Students' Types of Interest in Physics

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Most students can be categorised into **one single type of interest in physics**

Theoretical and Empirical Background

Interest in Physics

"… most studies report a positive effect of context-based science education on students' interest …"

(Habig et al., 2018)

Types of Interest in Physics

The IPN study describes **2 types of interest**
(Sievers, 1999; Rost, Sievers, Häußler, Hoffmann, & Langeheine, 1999)

1. **Generally** and **highly interested**

2. **Highly interested** in relation to **nature** and **humans**, **applications**, and **relevance for society**

Physics?
Only in the **right contexts**!

Research Gap

Previous studies did not …

- describe how interesting different contexts are relative to each other within the **students' different types of interest**.
- include **modern physics content areas,** such as particle physics.

Research Interest and Design

Research Interest

RQ: Into which different **types of interest** in physics can German-speaking students aged 14 to 16 years be categorised, while **comparing classical and modern physics content areas** (namely mechanics and particle physics)?

Research Design

Online questionnaire in German language to assess

- **Interest in Mechanics**
  from IPN study (Häußler, Lehrke, & Hoffmann, 1998)
- **Interest in Particle Physics**
  modelled on IPN study (Zoechling, Hopf, Woithe, & Schmeling, 2022)

Questionnaire

Mechanics

How interested are you in doing the following?

	My interest in it is ...				
	very high	high	medium	low	very low
Getting insight into the artificial organs (e.g., heart as blood pump) and joints used in medicine today	○	○	○	○	○

Questionnaire

Particle Physics

How interested are you in doing the following?

	My interest in it is ...				
	very high	high	medium	low	very low
Getting insight into the workflow in a medical diagnostic centre	○	○	○	○	○

Research Design

- **Cross-cohort study:** German-speaking students aged 14-16 years (May - September 2021)
- **Sample size:** 1214 students
  - **Different German-speaking countries represented**
    Austria (N=798), Germany (N=233), and Switzerland (N=183)
  - **Both sexes equally represented**
    Girls (N=595), boys (N=529), prefer not to say (N=90)
- **Analysis method:** Mixed Rasch rating scale model

Results

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Mechanics

- **100% of the students** have **similar interests** regardless of their degree of interest!

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Particle Physics

- **79% of the students** have **similar interests** regardless of their degree of interest!

- **21% of the students** have **similar interests** and are **highly interested in Particle Physics!**

Discussion and Implications for Practice

Discussion

Physics? Only in the **right contexts**!

Mechanics

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Physik!!!

Discussion

Physics? Only in the **right contexts**!

Mechanics

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Particle Physics

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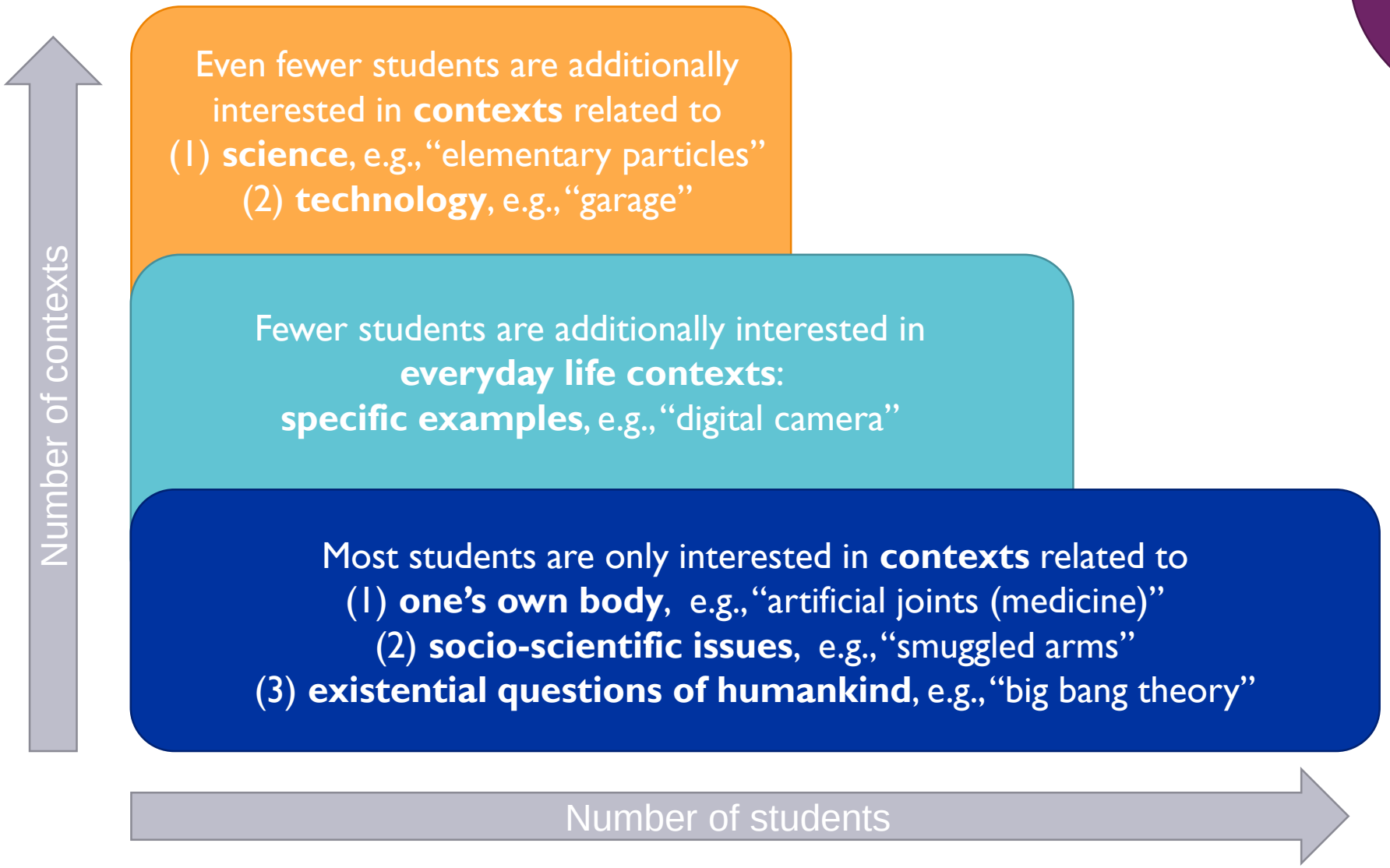
Physik!!!

