenooge.be
Universiteit Utrecht

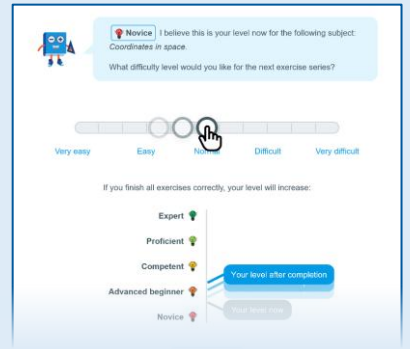




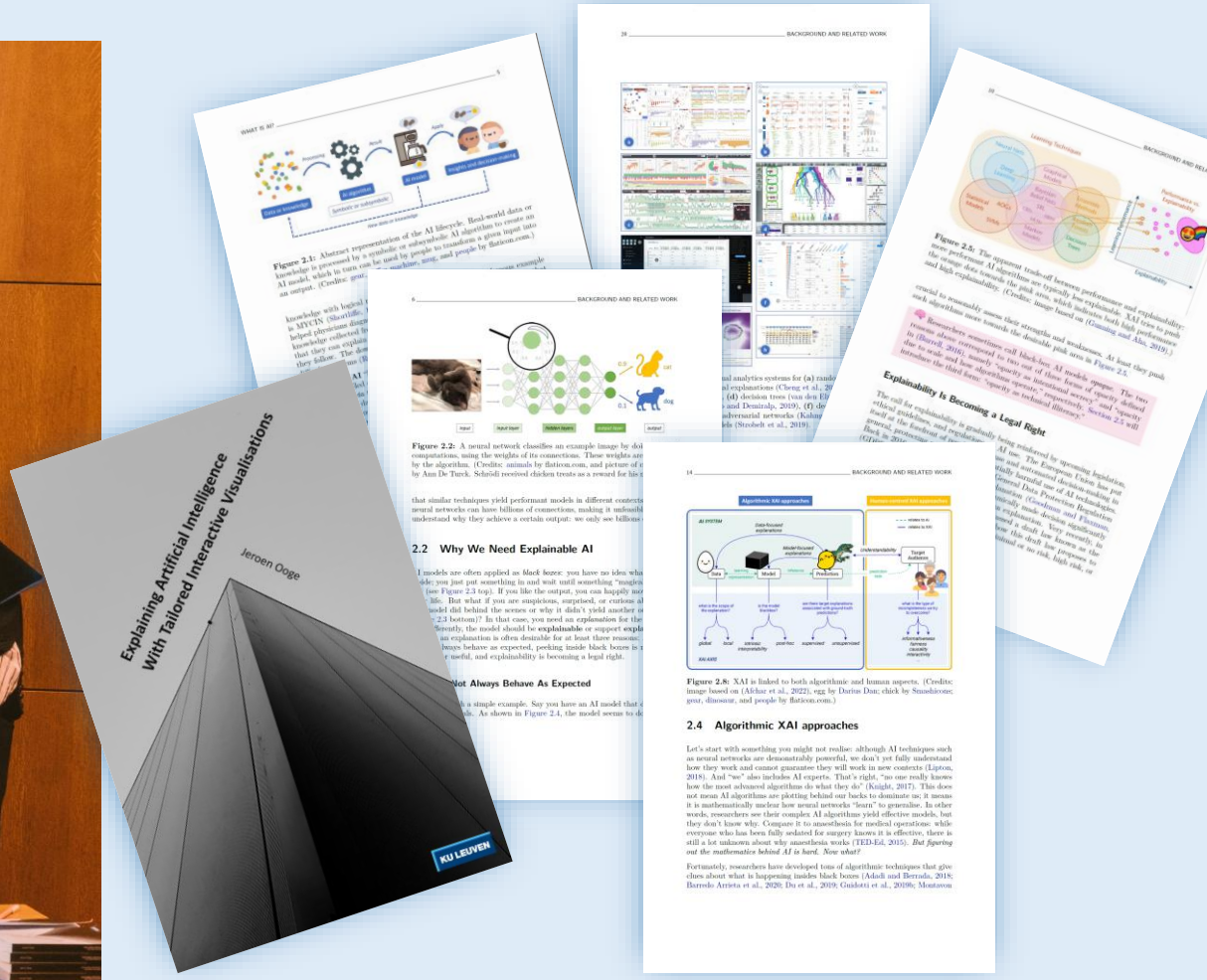








About 2 years ago



https://jeroenooge.be/thesis

My (professional) life in 1 slide

Explainable and controllable AI systems to personalise education and motivate learners

MSc fundamental mathematics
MSc applied informatics
2012-2019

KU LEUVEN

PhD in computer science
2019-2023

Assistant professor
in computer science
Nov 2023-now

Universiteit Utrecht

Jeroen Ooge
jeroenooge.be

How can AI systems help with differentiation in education?

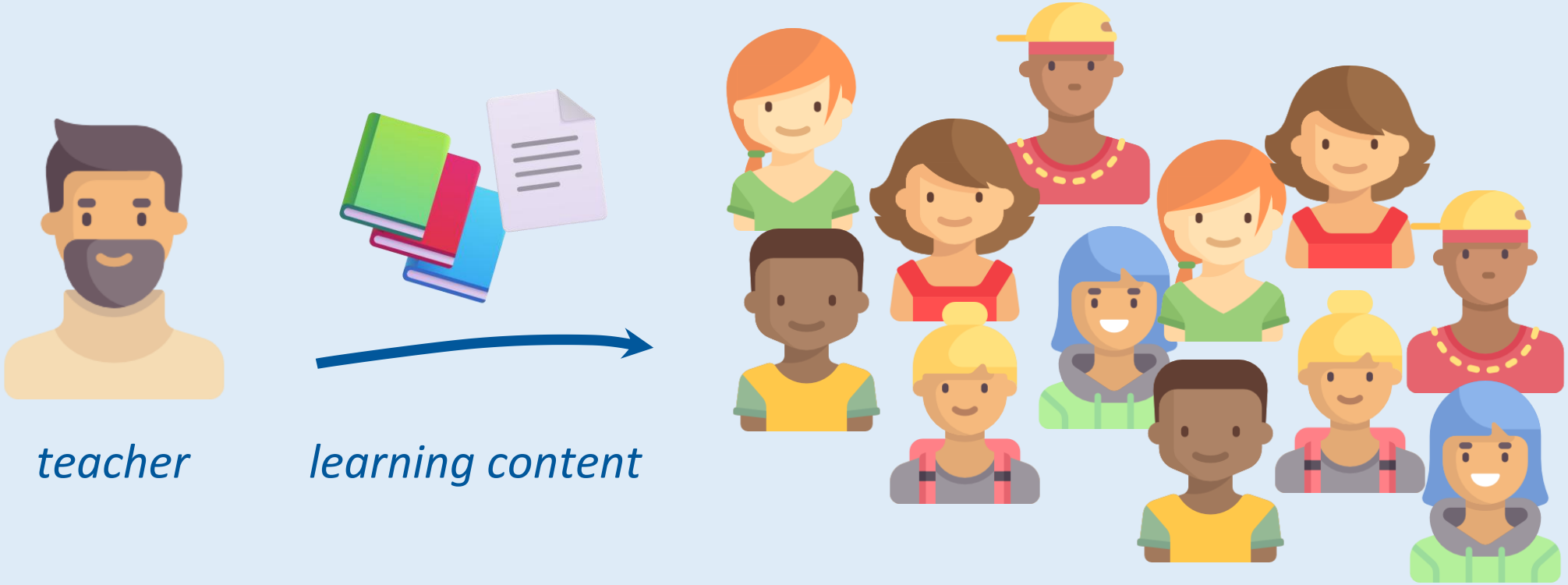
What's that?

