


# Explaining Recommendations in E-Learning: Effects on Adolescents' Trust



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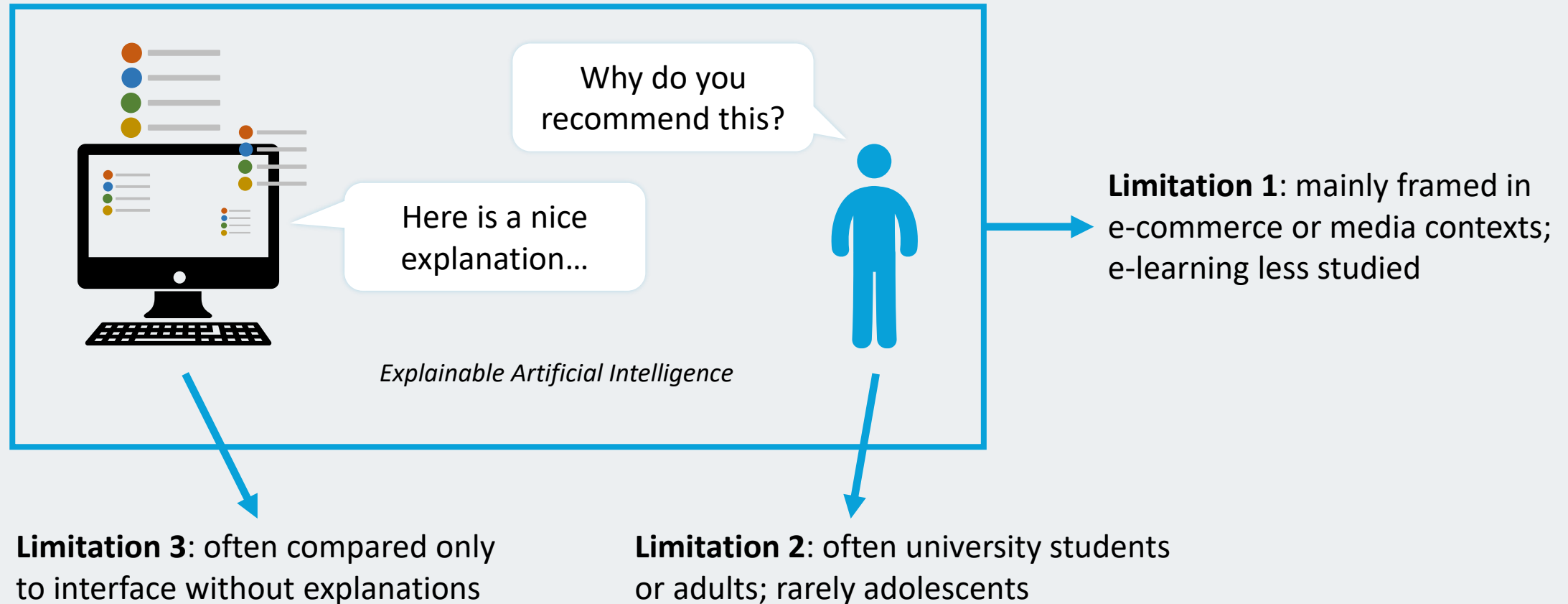
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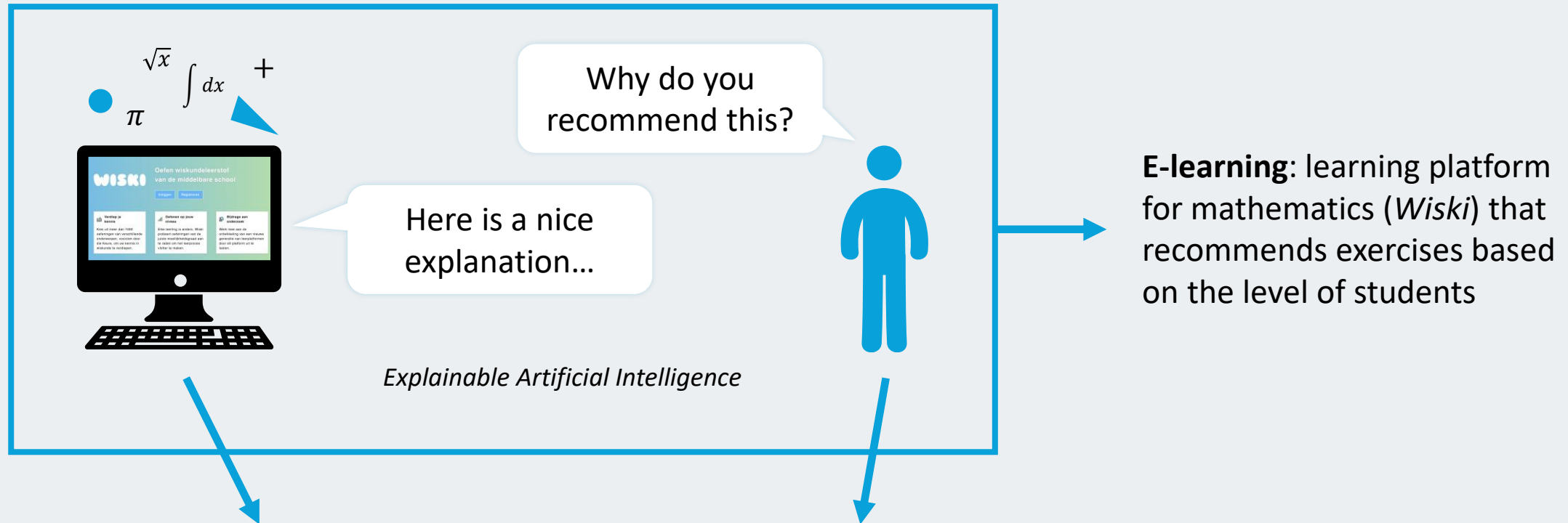
**KU LEUVEN**