Conceptualisation of Interest in Physics

Physics?
Only in the **right contexts**!



Implications for Practice

Educators trying to address the students' interest can match the **design of their learning activities** with the **conceptualisation of interest**.

Most students can be categorised into **one single type of interest in physics**

Thank you very much for your attention!

Looking forward to your comments and questions!

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References

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9. Student group photo created by lookstudio - www.freepik.com

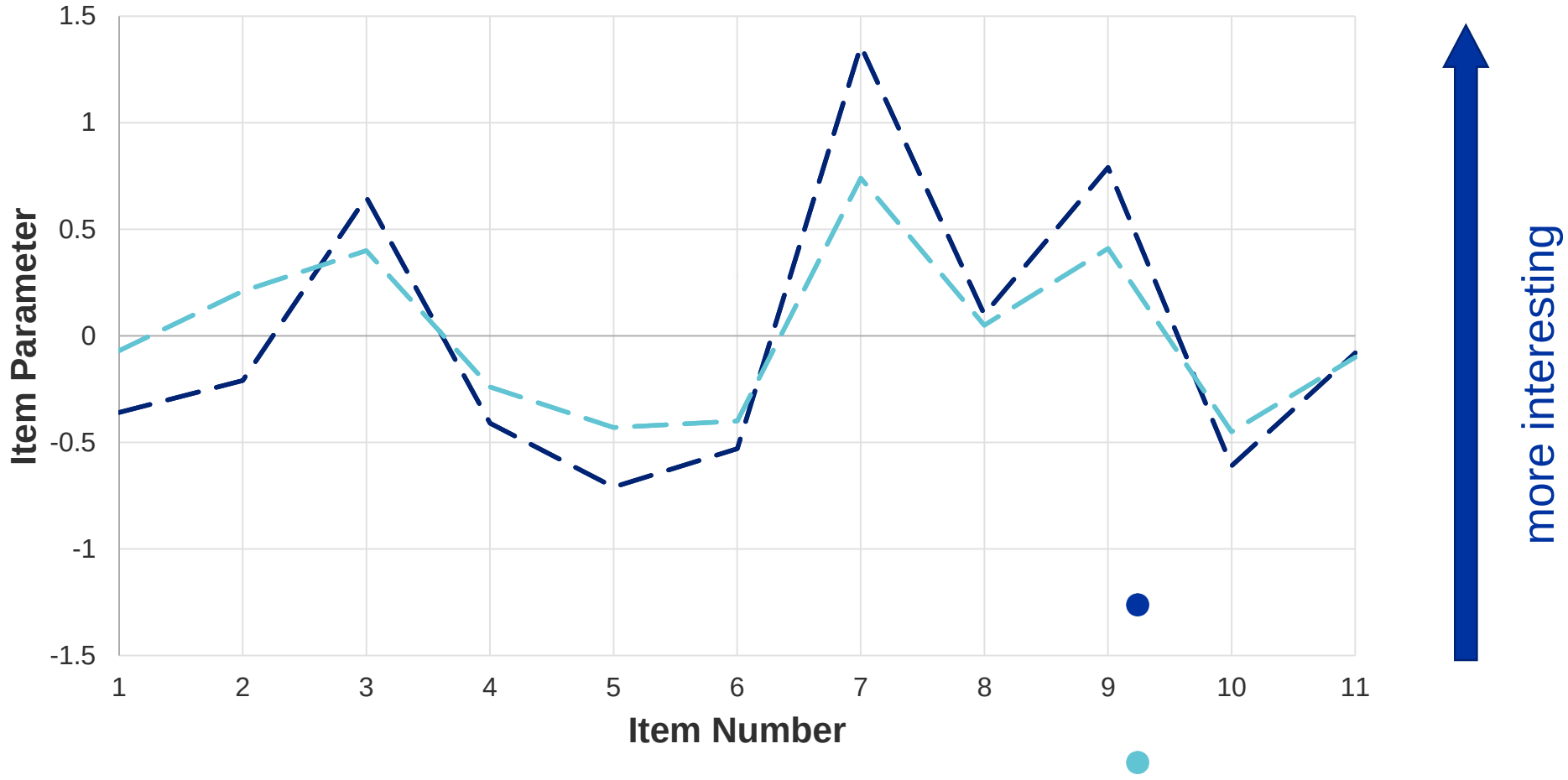
Back-up Slides

Results

Students' Interest in Mechanics

- Model of **two latent groups** describes the data the best
  - **Group 1_M:** 49% of the sample
  - **Group 2_M:** 51% of the sample
- **Different mean interest** (Group 1_M > Group 2_M)
- **Similar interest profiles**