Jeroen Ooge

jeroenooge.be

Universiteit Utrecht

The non-differentiated (usual?) way

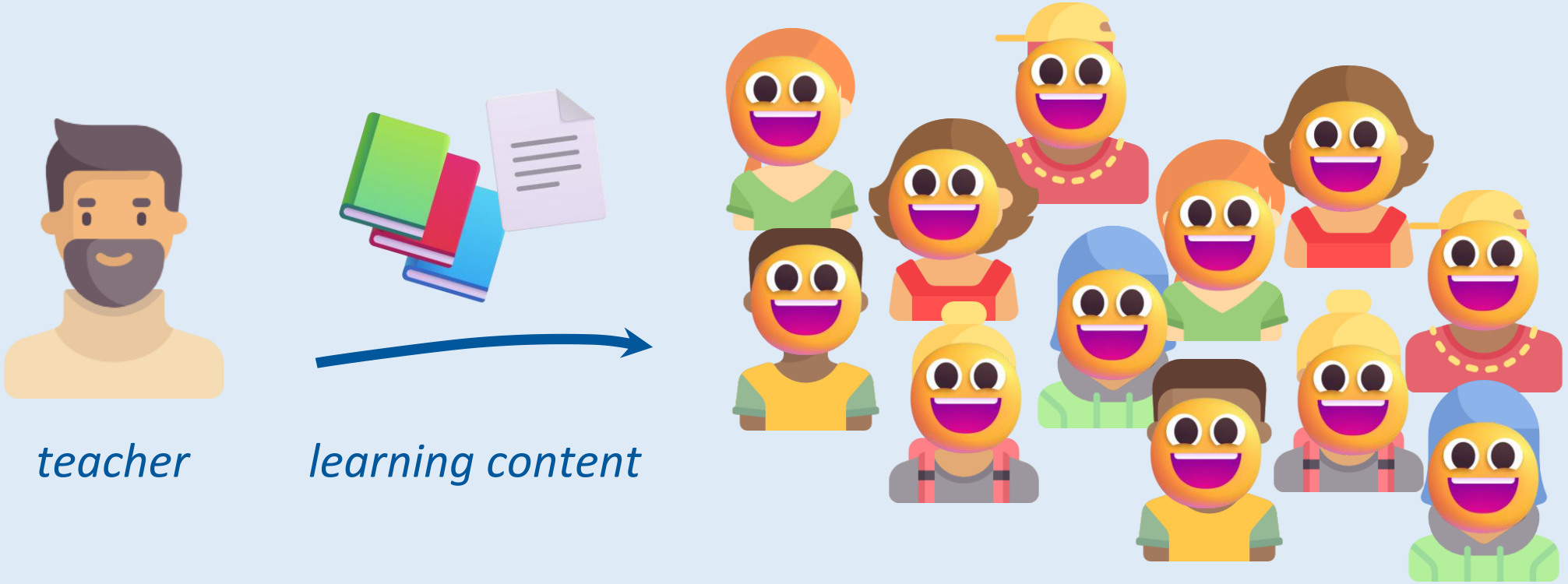


teacher

learning content

learners

What teachers might expect

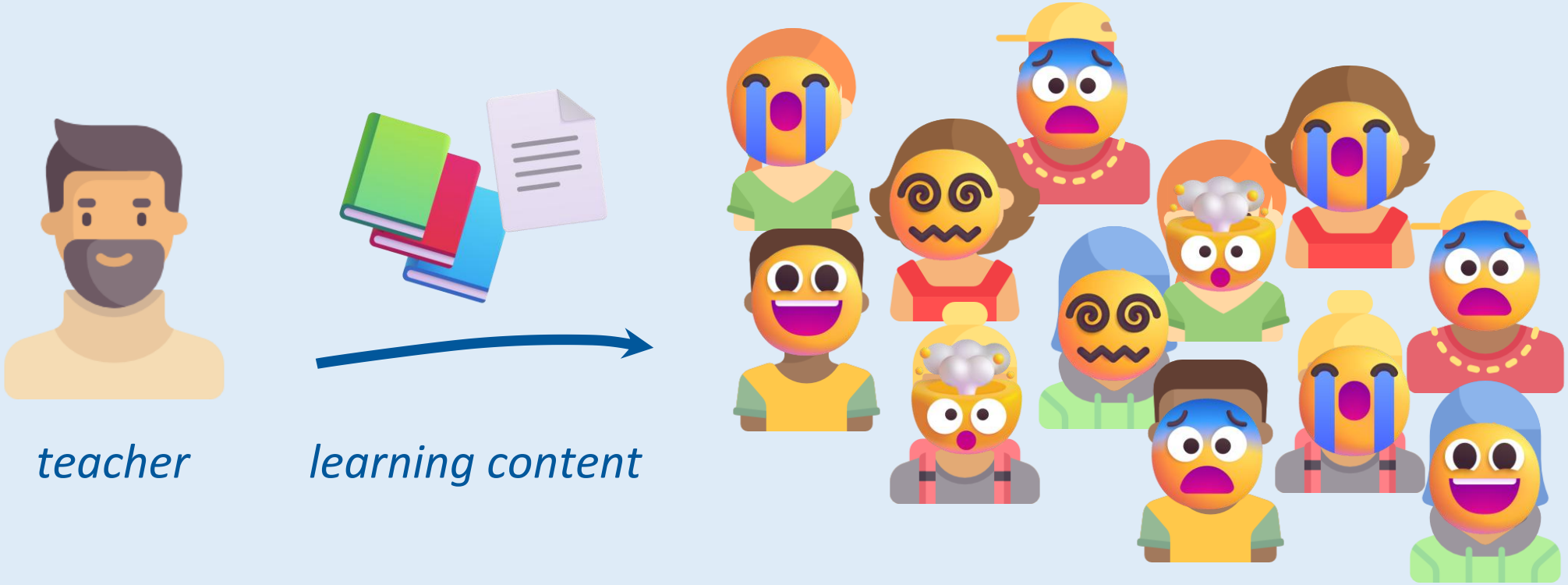


teacher

learning content

one-size-fits-all approach works for everyone

Reality

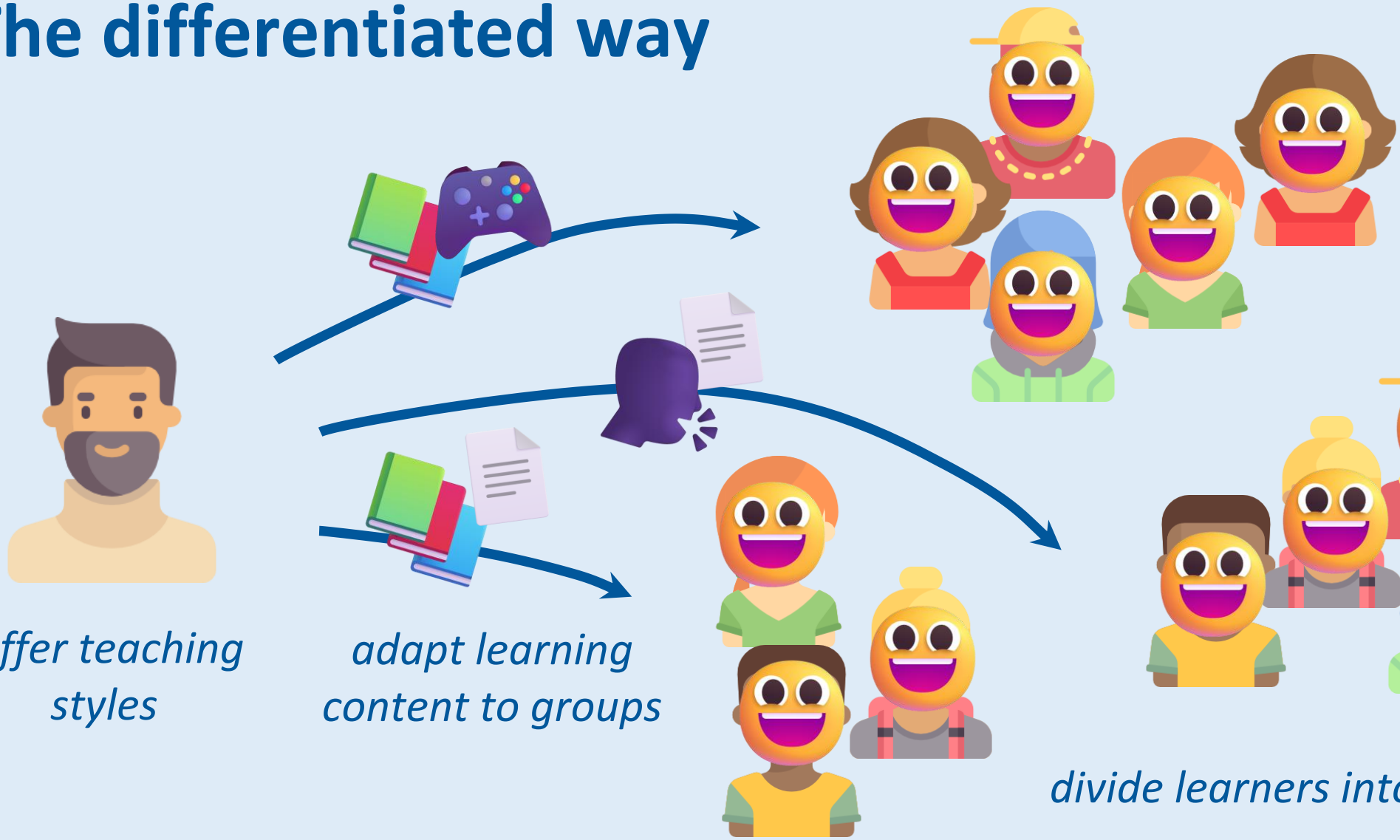


teacher

learning content

effectiveness depends on abilities, interests, background…

The differentiated way



differ teaching styles

adapt learning content to groups

divide learners into groups

How can AI systems help with differentiation* in education?

*in the sense of individualisation/personalisation

Make learning experiences more
1 adaptive, 2 transparent, and 3 motivating

How can AI systems help with differentiation?

1 Adaptation

2 Transparency

3 Motivation

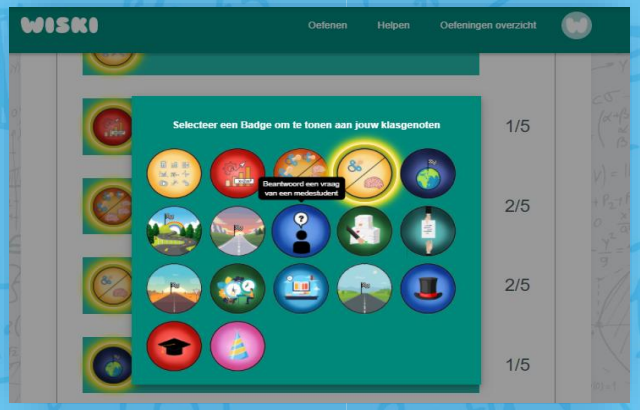
How can AI systems help with differentiation?

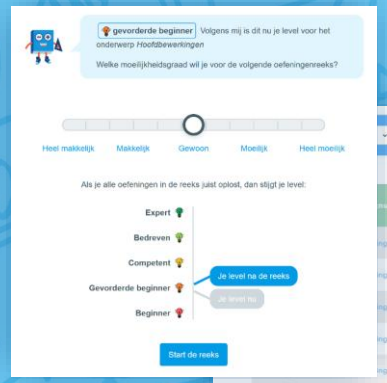
1 Adaptation

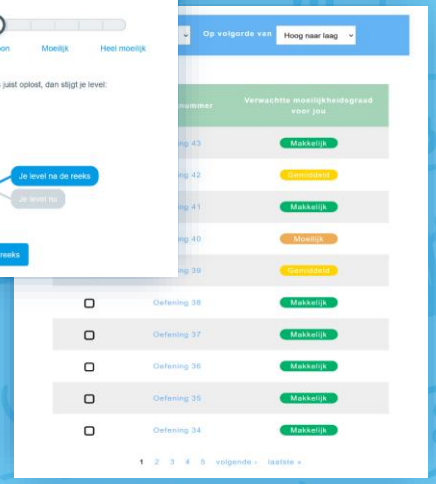
2 Transparency

3 Motiva

About fake whiskey, Elo ratings, and spying dashboards

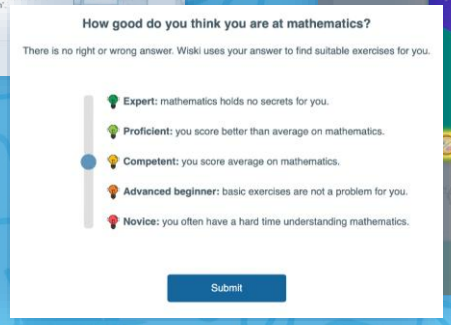


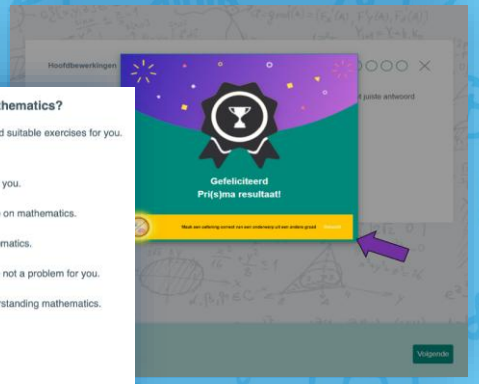


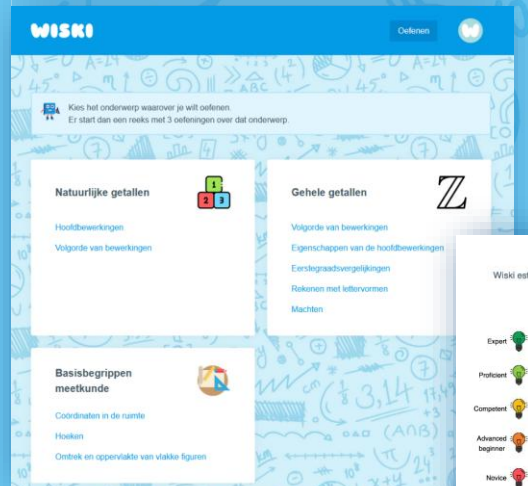


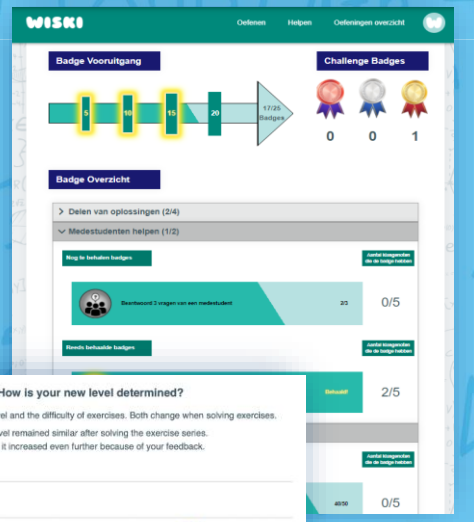
WISKI

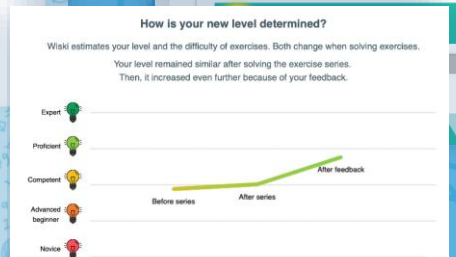
personalised maths practice with AI











Volgorde van bewerkingen

$6 \cdot (-12) + 36 \cdot 2 = \ldots$ Bereken en tik de juiste oplossing aan.

- (•) 0
- ( ) -144
- ( ) 72
- ( ) 144

Correct

Top-π!

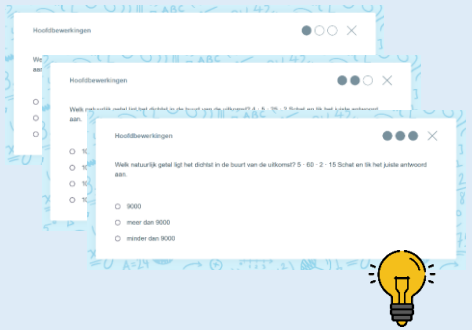
Overslaan Volgende

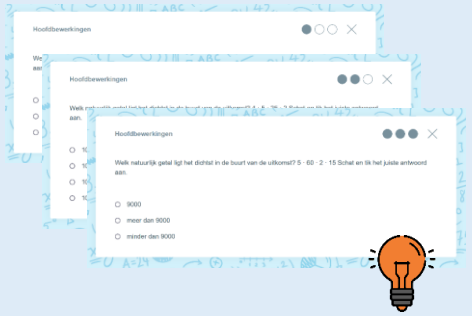
expert

competent

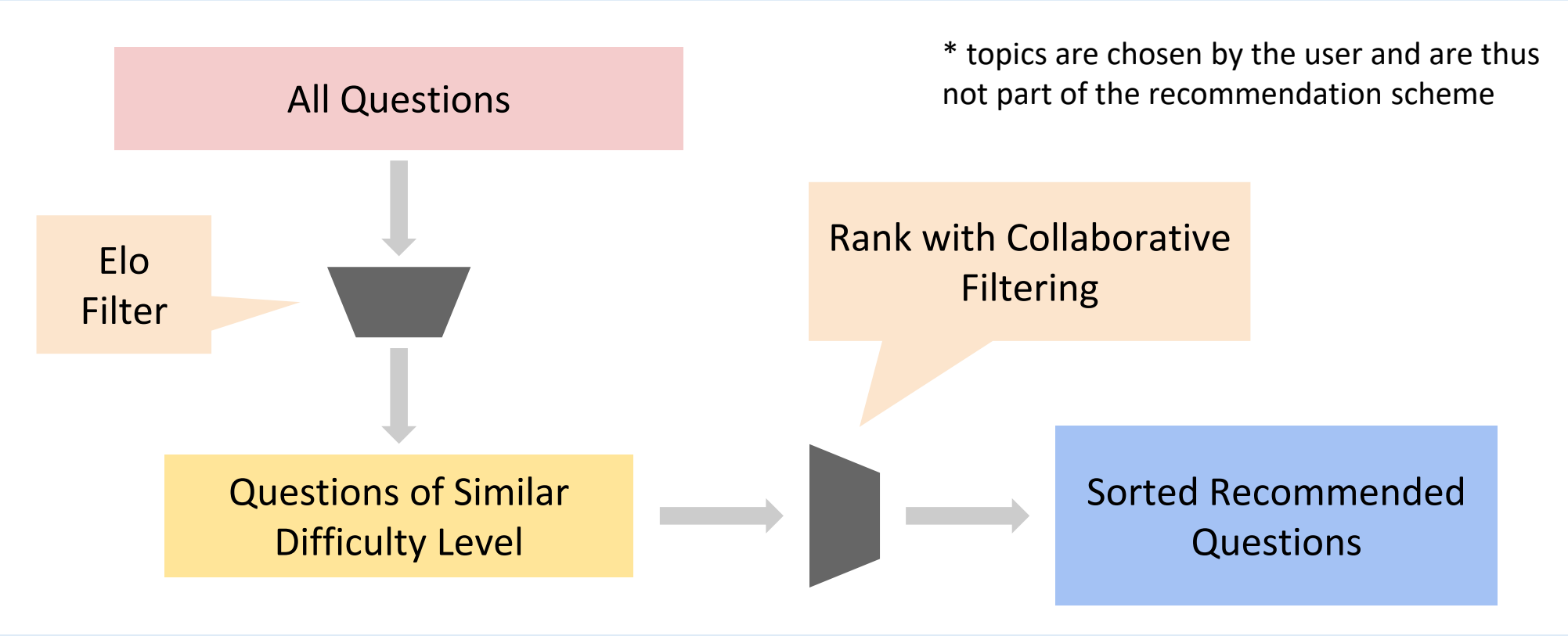
beginner

Recommender system



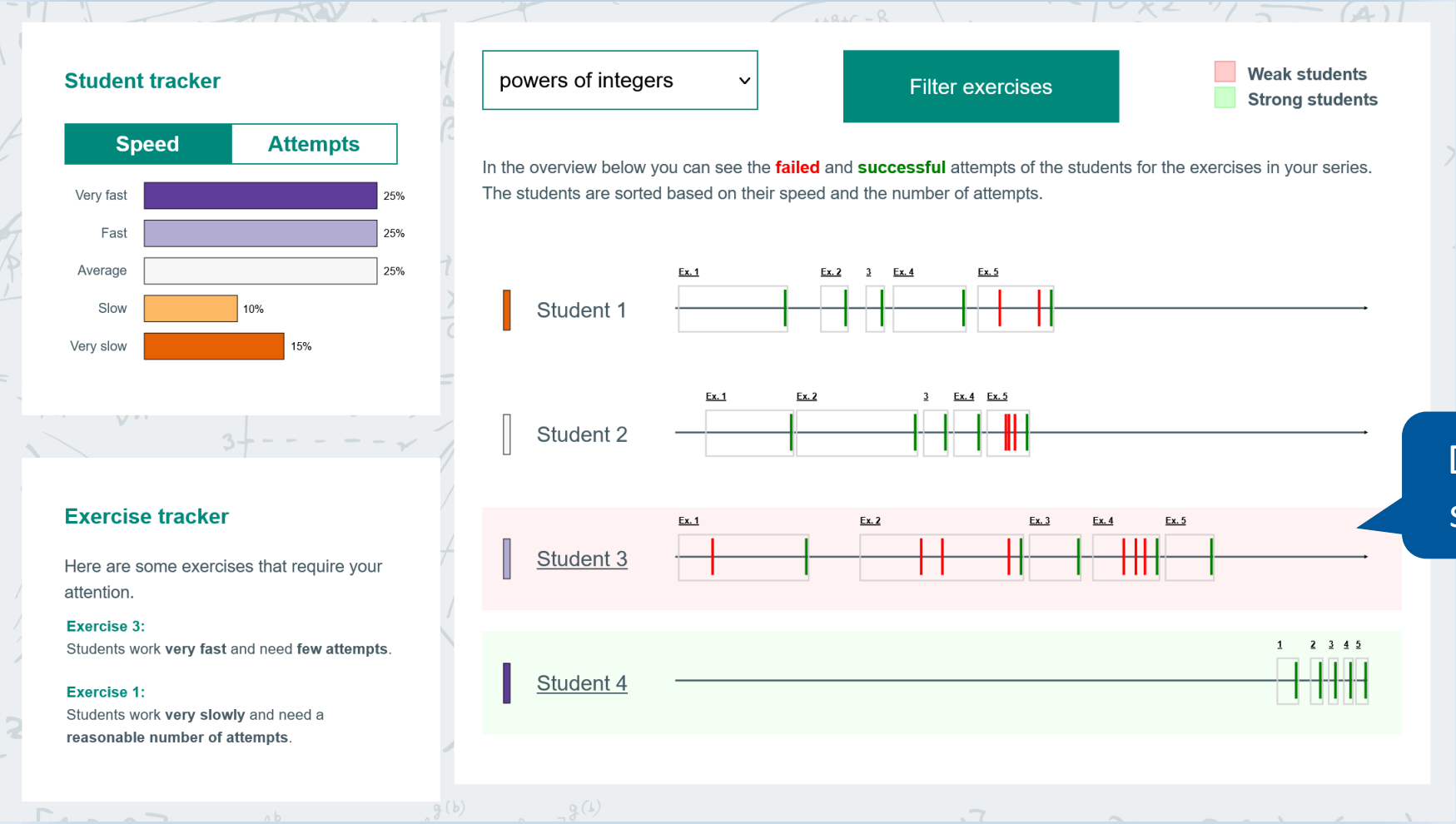


Recommending with Elo and collaborative filtering



Jeroen Ooge*, Shotallo Kato*, and Katrien Verbert. 2022. Explaining Recommendations in E-Learning: Effects on Adolescents' Trust. In *27th International Conference on Intelligent User Interfaces* (IUI '22), 93–105. https://doi.org/10.1145/3490099.3511140