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# Current studies for explaining recommendations are limited



# We address limitations of previous studies

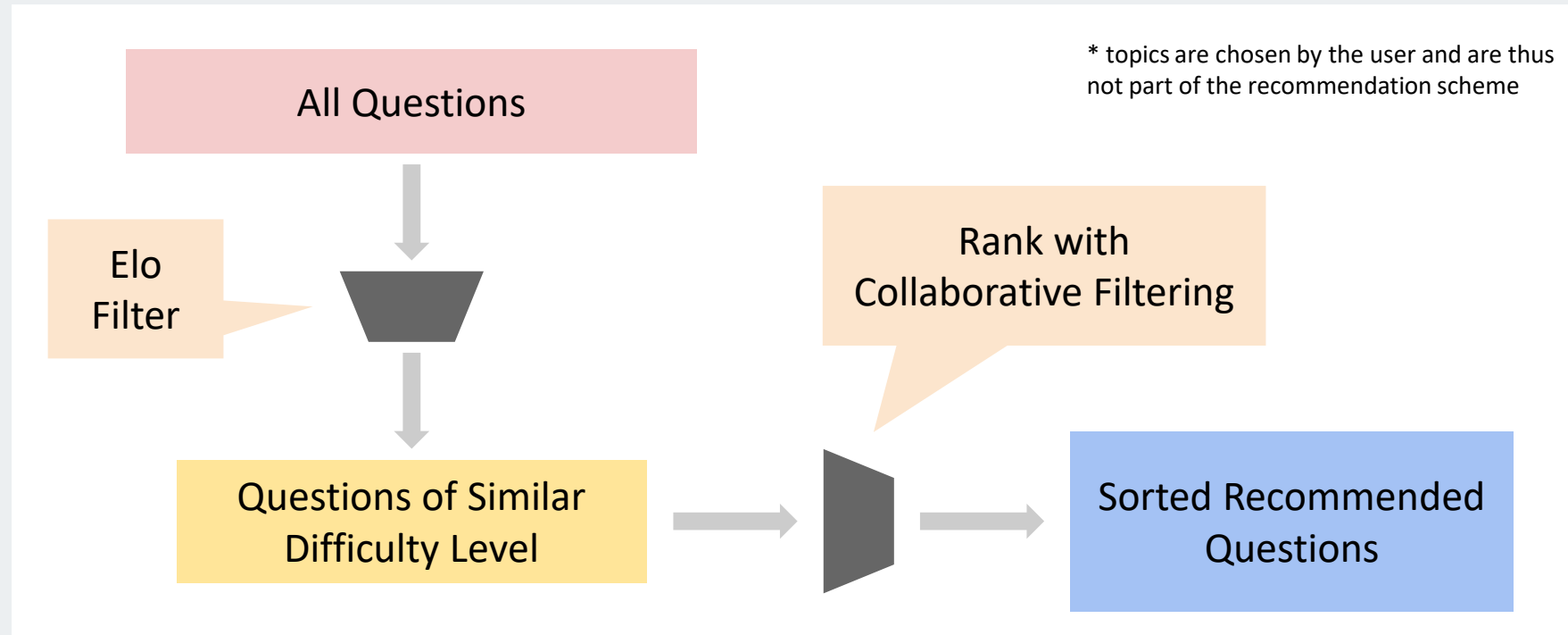


**Two baselines:** compare to interfaces without explanations *and* placebo explanations

**Adolescents:** middle and high school students

**RQ.** How do (placebo) explanations affect initial trust in *Wiski* for recommending exercises?

# Recommending with Elo ratings and collaborative filtering



# User-centred design of explanations: 3 iterations & think-alouds

**Hoe kiezen wij de aangeraden oefening voor jou?**

Stap 1/3  
Wij zoeken naar studenten die gelijkaardige resultaten behaald als jou.  
Met gelijkaardige resultaten bedoelen we dat deze studenten dezelfde oefeningen juist of fout hadden als jou.

Stap 2/3  
Wij bekijken dan hoe zij presterden op de oefeningen die jij nog niet gemaakt hebt.

Stap 3/3  
Op basis van deze informatie kiezen wij de nuttigste oefening uit voor jou!

Verwachte slaagkans voor jou: Oef 1 (100%), Oef 3 (23%), Oef 5 (66%).

Aangeraden: Oefening 5

VORIGE PAGINA | VOLGENDE PAGINA

Tutorial for full transparency



**Oefening 5 voltooid! Jij had 1 poging nodig.**

De volgende oefeningen zijn aangeraden voor jou!

**Aangeraden**  
Oefening 25  
Waarom? 57% van je medestudenten met gelijkaardige prestaties hadden deze vraag vanaf de eerste poging juist!  
Hoeveel pogingen hebben gelijkaardige studenten nodig? Oef 25  
1/3 aangeraden oefeningen

**Uitdaging Nodig?**  
Oefening 19  