Mechanics Interest Profiles



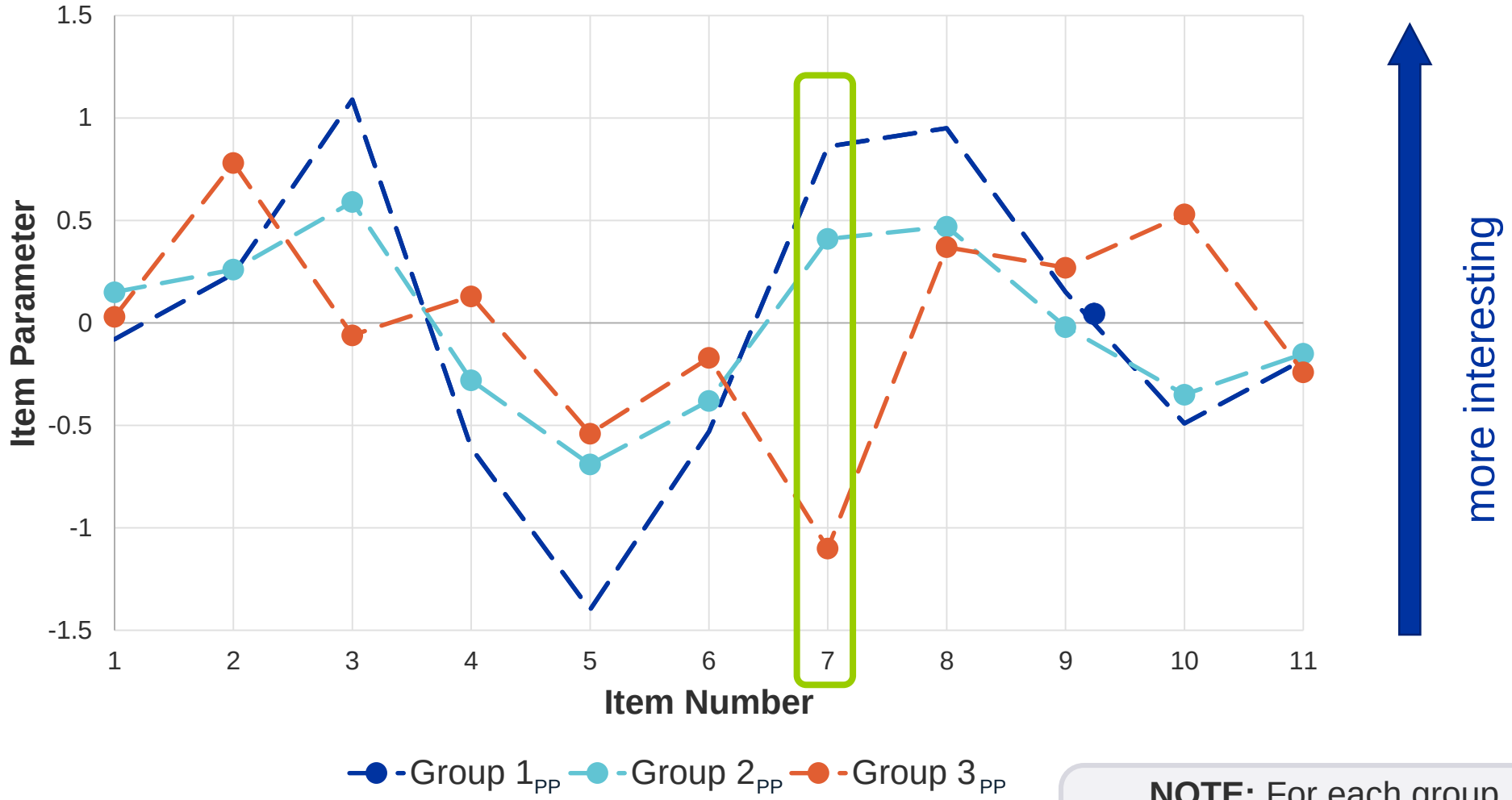
NOTE: For each group, the **item parameter means** are **normalised to 0** in Rasch analysis.

Results

Students' Interest in Particle Physics

- Model of **three latent groups** describes the data the best
  - **Group 1_{PP}:** 45% of the sample
  - **Group 2_{PP}:** 34% of the sample
  - **Group 3_{PP}:** 21% of the sample
- **Different mean interest:** (Group 3_{PP} > Group 1_{PP} > Group 2_{PP})

Particle Physics Interest Profiles



NOTE: For each group, the **item parameter means** are **normalised to 0** in Rasch analysis.

Results

Students' Interest in Particle Physics

- **Interest profiles of Group 1_{PP} and 2_{PP} are similar!** (79% of the sample)
- **Different interest profile of Group 3_{PP},** which has the **highest mean interest in particle physics!** (21% of the sample)

IPN Interest Study

- **Germany**
- **Cross-sectional** and **longitudinal study**
  - **Longitudinal**: 51 classes participated annually (**1984 – 1989, 5th - 10th grade**)
  - **Cross-sectional:** 24 classes each participated once (**1984, 5th - 10th grade**)
  - **Cohort:** 24 classes (**9th grade**) participated once (**1984 – 1989**)

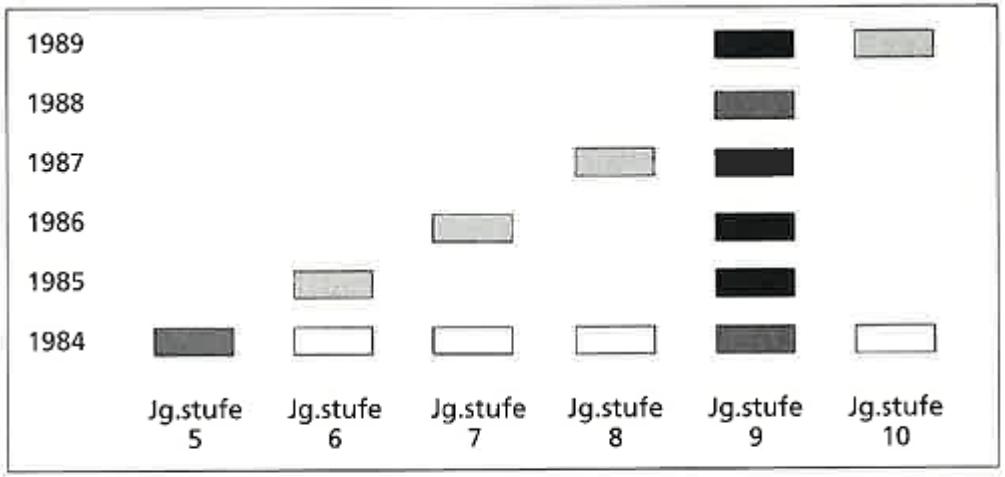


Abb. 3.1: Übersicht über den Erhebungsplan. Die treppenförmig ansteigenden Kästchen stellen den Längsschnitt, die Kästchen in der unteren Zeile den Querschnitt und die dunklen Kästchen über der 9. Jahrgangsstufe den Kohortenquerschnitt dar.