Monitoring dashboard for teachers



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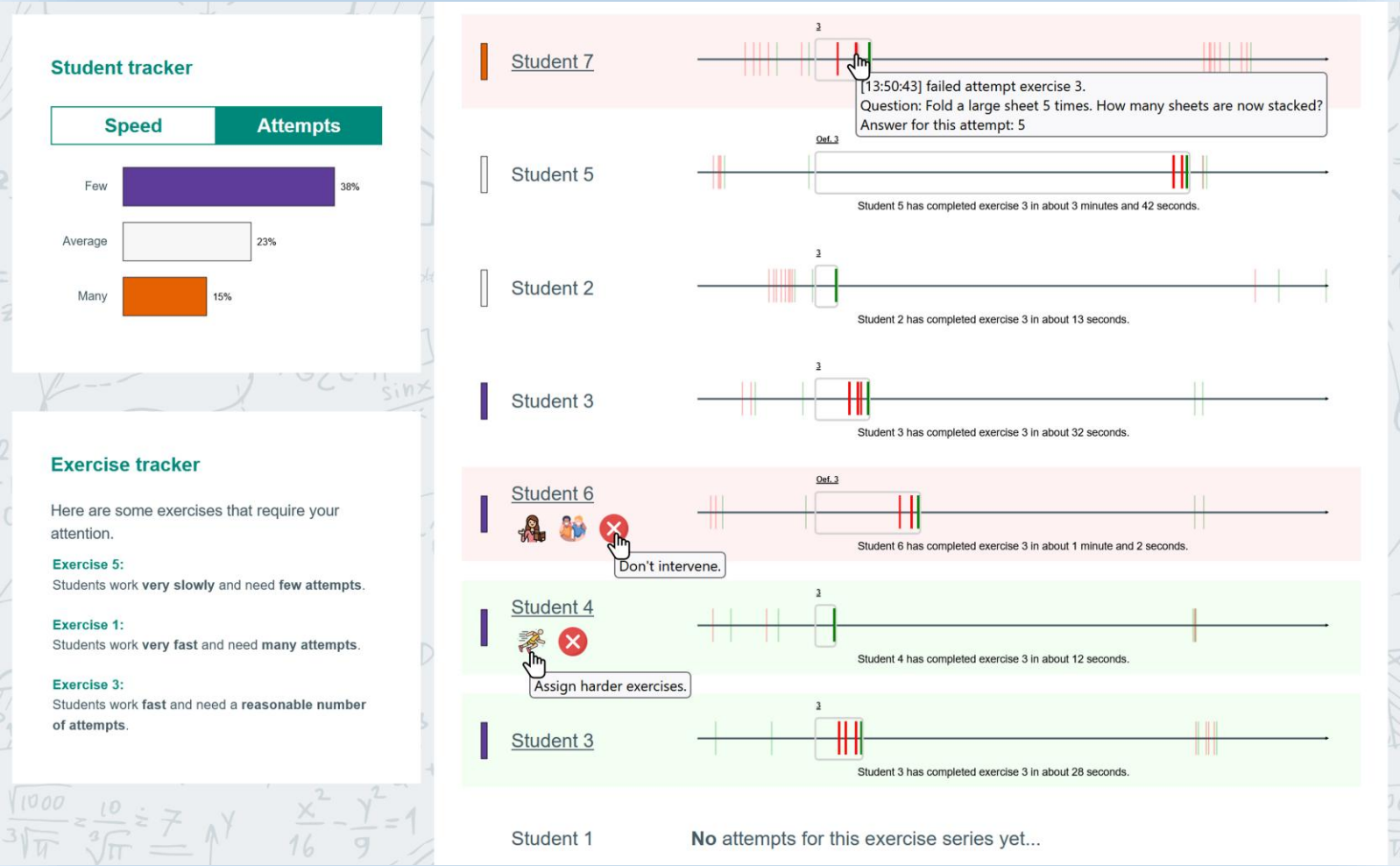
Monitoring dashboard for teachers



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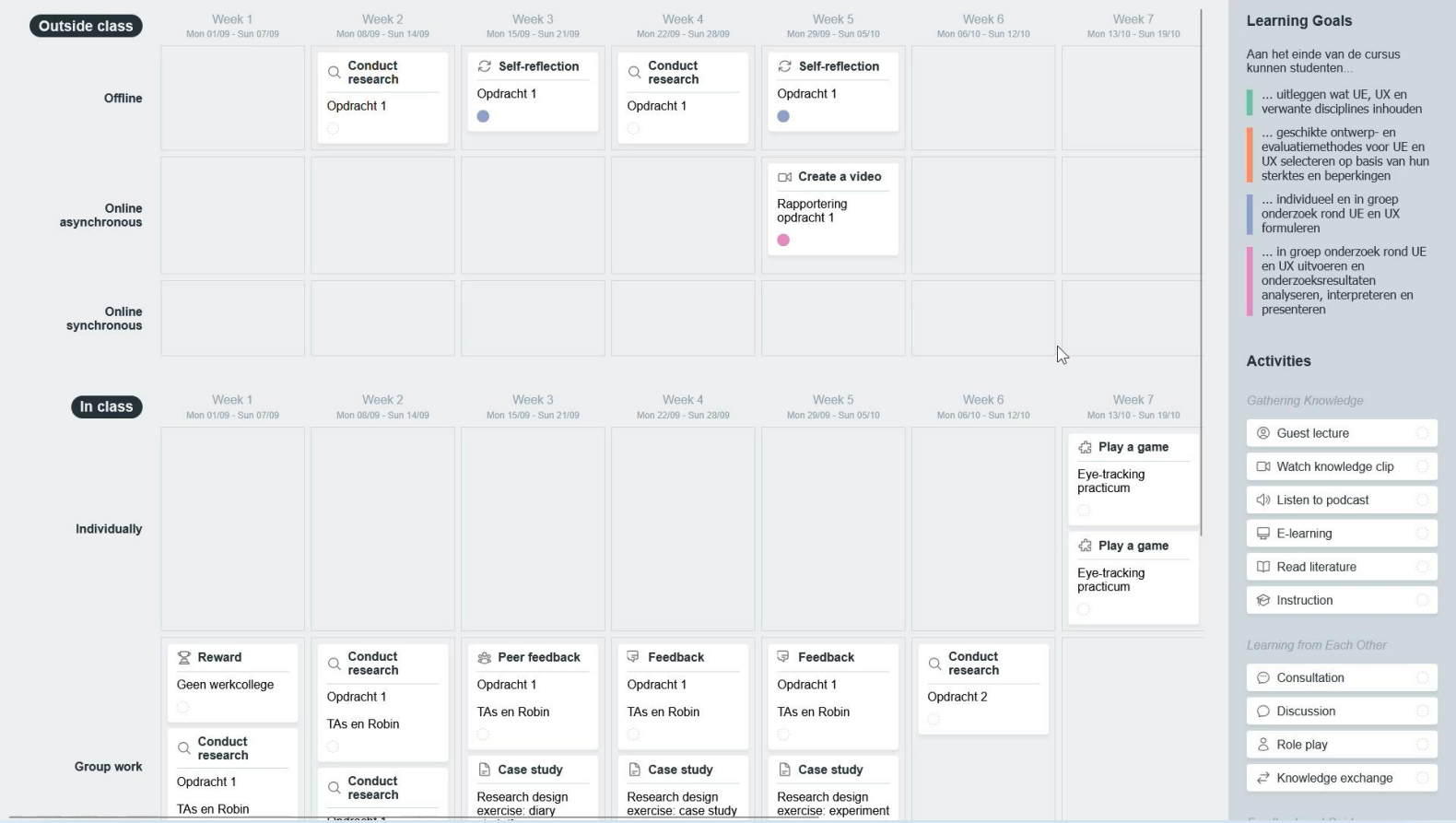
Ongoing project: adaptive planning



Add explainable recommendations based on blended learning theory to a planner tool

e.g., can teachers more efficiently plan blended courses?


TIME FOR
QUESTIONS

How can AI systems help with differentiation?

1 Adaptation

2 Transparency

3 Motiva

About fake whiskey, Elo ratings, and spying dashboards

How can AI systems help with differentiation?

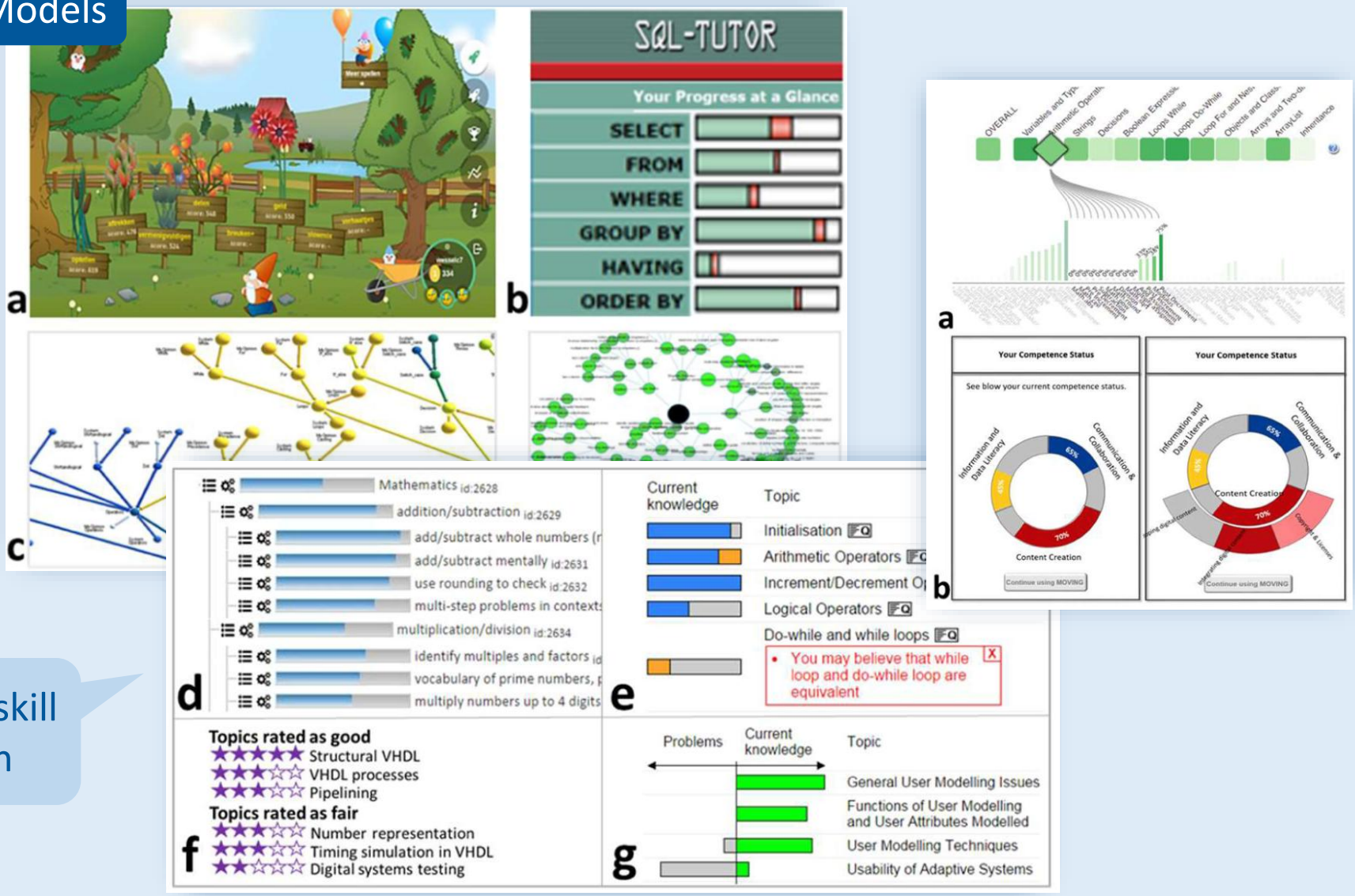
1 Adaptation

2 Transparency

3 Motivation

About seeing what you master,
explaining AI decisions, and control

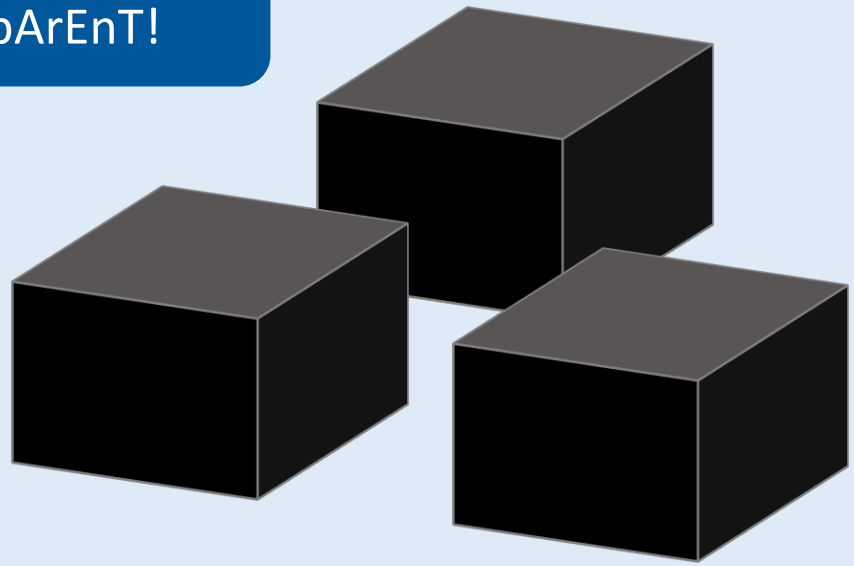
Open Learner Models



Algorithmic skill estimation

Susan Bull. 2020. There are Open Learner Models About! *IEEE Transactions on Learning Technologies* 13, 2: 425–448. https://doi.org/10.1109/TLT.2020.2978473

We need to make AI black boxes TrAnSpArEnT!