Hoeveel pogingen hebben gelijkaardige studenten nodig? Oef 19

Ik kies zelf mijn volgende oefening | Terug naar Oefeningenoverzicht

Single-screen explanation



**Goed gewerkt!**

**Maak een aangeraden oefening van hetzelfde hoofdstuk**  
Waarom deze oefening? Wiki denkt dat jouw huidige niveau past bij dat van deze oefening!  
Wiki verwacht dat je 1 of 2 pogingen nodig gaat hebben om oefening 32 juist te maken, gebaseerd op de resultaten van jou en je medeleerlingen.

Aangeraden:  
Oefening 32  
Oefening 42  
Oefening 3

Aantal pogingen medeleerlingen nodig hadden om oefening 32 juist op te lossen

Maak oefening 32

... of kies zelf je volgende oefening  
Near het oefeningenoverzicht

Final explanation interface

## Maak een aangeraden oefening van hetzelfde hoofdstuk

Aangeraden

Oefening 37

Oefening 26

Oefening 21

1

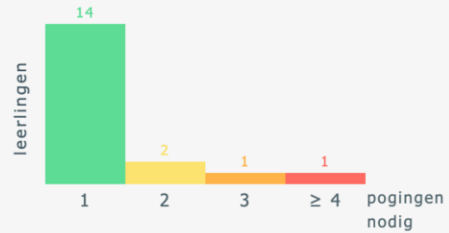
**Waarom deze oefening?** Wiski denkt dat jouw huidig niveau past bij dat van deze oefening!

2

Wiski verwacht dat je **1 of 2 pogingen** nodig gaat hebben om oefening 21 juist te maken, gebaseerd op de resultaten van jou en je medeleerlingen.

3

Aantal pogingen medeleerlingen nodig hadden om oefening 21 juist op te lossen



Maak oefening 21

... of kies zelf je volgende oefening

Naar het oefeningenoverzicht

Why?

Justification

Comparison with others

Real explanation

## Maak een aangeraden oefening van hetzelfde hoofdstuk

Aangeraden

Oefening 27

Oefening 40

Oefening 45

**Waarom deze oefening?**

Oefening 27 is aangeraden omdat het algoritme van Wiski dat zo heeft berekend.