(Häußler, Lehrke, & Hoffmann, 1998)

Examplary Item Categories

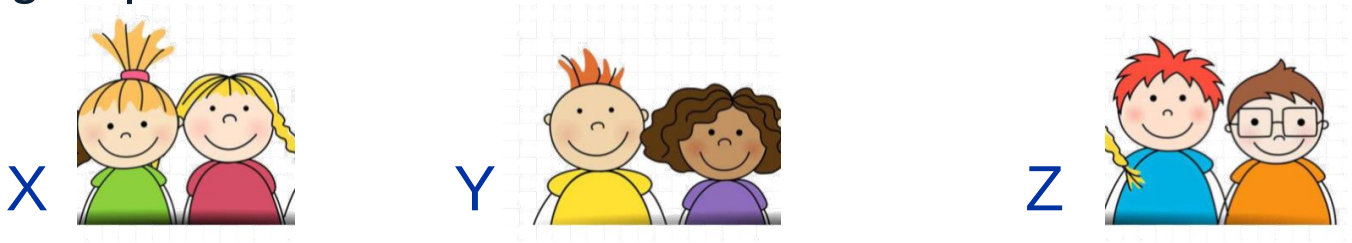
Item category	Exemplary item
Learning more about the function principle of technical devices	Learning more about how a particle accelerator works
Learning more about qualitative physics	Learning more about which interaction binds together the elementary particles in the nucleus space
Constructing technical devices	Building a particle detector out of daily life objects

Analysis of the Main Study

Mixed Rasch Analysis:

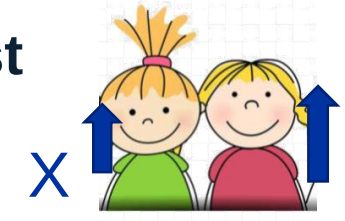
1. *Latent class analysis:* latent, "**qualitative"** person variable, according to which persons are sorted into groups

   ⇨ **Type of interest**



2. *Rasch analysis:* individual **quantitative** parameter within each class

   ⇨ **Degree of interest**



Research Interest

RQ: To what extent is **physics-related self-concept** a better clustering variable than gender for distinguishing between different types of interest in mechanics and in particle physics?

Hypothesis: **When using self-concept instead of gender** as clustering variable, the **interest types** are **described better.**

Research Design

Linear regression analysis for the Mechanics and Particle Physics groups using different **student characteristics**

- **Dependent Variable:** Interest *(Rasch person parameter)*
- **Independent Variables:**
  - Interest group assignment *(factor)*
  - Sex *(factor)*
  - Physics-related self-concept *(Rasch person parameter)*
  - Self-reported experience in school *(Rasch person parameter)*

Results of Linear Regression Analysis

Students' Interest in Mechanics

		Group 1	Group 2
Mean interest		0.69	0.02
Mean self-reported experience in school		-0.27	-0.24
Mean self-concept		-0.35	-0.73
Sex	female (Count, %)	323 (52.8%)	272 (45.2%)
	male (Count, %)	255 (41.7%)	274 (45.5%)
	no-answer (Count, %)	34 (5.6%)	56 (9.3%)