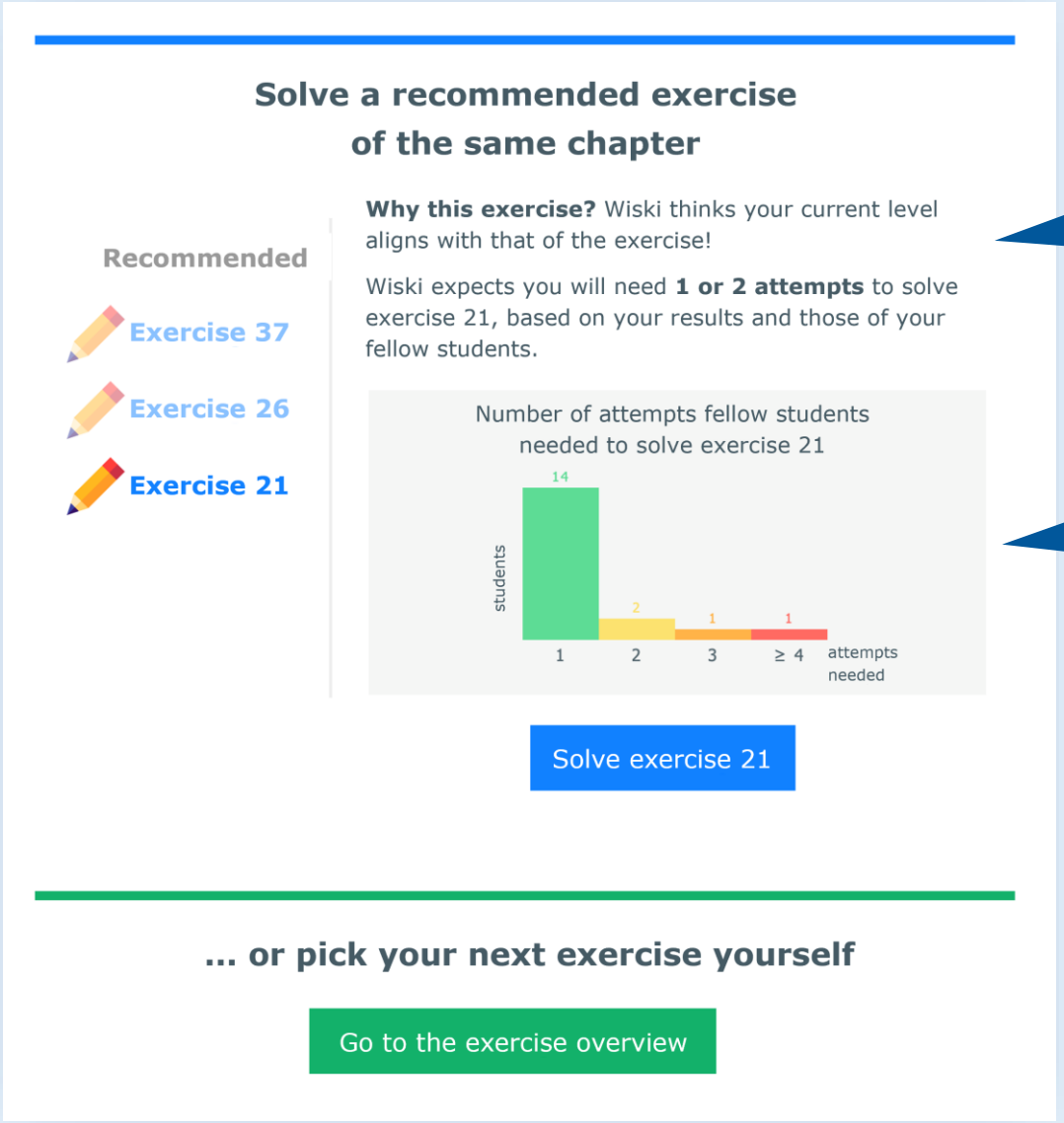


Explanations + Control + Human-Centred

Explanations + Control + Human-Centred

Design explanations and control mechanisms for/with a specific audience and **evaluate** how they affect behaviours

(e.g., trust, understanding, motivation, learning)



Textual explanation

Visual explanation

Explanations: *why* explanations for recommendations

Control: choose next exercises

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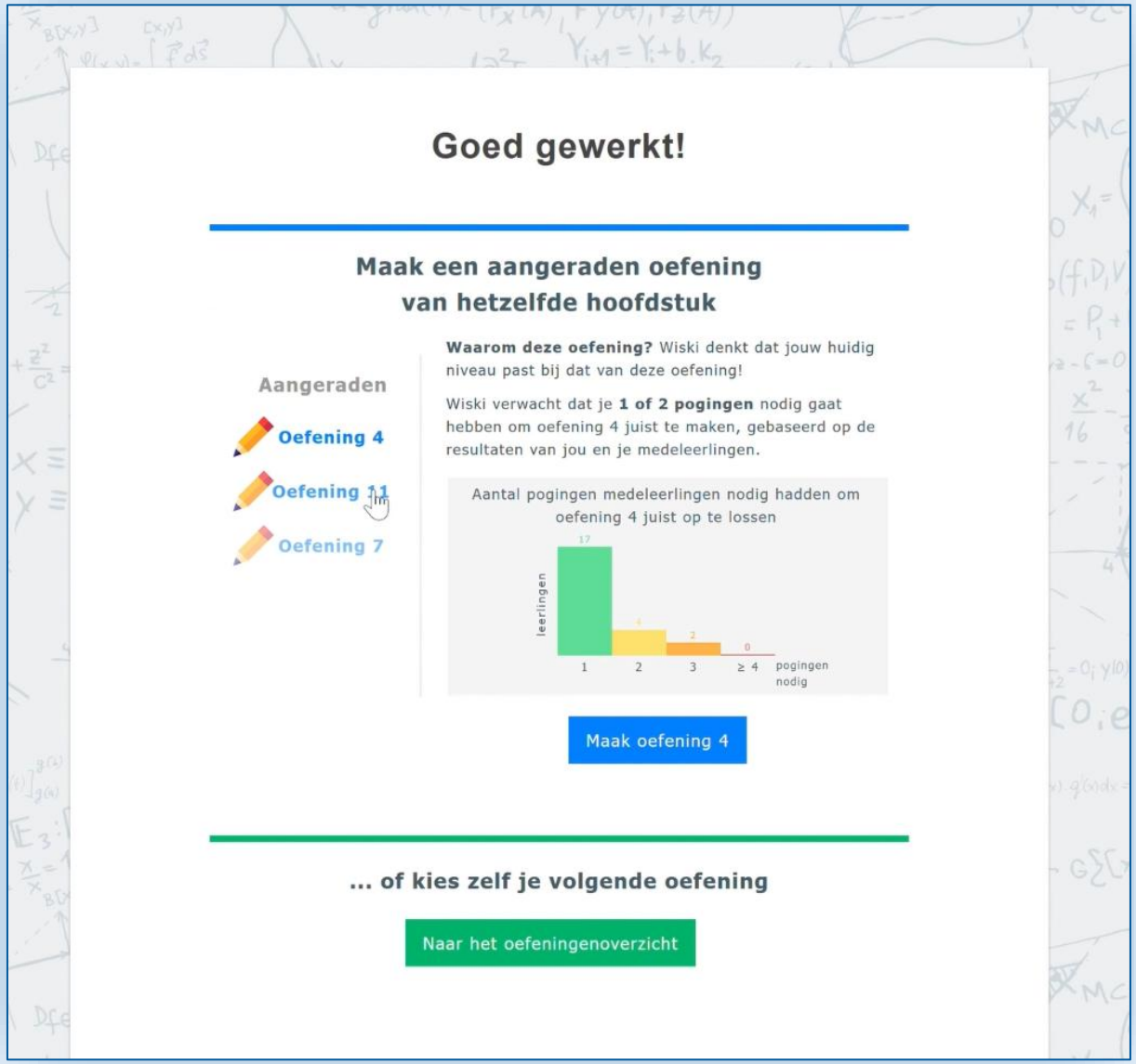

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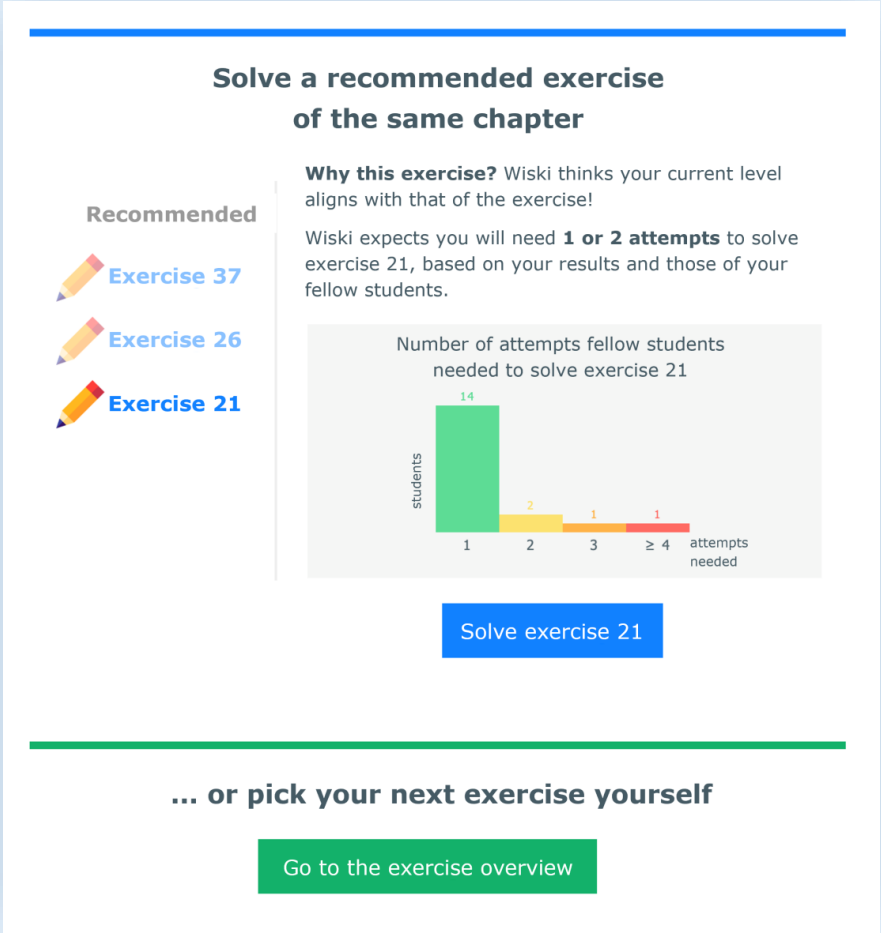
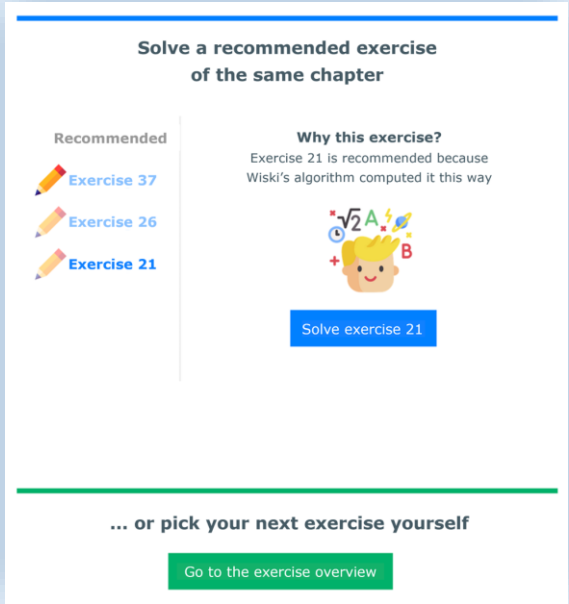
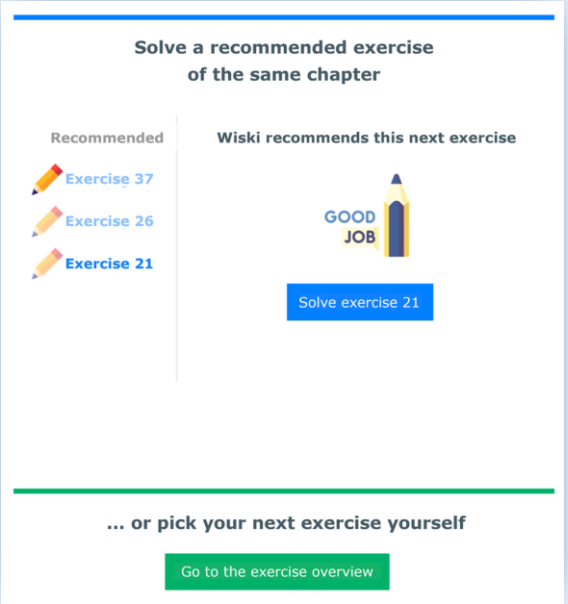
How was trust in the platform affected?