Maak oefening 27

... of kies zelf je volgende oefening

Naar het oefeningenoverzicht

Placebo explanation

## Maak een aangeraden oefening van hetzelfde hoofdstuk

Aangeraden

Oefening 27

Oefening 40

Oefening 45

**Wiski raadt de volgende oefening aan**

GOOD JOB



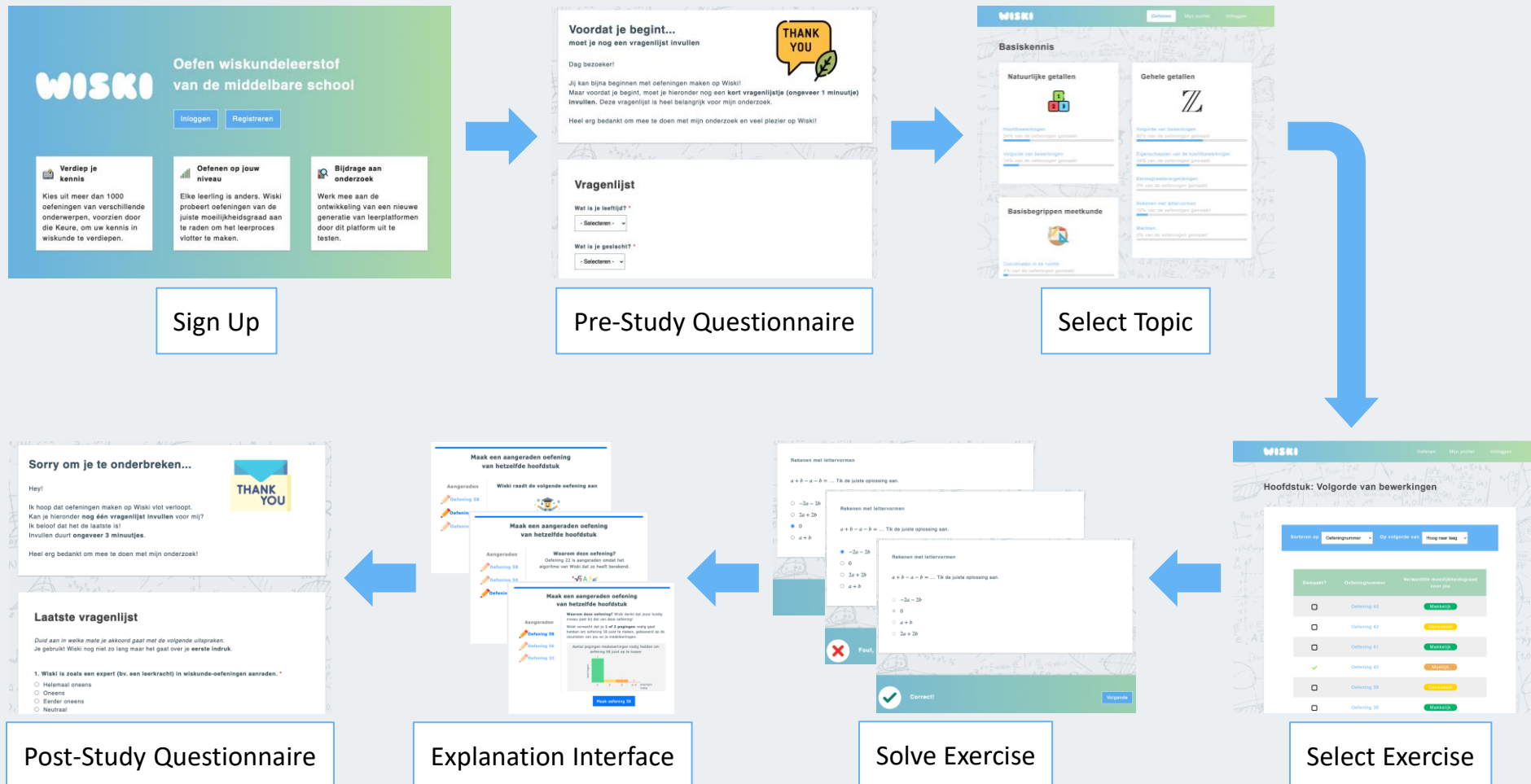
Maak oefening 27

... of kies zelf je volgende oefening

Naar het oefeningenoverzicht

No explanation

# Randomised controlled experiment for 3 explanation interfaces



# How do (placebo) explanations affect initial trust in *Wiski* for recommending exercises?

## Direct measurements

7-point Likert-type questions and open comments

**Multidimensional trust**

Trusting beliefs

| Competence              |   |
|-------------------------|---|
| Q1                      | Wiski is like an expert (for example, a teacher) for recommending math exercises.                             |
| Q2                      | Wiski has the expertise (knowledge) to estimate my math level.  |
| Q3                      | Wiski can estimate my math level.   |
| Q4                      | Wiski understands the difficulty level of math exercises well.  |
| Q5                      | Wiski takes my math level into account when recommending exercises.   |
| Benevolence             |   |
| Q6                      | Wiski prioritizes that I improve in math.   |
| Q7                      | Wiski recommends exercises so that I improve in math.   |
| Q8                      | Wiski wants to estimate my math level well.   |
| Integrity               |   |
| Q9                      | Wiski recommends exercises as correctly as possible.  |
| Q10                     | Wiski is honest.  |
| Q11                     | Wiski makes integrous recommendations.  |
| Trust (one-dimensional) |   |
| Q12                     | I trust Wiski to recommend me math exercises.   |
| Intention to return     |   |
| Q13                     | If I want to solve math exercises again, I will choose Wiski.   |
| Q14                     | If I want to be recommended math exercises again, I will choose Wiski.  |
| Perceived transparency  |   |
| Q15                     | I find that Wiski gives enough explanation as to why an exercise has been recommended.                        |
| General questions       |   |
| Q16                     | I do NOT want any explanations about why an exercise has been recommended when I use Wiski.                   |
| Q17                     | I find an explanation for why an exercise is recommended more important than for why a movie is recommended.  |
| Q18                     | I am NOT happy with the level of math exercises Wiski recommended.  |