Results of Linear Regression Analysis

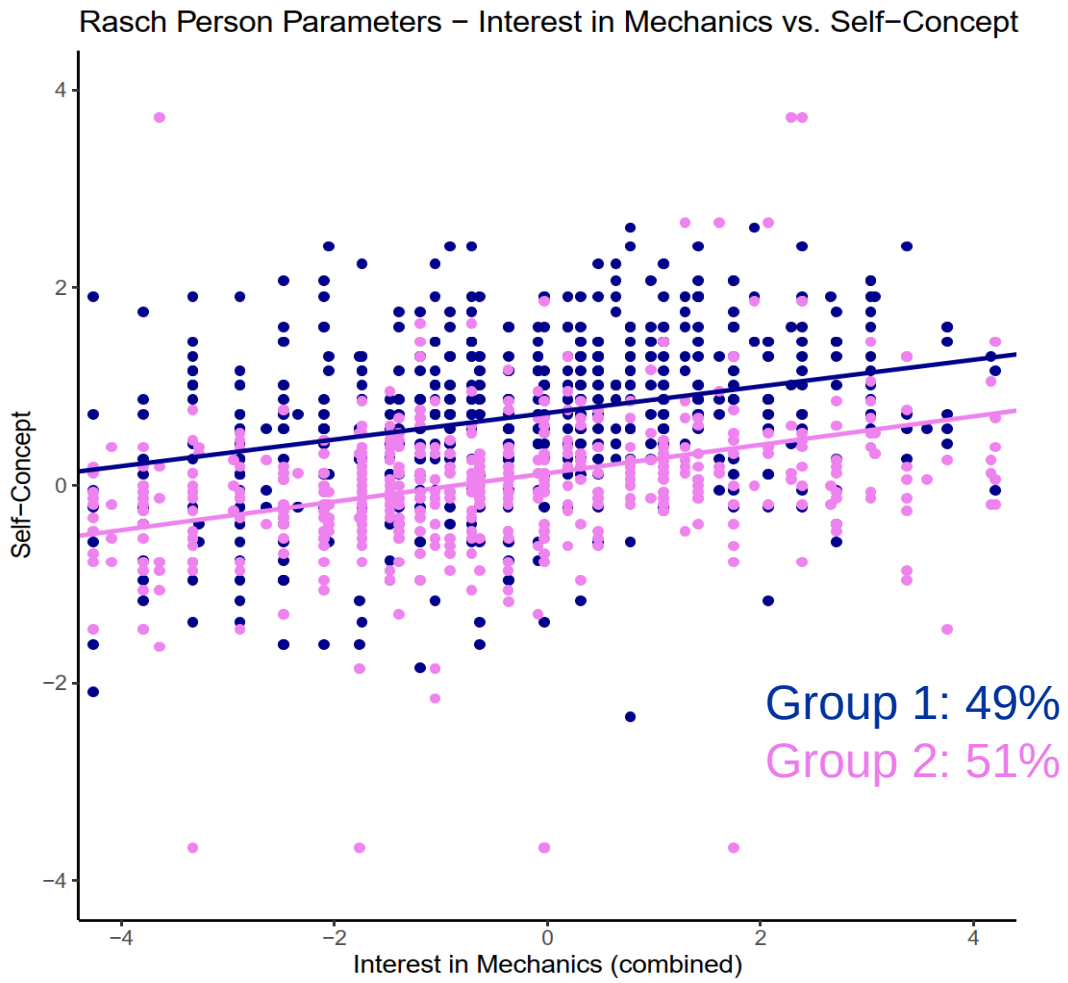
Students' Interest in Mechanics

Variable	Model 1	Model 2	Model 3	Model 4
Self-concept	0.12*** (0.02)	0.11*** (0.03)	0.14*** (0.01)	x
Mechanics Class Assignment (Factor)	-0.64*** (0.05)	-0.54*** (0.07)	-0.61*** (0.05)	-0.83*** (0.07)
Sex (Factor)	x	**Significant:** 1&2 (females and males): 0.17* (0.07)	x	Not significant
Self-reported experience	Not significant	Not significant	x	x
Interaction	**Significant:** Class 1&2 INT SRE: 0.14** (0.02) Class 1&2 INT SRE INT SC: 0.06** (0.02)	**Significant:** Class 1&2 INT SRE: 0.15* (0.07) Class 1&2 INT sex 1&2 (females and males): 0.21* (0.10) SE INT SRE INT sex 2&3 (males and no-answer): -0.19* (0.09)	N	**Significant:** Class 1&2 INT sex 1&2 (females and males): 0.33 (0.11)**
Adjusted R^2 values	0.31***	0.31***	0.26***	0.13***
Summary	**M2 group & SC & SRE**	**M2 group & SC & SRE & sex**	**SC & M2 group**	**Sex & M2 group**

Results of Linear Regression Analysis

Students' Self-Concept and Interest in Mechanics

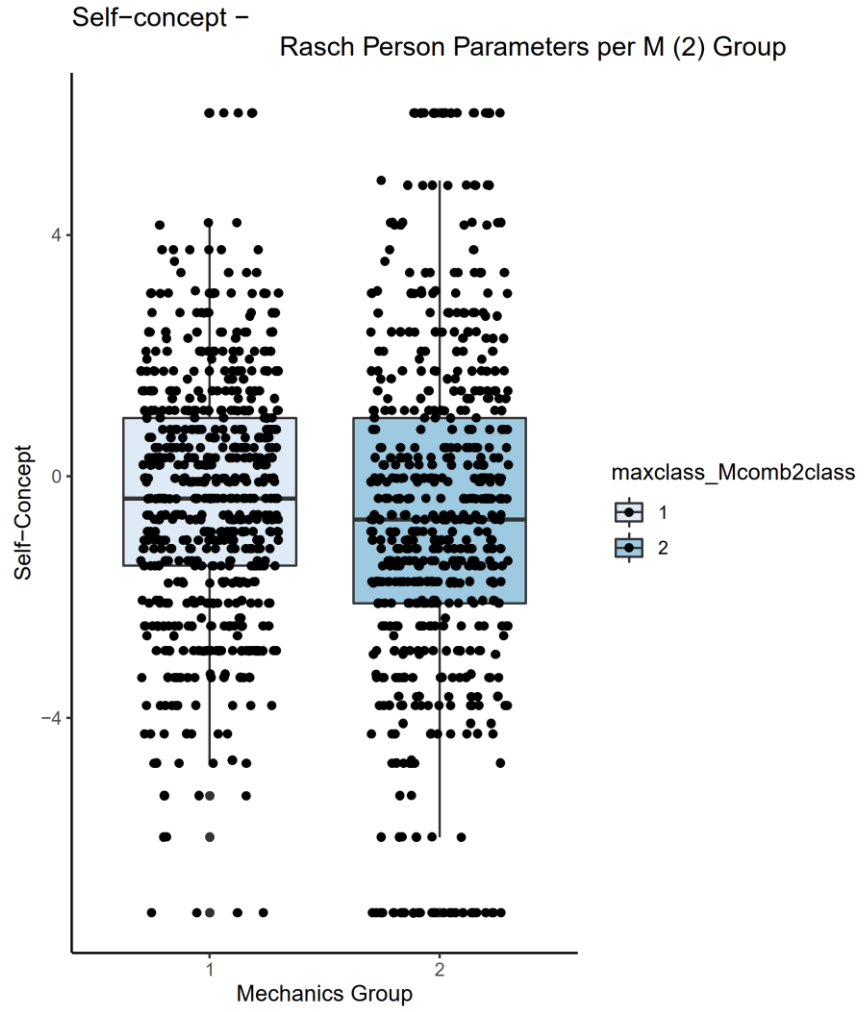
Variable	Model 3
Self-concept	0.14*** (0.01)
Mechanics Class Assignment (Factor)	-0.61*** (0.05)
Sex (Factor)	x
Self-reported experience	x
Interaction	N
R^2 values (adjusted)	0.26***
Summary	**SC & M2 group**