Real explanation



Placebo explanation



No explanation

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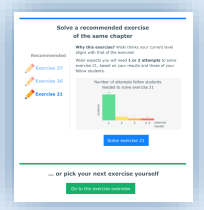

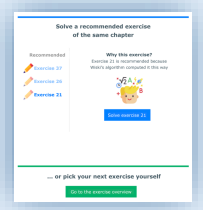

Real vs no explanation

trust increased

trust unchanged

trust decreased

Placebo vs no explanation

trust increased

trust unchanged

trust decreased

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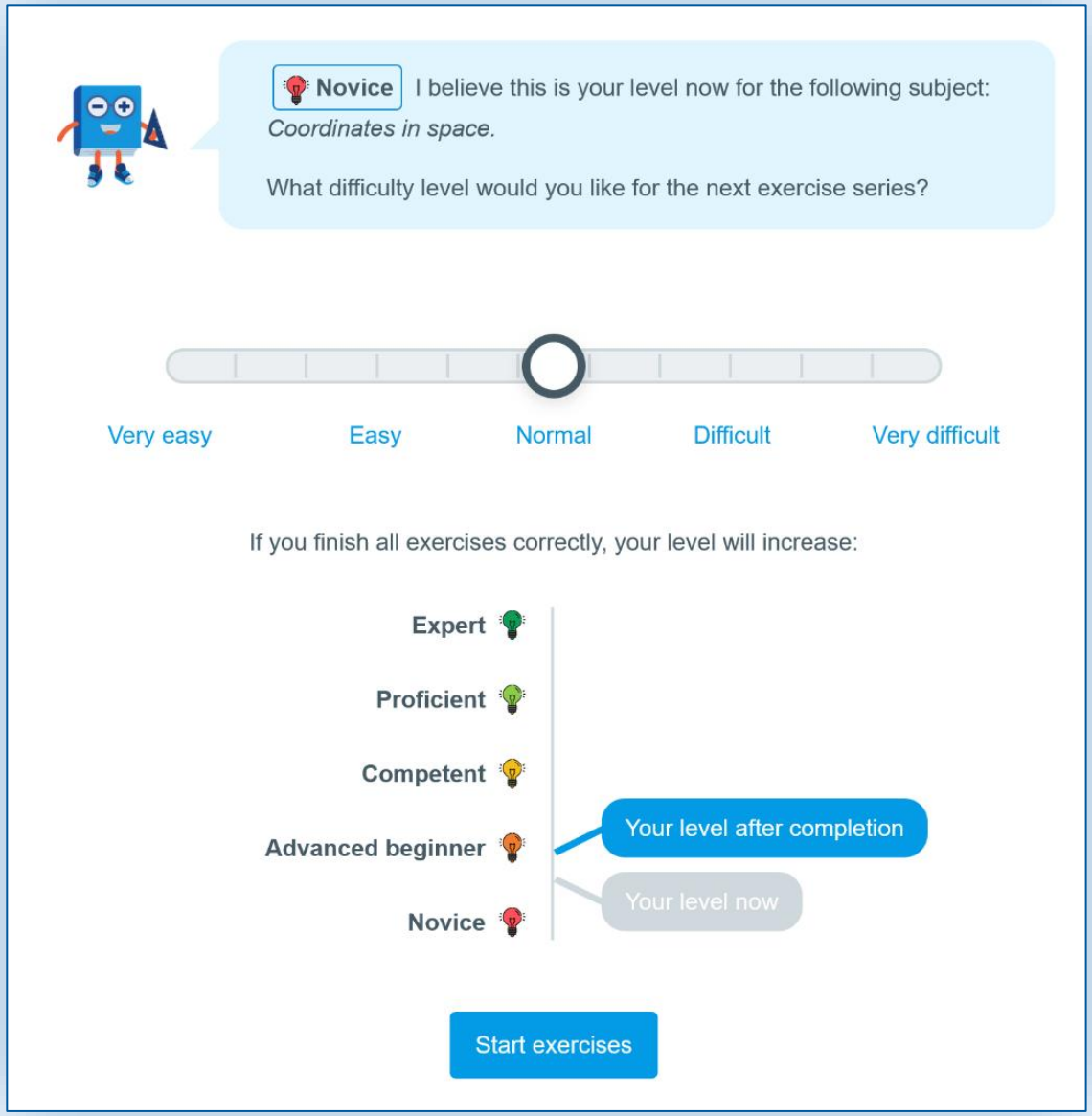

Control: choose difficulty of recommended exercises series

Explanations: real-time *what-if* explanations ("how does my level change if I solve this series correctly?")

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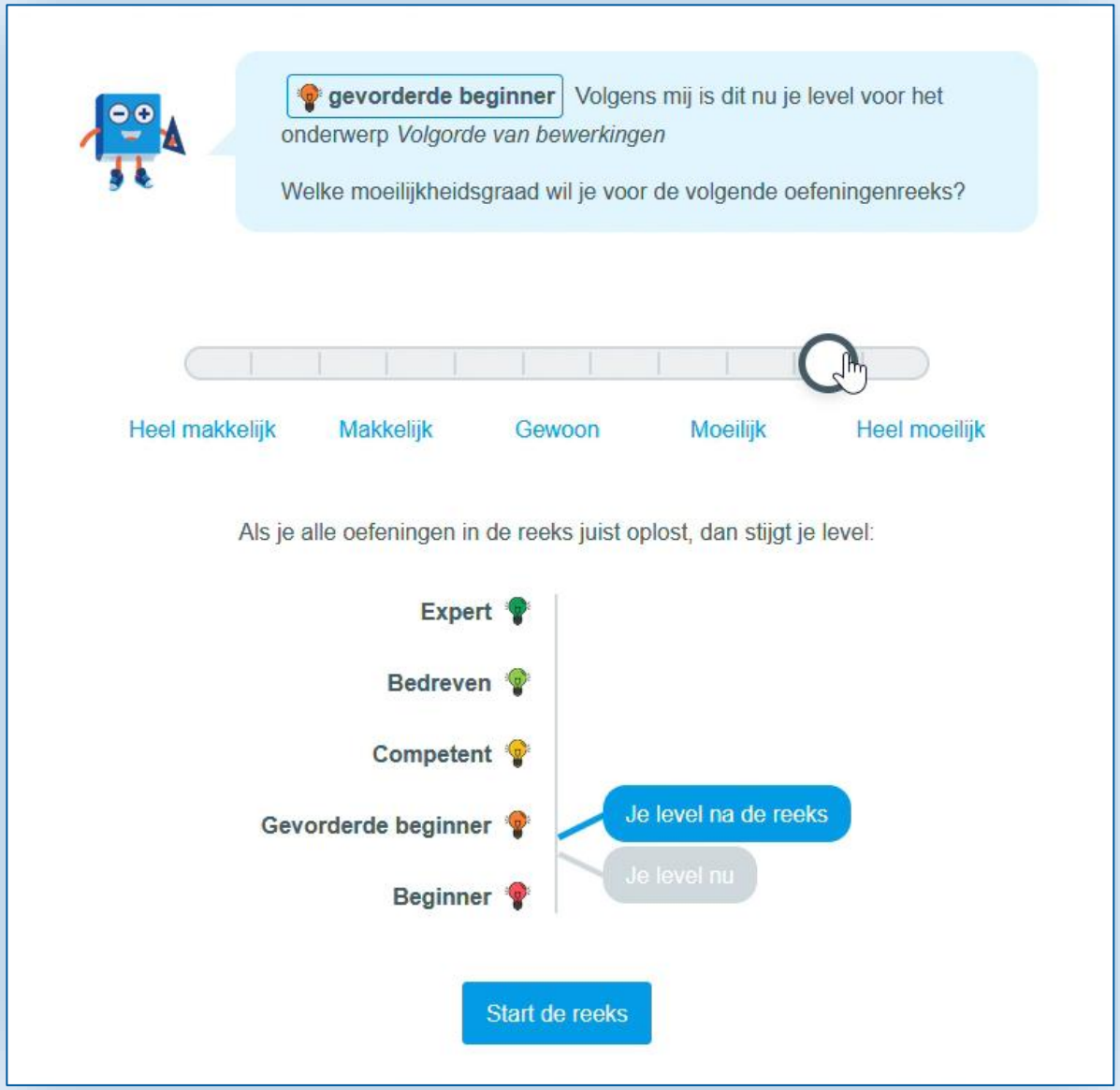

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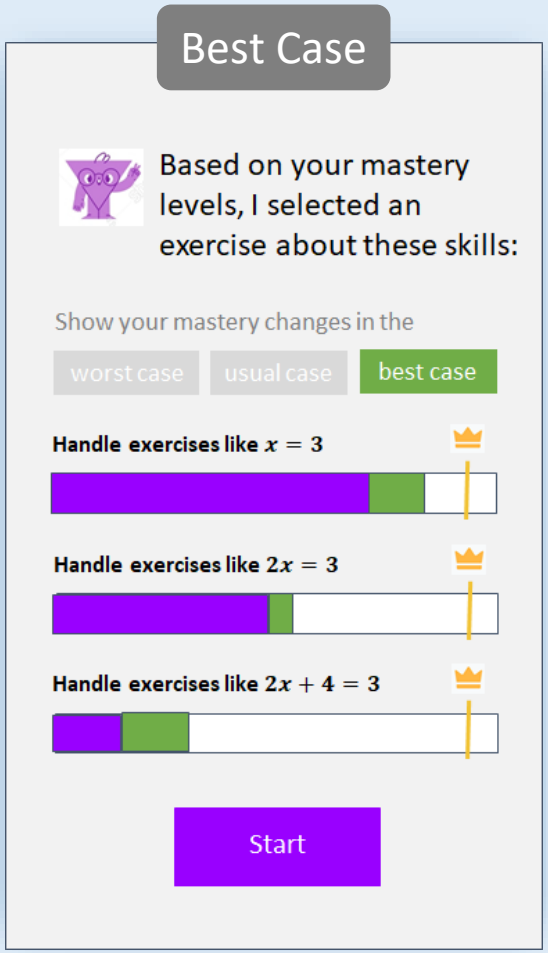
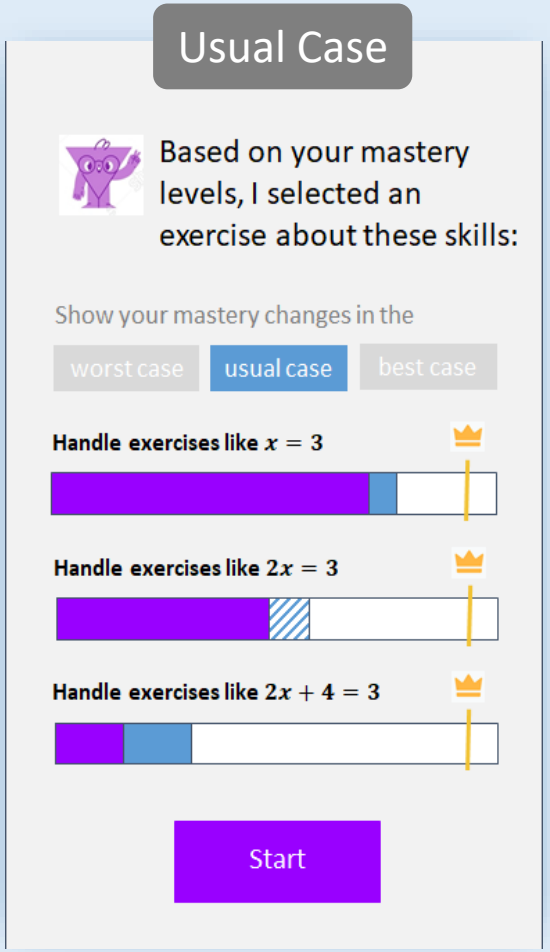
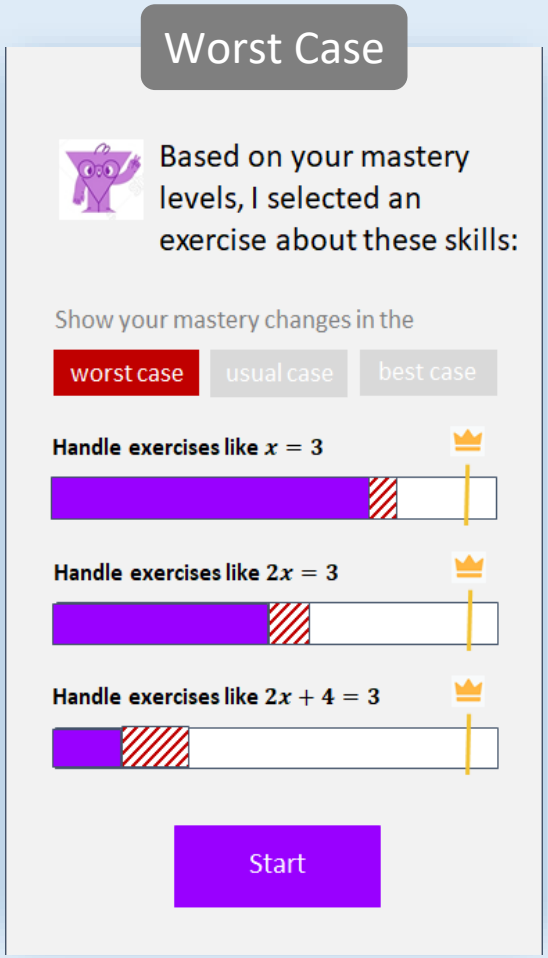
What-if explanations