| Q19                     | I find it important to receive explanations when something (exercise/movie/product/...) has been recommended. |

## Indirect measurements

Log whether students accept recommendations or not

**One-dimensional trust**



# Real explanations...

... did **increase** multidimensional initial trust

... did **not increase** one-dimensional initial trust

... led to **accepting more** recommended exercises

## Main lessons

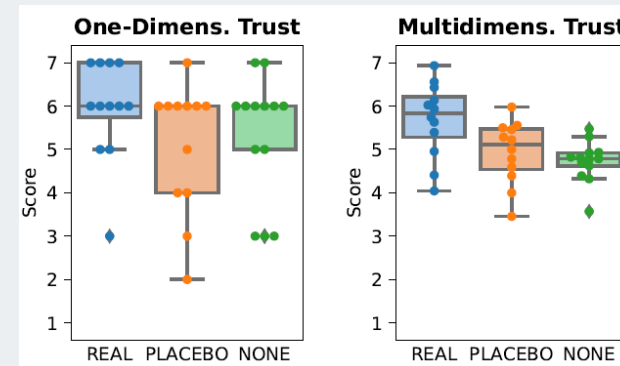
- Multidimensional trust measures are more nuanced than one-dimensional trust measures
- Dynamically learned factors (e.g., perceived accuracy of recommendations, exercises' quality) may be more important than explanations for building initial trust

| (a) REAL vs. NONE      |                 |                 |       |
|------------------------|-----------------|-----------------|-------|
|                        | <i>p</i> -value | <i>U</i> -value | CLES  |
| Competence             | 0.030*          | 113.0           | 0.724 |
| Benevolence            | 0.030*          | 112.5           | 0.721 |
| Integrity              | 0.261           | 90.0            | 0.577 |
| Trusting beliefs       | 0.048*          | 109.0           | 0.699 |
| Intention to return    | 0.109           | 100.5           | 0.644 |
| Perceived transparency | 0.002**         | 130.5           | 0.837 |
| One-dimensional trust  | 0.137           | 97.5            | 0.625 |
| Multidimensional trust | 0.002**         | 131.0           | 0.840 |

\**p* < 0.05, \*\**p* < 0.01, CLES = common language effect size

| (b) REAL vs. PLACEBO   |                 |                 |       |
|------------------------|-----------------|-----------------|-------|
|                        | <i>p</i> -value | <i>U</i> -value | CLES  |
| Competence             | 0.023*          | 106.5           | 0.740 |
| Benevolence            | 0.074           | 97.0            | 0.674 |
| Integrity              | 0.054           | 100.0           | 0.694 |
| Trusting beliefs       | 0.026*          | 106.0           | 0.736 |
| Intention to return    | 0.139           | 90.0            | 0.625 |
| Perceived transparency | 0.041*          | 102.0           | 0.708 |
| One-dimensional trust  | 0.071           | 96.5            | 0.670 |
| Multidimensional trust | 0.013*          | 111.0           | 0.771 |

\**p* < 0.05, CLES = common language effect size



# Placebo explanations...

... did **not increase** initial trust compared to no explanations

... may undermine perceived integrity when used instead of real explanations

... are a **useful baseline**, especially when combined with qualitative data:

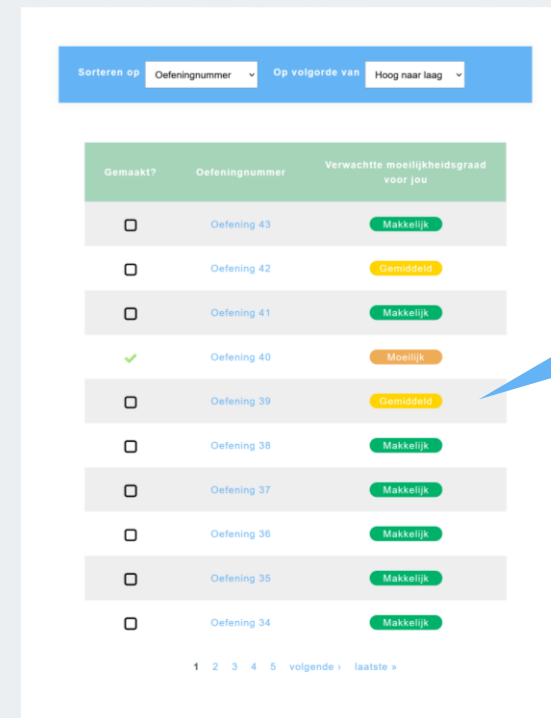
- how critical are students towards explanations?
- how much transparency do students need?

The screenshot shows a user interface for recommending an exercise. At the top, it says "Maak een aangeraden oefening van hetzelfde hoofdstuk". Below this, there is a section titled "Aangeraden" with three options: "Oefening 27", "Oefening 40", and "Oefening 45", each with a pencil icon. To the right, under "Waarom deze oefening?", it explains: "Oefening 27 is aangeraden omdat het algoritme van Wiski dat zo heeft berekend." Below this text is a cartoon character with a lightbulb above its head, surrounded by mathematical symbols like  $\sqrt{2}$ ,  $A$ ,  $B$ , and a plus sign. A blue button labeled "Maak oefening 27" is positioned below the character. At the bottom of the interface, it says "... of kies zelf je volgende oefening" and provides a green button labeled "Naar het oefeningenoverzicht".

# Taking a step back: explanations in e-learning

No explanations may be acceptable in **low-stakes** situations (e.g., drilling exercises): indications of difficulty level might suffice

Tailoring explanations remains important, especially in **high-stakes** situations (e.g., preparing an exam)



The screenshot shows a user interface for an e-learning platform. At the top, there is a blue header with sorting options: 'Sorteren op' (sorted by) 'Oefeningnummer' (exercise number) and 'Op volgorde van' (order) 'Hoog naar laag' (high to low). Below this is a table with three columns: 'Gemaakt?' (Completed?), 'Oefeningnummer' (Exercise number), and 'Verwachte moeilijkheidsgraad voor jou' (Expected difficulty level for you). The table lists exercises 34 through 43. Each row has a checkbox in the 'Gemaakt?' column, the exercise number in the middle, and a difficulty tag in the right column. The tags are color-coded: green for 'Makkelijk' (Easy), yellow for 'Gemiddeld' (Medium), and orange for 'Moeilijk' (Hard). Exercise 40 is marked as completed with a green checkmark and has a 'Moeilijk' tag. Exercise 39 has a 'Gemiddeld' tag. At the bottom of the table, there is a pagination bar with the numbers 1, 2, 3, 4, 5, 'volgende' (next), and 'laatste' (last).

| Gemaakt?                            | Oefeningnummer | Verwachte moeilijkheidsgraad voor jou |
|-------------------------------------|----------------|---------------------------------------|
| <input type="checkbox"/>            | Oefening 43    | Makkelijk                             |
| <input type="checkbox"/>            | Oefening 42    | Gemiddeld                             |
| <input type="checkbox"/>            | Oefening 41    | Makkelijk                             |
| <input checked="" type="checkbox"/> | Oefening 40    | Moeilijk                              |
| <input type="checkbox"/>            | Oefening 39    | Gemiddeld                             |
| <input type="checkbox"/>            | Oefening 38    | Makkelijk                             |
| <input type="checkbox"/>            | Oefening 37    | Makkelijk                             |
| <input type="checkbox"/>            | Oefening 36    | Makkelijk                             |
| <input type="checkbox"/>            | Oefening 35    | Makkelijk                             |
| <input type="checkbox"/>            | Oefening 34    | Makkelijk                             |


Personal level indication:  
*Easy, Medium and Hard* tags

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