Results of Linear Regression Analysis

Students' Self-Concept and Interest in Mechanics

Variable	Model 3
Self-concept	0.14*** (0.01)
Mechanics Class Assignment (Factor)	-0.61*** (0.05)
Sex (Factor)	x
Self-reported experience	x
Interaction	N
R^2 values (adjusted)	0.26***
Summary	**SC & M2 group**



Discussion of Linear Regression Analysis

Students' Interest in Mechanics

- **Dependent Variable:** Mechanics interest *(Rasch person parameter)*
- **Independent Variables:**
  - Interest group assignment *(factor)* ✓
    ➔ Not surprising because interest is scaled per group
  - Sex *(factor)* ✘
    ➔ Evidence for hypothesis
  - Physics-related self-concept *(Rasch person parameter)* ✓
    ➔ Evidence for hypothesis
  - Self-reported experience in school *(Rasch person parameter)* ~
    ➔ Significant in interaction with group, and group and self-concept

Discussion of Linear Regression Analysis

Students' Interest in Mechanics

Mechanics interest is best described with a linear regression model comprising

- Interest group assignment,
- Physics-related self-concept, and
- Self-reported experience in school

Self-reported experience may be omitted

Research Interest

RQ: To what extent is **physics-related self-concept** a better clustering variable than gender for distinguishing between different types of interest in mechanics and in particle physics?

Hypothesis: **When using self-concept instead of gender** as clustering variable, the **interest types** are **described better.**

➔ **YES:** for **types of interest in mechanics**

Results of Linear Regression Analysis

Students' Interest in Particle Physics

		Group 1	Group 2	Group 3
Mean interest		0.62	-0.37	1.86
Mean self-reported experience in school		0.36	-0.36	1.02
Mean self-concept		-0.60	-1.38	0.89
Sex	female (Count, %)	324 (57.0%)	202 (51.9%)	69 (26.8%)
	male (Count, %)	213 (37.5%)	145 (37.3%)	171 (66.5%)
	no-answer (Count, %)	31 (5.5%)	42 (10.8%)	17 (6.6%)

Results of Linear Regression Analysis

Students' Interest in Particle Physics

Variable	Model a	Model b	Model c	Model d
Self-concept	**x**	0.04*** (0.01)	**x**	**x**
Mechanics Class Assignment (Factor)	1&2: --0.21*** (0.02) 1&3: 0.44*** (0.03) 2&3: 0.65*** (0.03)	**x**	**x**	**x**
Sex (Factor)	**x**	**x**	**Significant:** 1&2 (females and males): 0.12*** (0.03)	**x**
Self-reported experience	1.45**8 (0.02)	1.14*** (0.01)	1.13*** (0.02)	1.18*** (0.01)
Interaction	**Significant:** 1&2 INT SRE: -0.73*** (0.02) 1&3 INT SRE: -0.17*** (0.03) 2&3 INT SRE: -0.57*** (0.02)	**Significant:** 0.03*** (0.00)	**Significant:** Sex 1&2 (females and males) INT SRE: 0.11*** (0.03) Sex 1&3 (females and no-answer) INT SRE: -0.11** (0.04) Sex 2&3 (males and no-answer) INT SRE: -0.22*** (0.04)	x
Adjusted R^2 values	0.95***	0.88***	0.87***	0.87***
Summary	**PP group & SRE**	**SC & SRE**	**Sex & SRE**	**SRE**

Results of Linear Regression Analysis

Students' Interest in Particle Physics

- **Dependent Variable:** Particle Physics interest *(Rasch person parameter)*
- **Independent Variables:**
  - Interest group assignment *(factor)* ✓
  - Sex *(factor)* ~
  - Physics-related self-concept *(Rasch person parameter)* ~
  - Self-reported experience in school *(Rasch person parameter)* ✓

Discussion of Linear Regression Analysis

Students' Interest in Particle Physics

- **Dependent Variable:** Particle Physics interest *(Rasch person parameter)*
- **Independent Variables:**
  - Interest group assignment *(factor)* ✓
    ➔ Not surprising because interest is scaled per group
  - Sex *(factor)* ~
    ➔ Difference between females and males in group 3
  - Physics-related self-concept *(Rasch person parameter)* ~
    ➔ No evidence for hypothesis
  - Self-reported experience in school *(Rasch person parameter)* ✓
    ➔ Surprising