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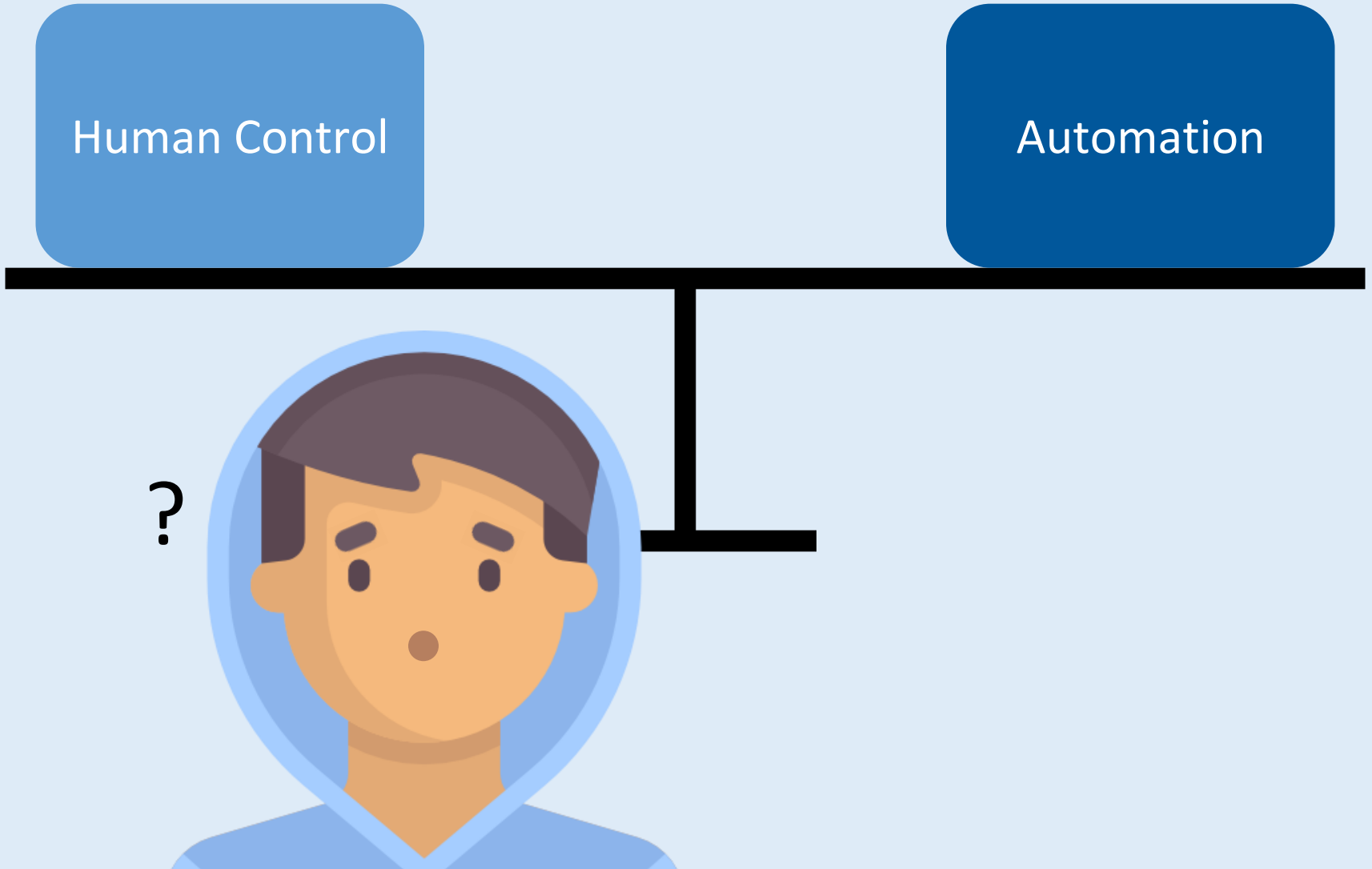
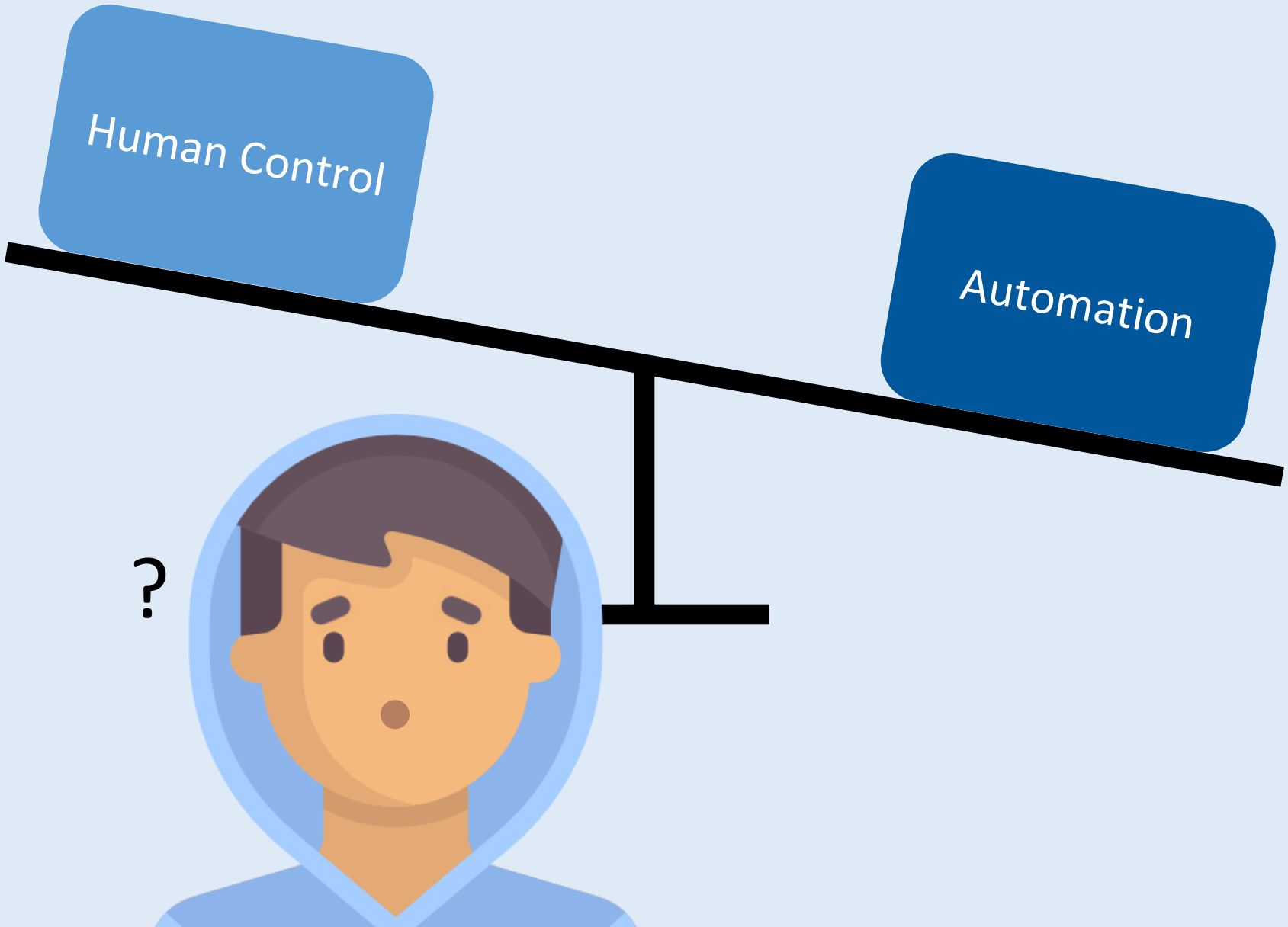

Human Control
Automation
?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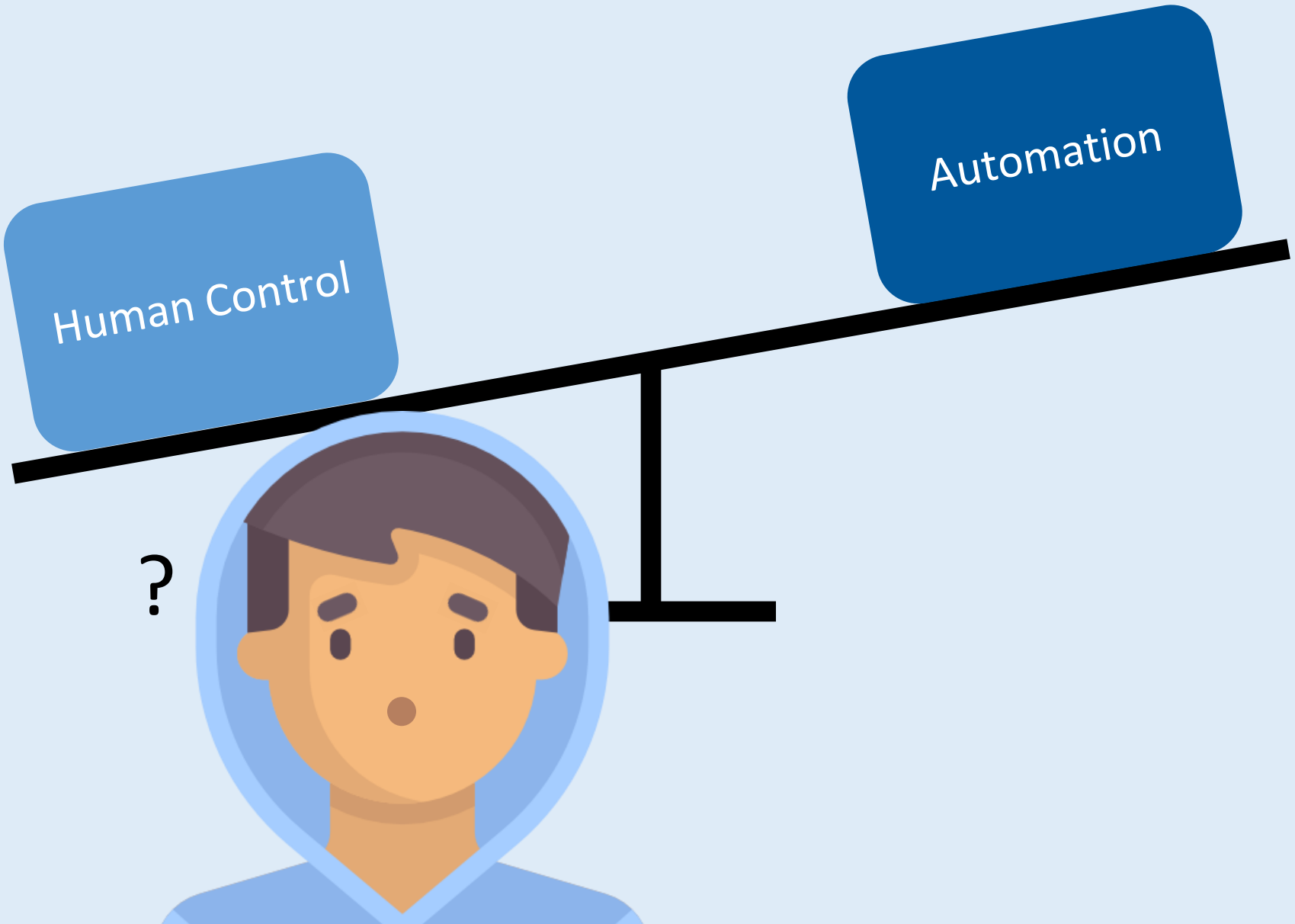
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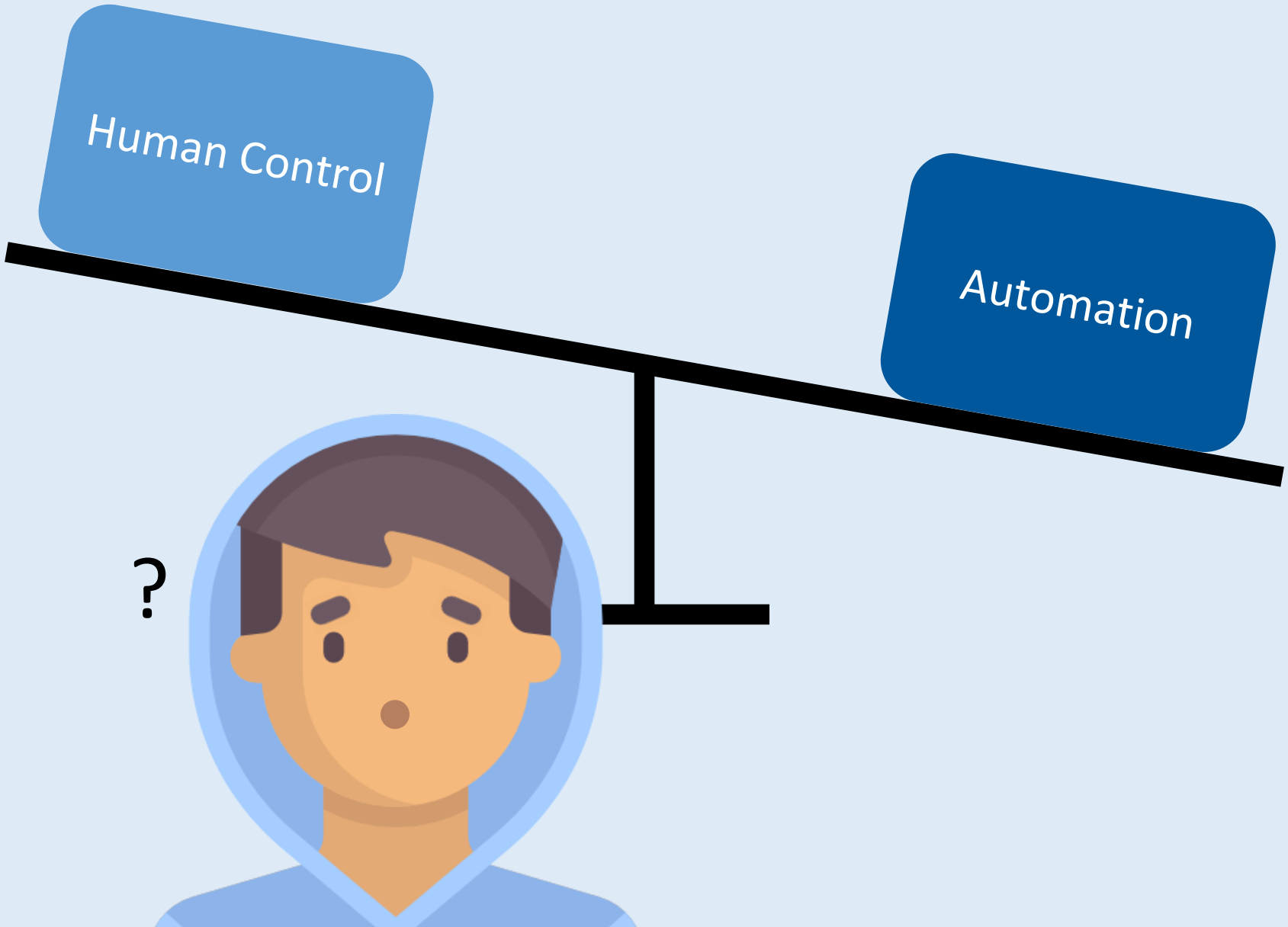
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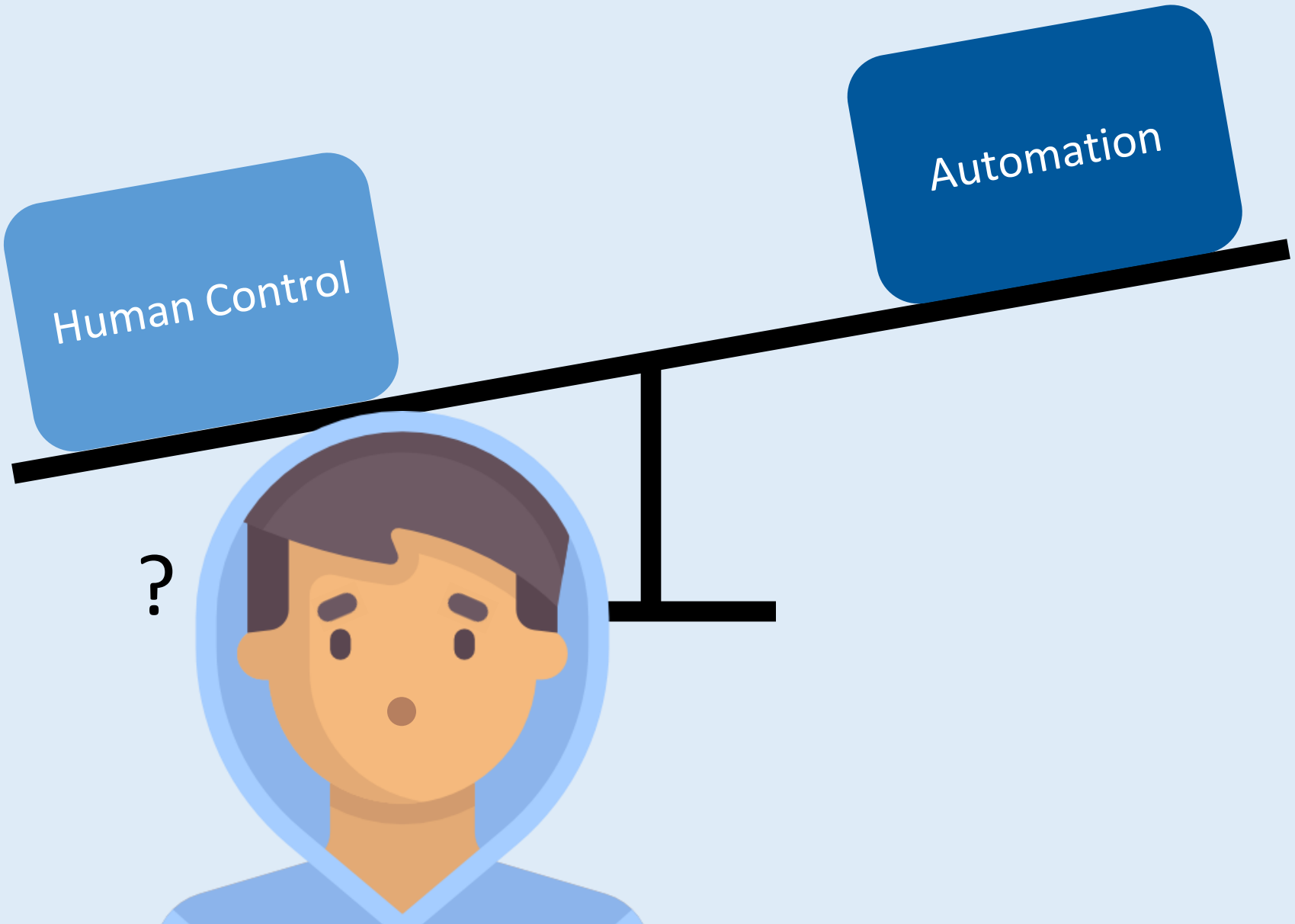
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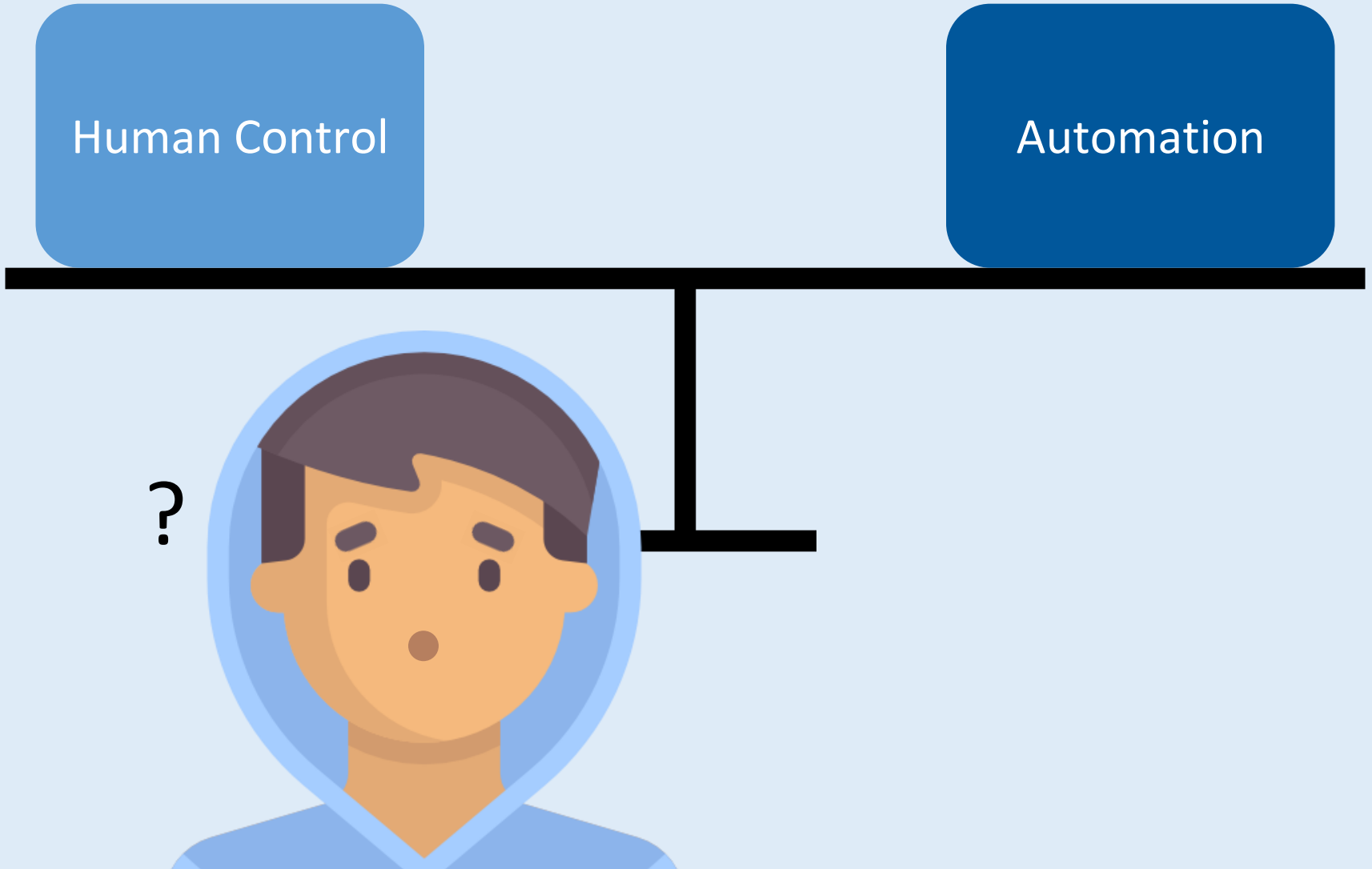
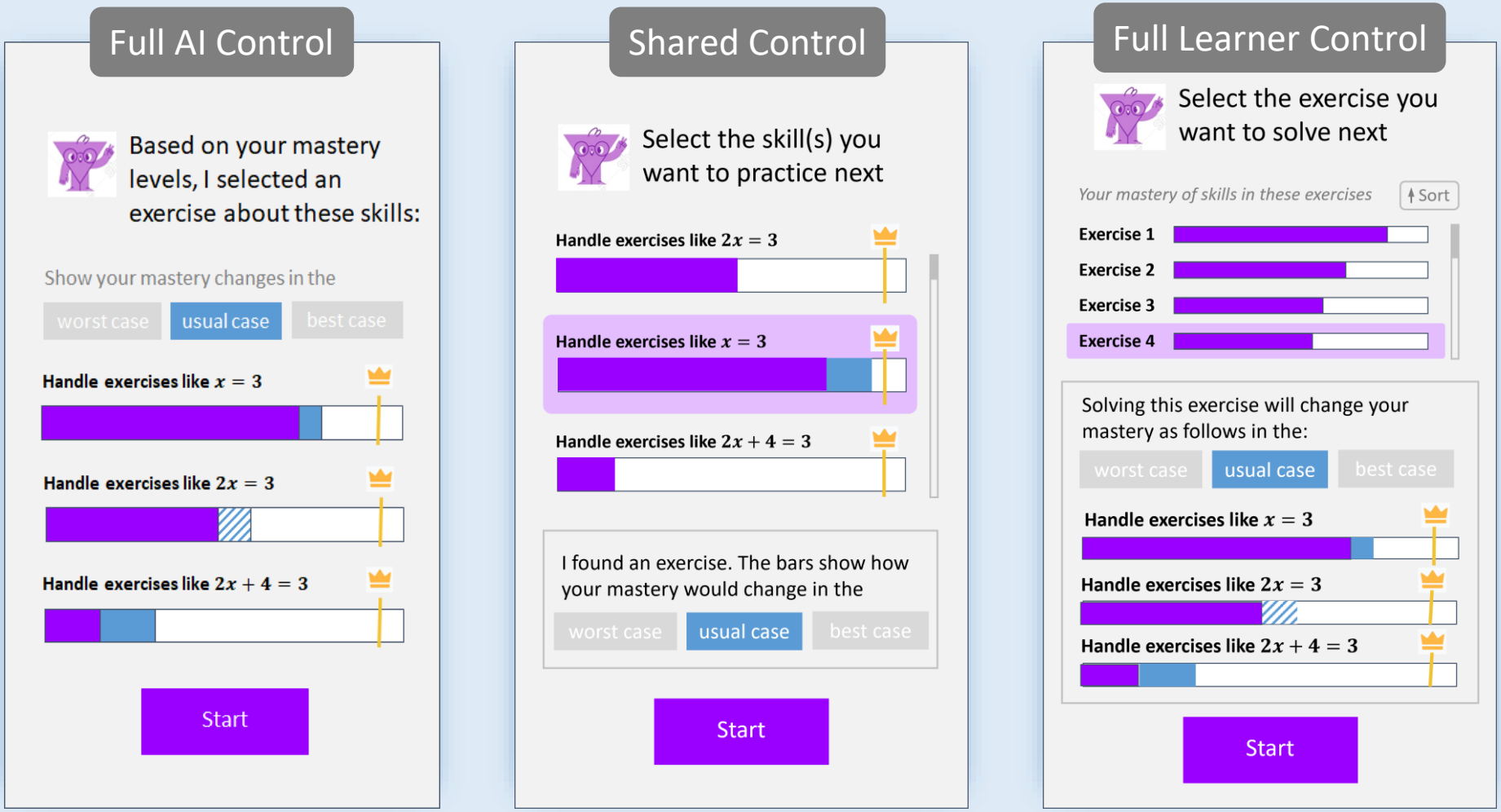