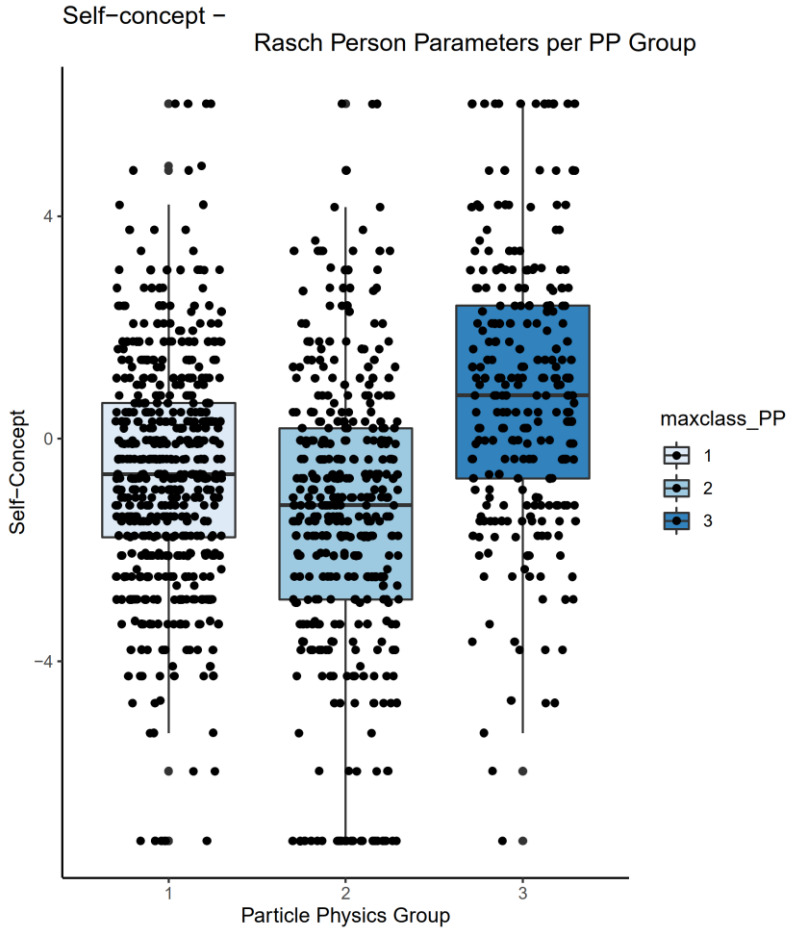
Results of Linear Regression Analysis

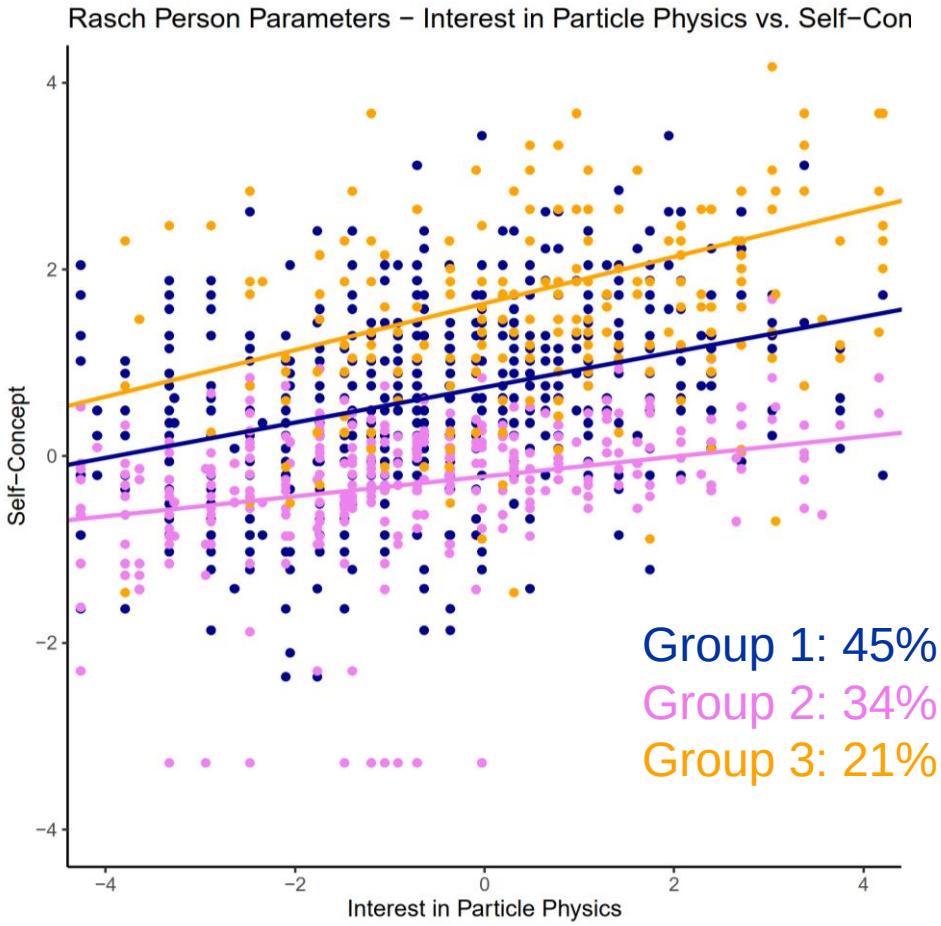
Students' Interest in Particle Physics

Variable	Model e	Model f
Self-concept	0.19*** (0.02)	**x**
Mechanics Class Assignment (Factor)	1&2: -0.96*** (0.07) 1&3: 0.90*** (0.08) 2&3: 1.85*** (0.09)	1&2: -0.97*** (0.09) 1&3: 0.89*** (0.14) 2&3: 2.33*** (0.12)
Sex (Factor)	**x**	**Not significant**
Self-reported experience	**x**	**x**
Interaction	**Significant:** SC INT 1&2: -0.08** (0.03) SC INT 2&3: -0.14*** (0.03)	**Significant:** Class 1&3 INT sex 1&2 (females and males): **0.43* (0.18)**
Adjusted R^2 values	0.46***	0.36***
Summary	**PP group & SC**	**PP group & sex**

Self-Concept and Interest

Students' Interest in Particle Physics





Research Interest

RQ: To what extent is **physics-related self-concept** a better clustering variable than gender for distinguishing between different types of interest in mechanics and in particle physics?

Hypothesis: **When using self-concept instead of gender** as clustering variable, the **interest types** are **described better.**

➔ **YES:** for **types of interest in particle physics**

➔ **BUT:** surprising importance of the self-reported experience

Research Interest

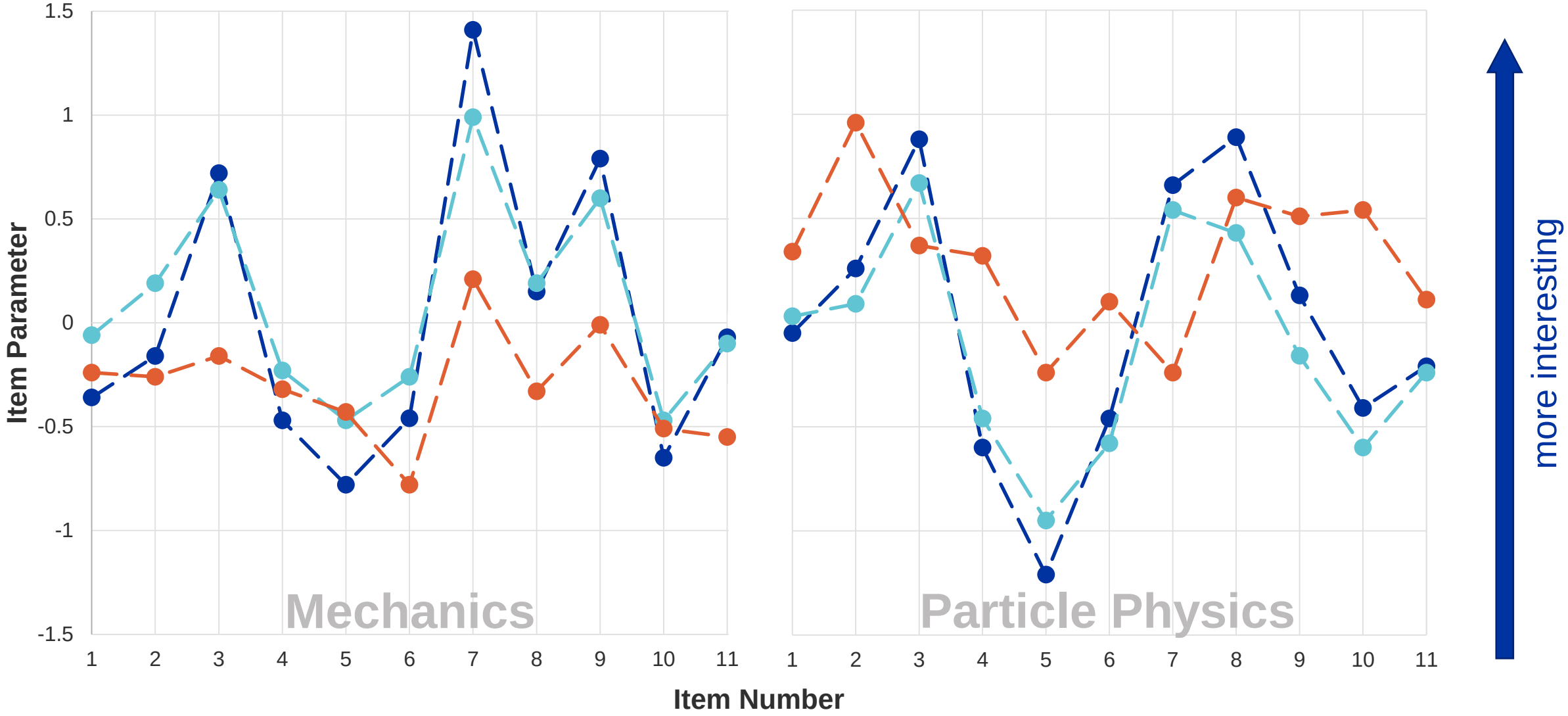
RQ: Which **physics content area** is overall more interesting, Particle Physics or Mechanics?

Hypothesis: **Particle Physics** is **more interesting** for high-school students **than Mechanics.**

Research Design

- **Combined analysis of Mechanics and Particle Physics items**
- **Analysis method:**
  - Mixed Rasch rating scale model
  - Based on 22 Items

Interest Profiles



Combined Rasch Analysis

	Rasch Analysis based on	Mean Item Parameters			
		Group 1	Group 2	Group 3	Mean
Mechanics	22 items	0	0.1	-0.3	**-0.1**
Particle Physics	22 items	0	-0.1	0.3	**0.1**
M+PP	22 items	0	0	0	**0**

Results of Combined Analysis

Students' Interest in Mechanics and Particle Physics

- **Different mean item parameters for the different groups**
  - **Group 1:** M and PP same mean item parameters
  - **Group 2:** M higher mean item parameter than PP
  - **Group 3:** M lower mean item parameter than PP
- **PP higher mean item parameter than M**

Discussion

Interestingness of Mechanics and Particle Physics

Overall, **Particle Physics** items were **more interesting** than Mechanics items

- **Group 3** (24% of the sample)**:** relatively highly interesting Particle Physics items
- **Group 1 and 2** (76% of the sample)**:** Mechanics items are similarly or slightly more interesting

Discussion

Students' Interest in Mechanics and Particle Physics

- **Group 1** is **more interested than Group 2**
- **Group 3** has the **highest interest**
  - **Combined analysis:**
    24% of the sample
  - **Separate analysis for Particle Physics:**
    21% of the sample

Research Interest

RQ: Which **physics content area** is overall more interesting, Particle Physics or Mechanics?

Hypothesis: **Particle Physics** is **more interesting** for high-school students **than Mechanics.**

➔ **YES:** for **group 3** students, that is, the highly interested students

➔ **NO:** for **group 1 and 2** students (76% of the sample)

Reminder: Group 3

Students' Interest in Particle Physics

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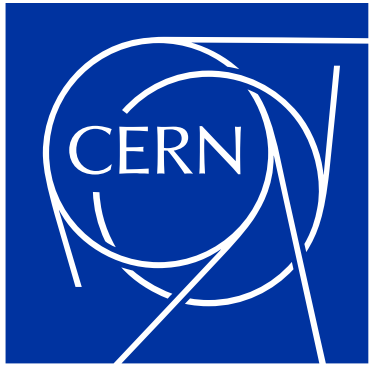

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