Human Control
Automation
?

Sharing control with recommender systems



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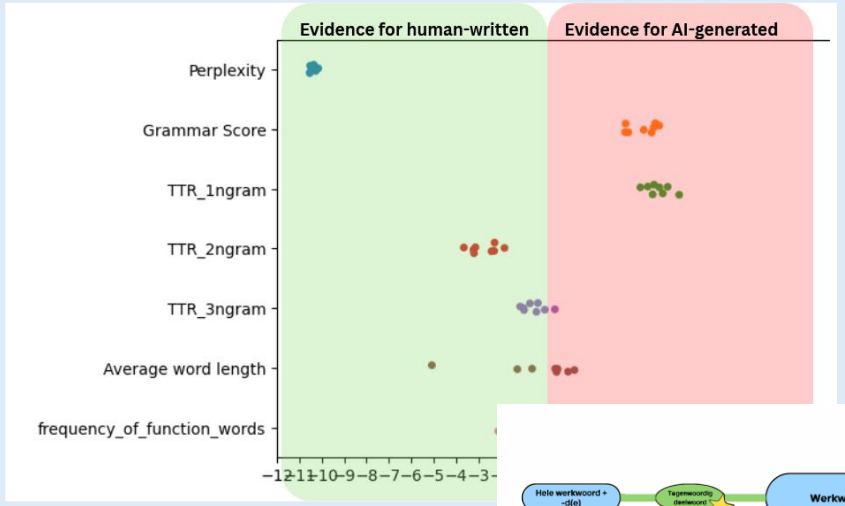
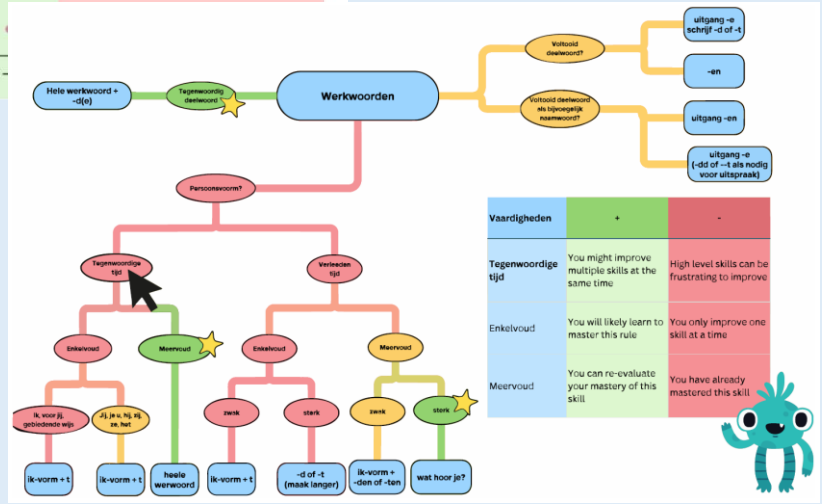
Ongoing project: evaluative AI



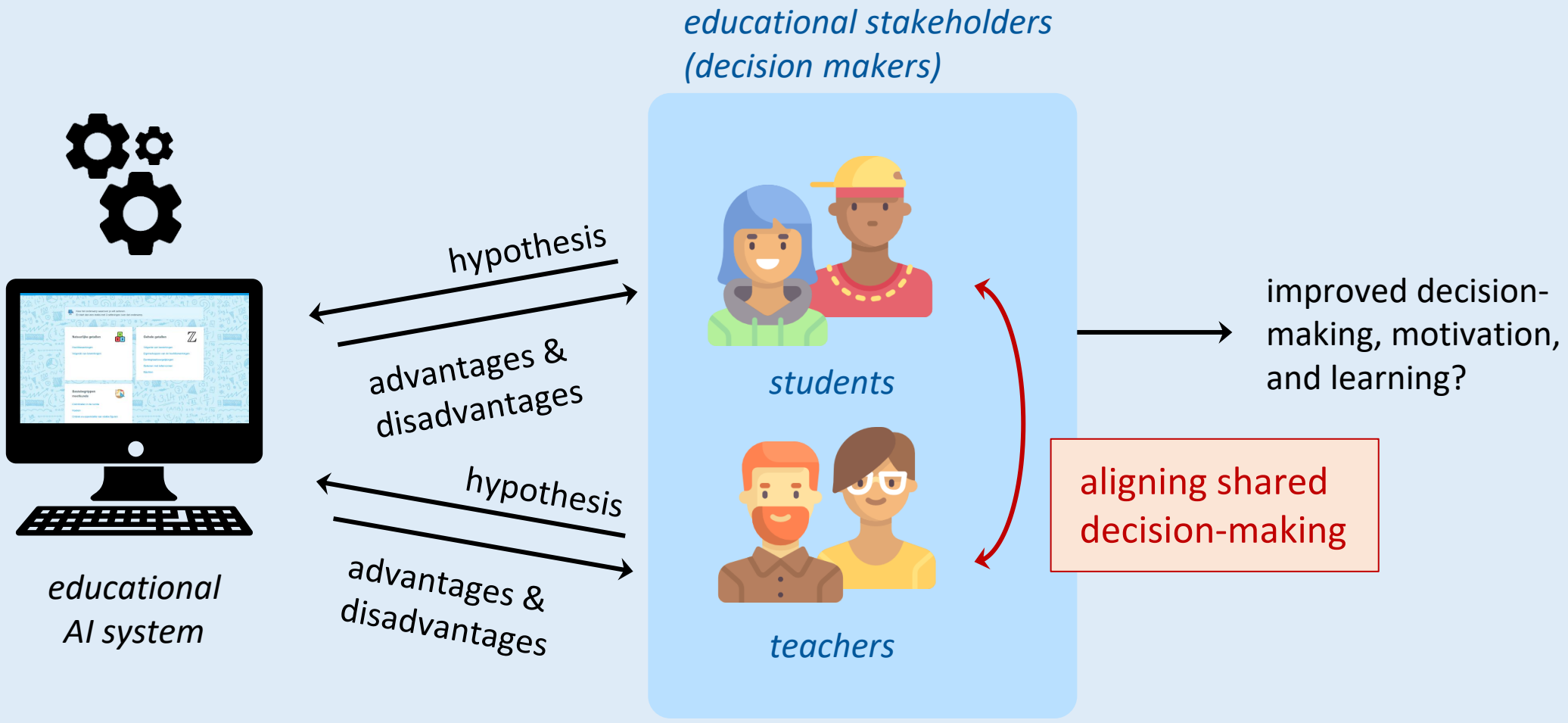
AI detection support in texts for teachers



Control for students over learning path

Marie-Sophie Simon
m.c.simon@uu.nl

Ongoing project: multi-stakeholder evaluative AI




TIME FOR
QUESTIONS

How can AI systems help with differentiation?

1 Adaptation

2 Transparency

3 Motivation

About seeing what you master and explaining AI decisions

How can AI systems help with differentiation?

1 Adaptation

2 Transparency

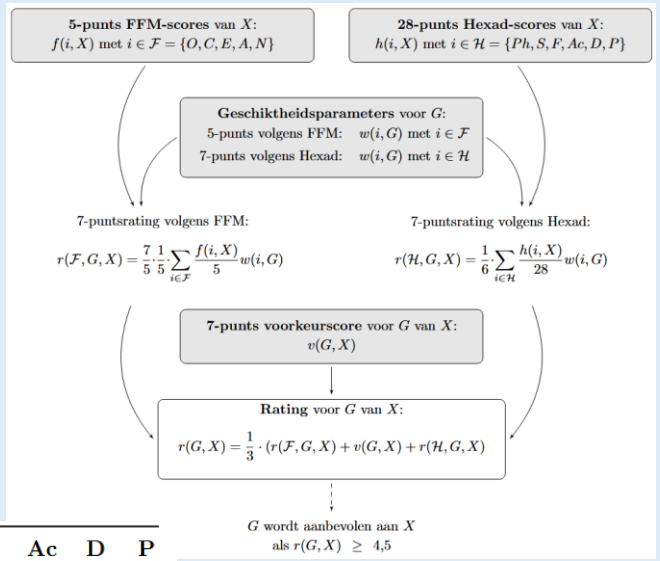
3 Motivation

About cool gamification and comparing yourself to others

Gamification needs to be personalised

Hexad gamification user types

Adapt gamification based on personality, Hexad profile, and preferences

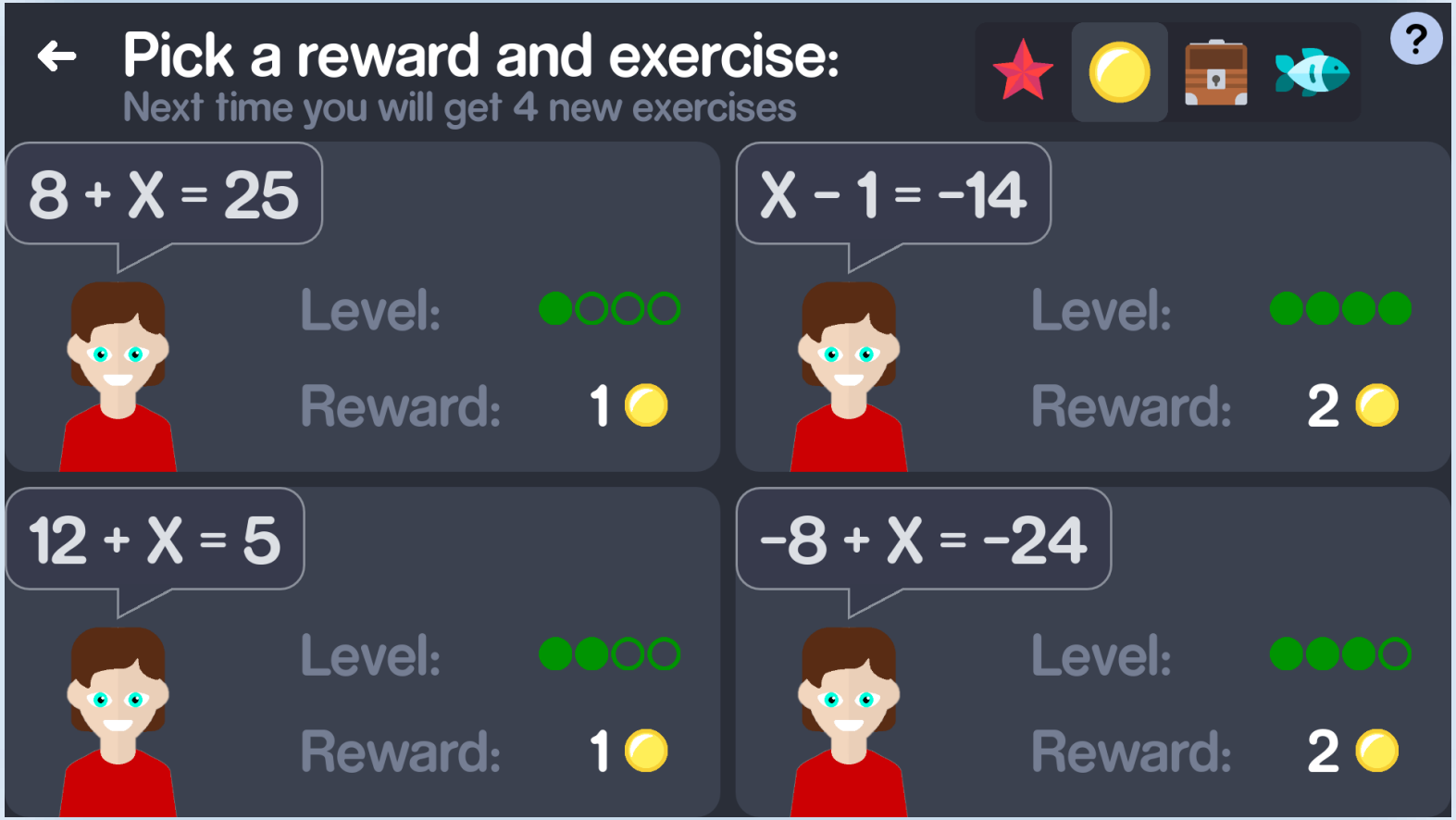


	O	C	E	A	N	Ph	S	F	Ac	D	P
Punten	5a	3	4c	3	4c	4	6c	5b	5b	5c	7a
Puntenklassement	3	4c	5a	4c	3	4	7a	5b	6a	6b	6a
Oefeningenklassement	3	4c	5a	4c	3	4	7a	5b	6a	6b	6a
Day streak	3	4c	3	3	5c	5a	5b	5b	5c	4	6b
Helpen	3	4c	4a	5c	3	7a	6a	5b	6a	5b	6b
Verrassingen	4c	4c	4c	3	5c	5a	5b	7a	7a	5a	7a
Uitdagingen	4c	4c	3	4c	2c	5b	4	7b	7a	5a	6a
Motiverende feedback	5a	3	4d	3	3	4	4	5b	4	5b	5b

Maximilian Altmeyer, Gustavo F. Tondello, Antonio Krüger, and Lennart E. Nacke. 2020. HexArcade: Predicting Hexad User Types By Using Gameful Applications. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play* (CHI PLAY '20), 219–230. https://doi.org/10.1145/3410404.3414232

Jeroen Ooge. 2019. Het personaliseren van motivationele strategieën en gamificationtechnieken m.b.v. recommendersystemen. Master's thesis, KU Leuven. https://jeroenooge.be/research/masters-thesis-personalising-motivational-strategies-and-gamification-techniques

Jeroen Ooge*, Joran De Braekeleer*, and Katrien Verbert. 2024. Nudging Adolescents Towards Recommended Maths Exercises with Gameful Rewards. In: Artificial Intelligence in Education. AIED 2024. Lecture Notes in Computer Science, vol 14830. Springer, Cham. https://jeroenooge.be/alchemath



Difficulty for the learner

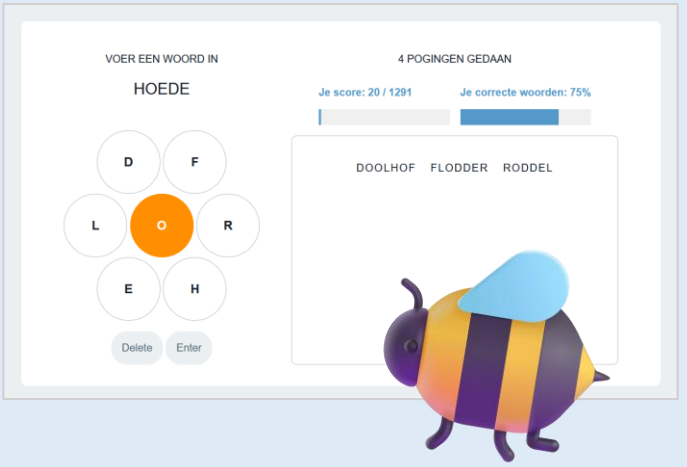
Reward for a correct answer

Transparency: difficulty labels

Control: choose next exercise while being nudged

Jeroen Ooge*, Joran De Braekeleer*, and Katrien Verbert. 2024. Nudging Adolescents Towards Recommended Maths Exercises with Gameful Rewards. In: Artificial Intelligence in Education. AIED 2024. Lecture Notes in Computer Science, vol 14830. Springer, Cham. https://doi.org/10.1007/978-3-031-64299-9_28

Ongoing project: social comparison



People have many reasons to compare themselves

seeing yourself below average = 😟

seeing yourself above average = 🙂

Fleur Leenders. To compare or not to compare oneself? Studying the effect of motivation, affect, and comparison direction. Bachelor's thesis, Utrecht University, 2025. Paper under review. ☝️

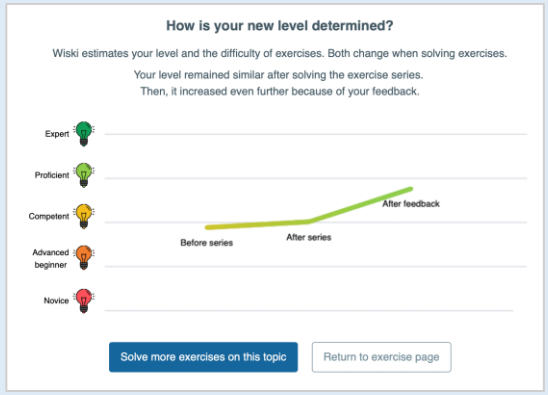

TIME FOR
QUESTIONS

How can AI systems help with differentiation* in education?

*in the sense of individualisation/personalisation

Make learning experiences more
1 adaptive, 2 transparent, and 3 motivating

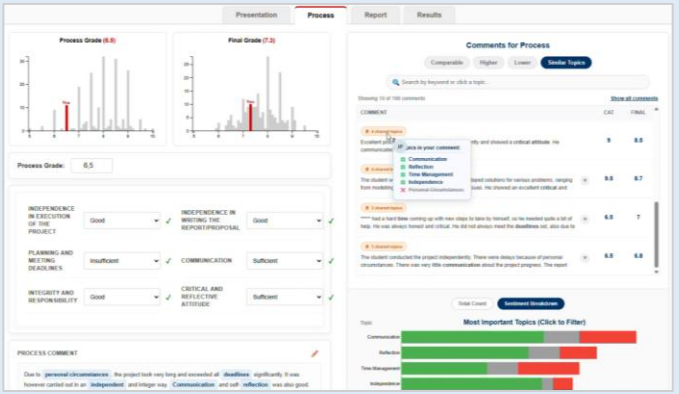
I did and do much more research

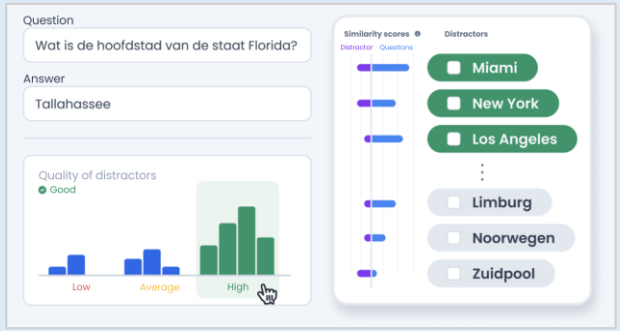


Trust effects of steering recommended exercises

https://doi.org/10.1145/3581641.3584046

Visual analytics to support grading (ongoing)





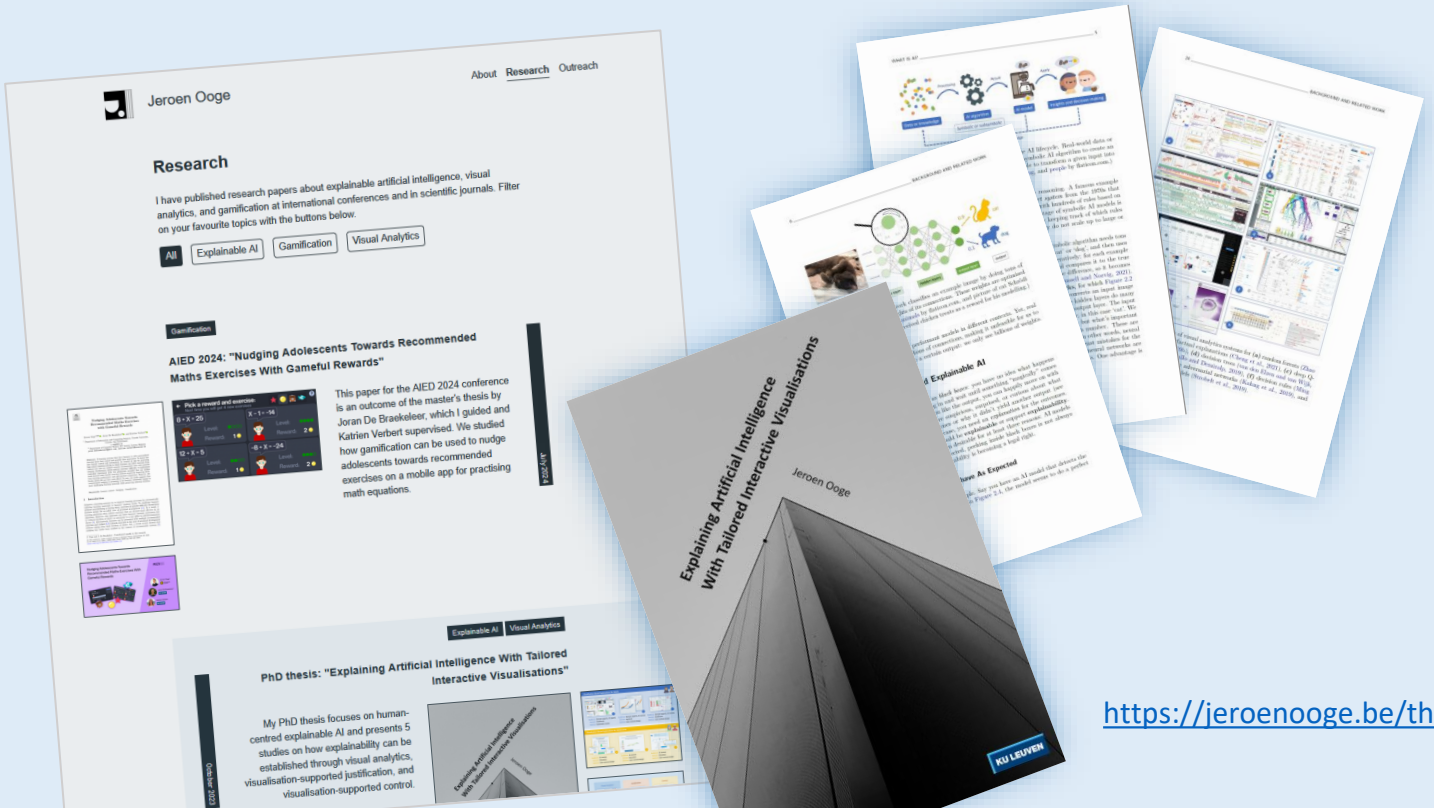
Help teachers create new content

https://doi.org/10.1145/3636555.3636933

XAI-related work in other domains

https://doi.org/10.1145/3636555.3636933, https://doi.org/10.1002/widm.1427

Check out **jeroenooge.be** and reach out for projects together!



https://jeroenooge.be/thesis